SFG1259 REV

World Bank Loan Project
China: Zhuzhou Brownfield Remediation Project (Qingshuitang Area)

Environmental Impact Assessment Report (EIA)

Constructed by: Zhuzhou Recycling Economy Investment and Development Co., Ltd (ZREIDC)
Assessed by: Nanjing Guohuan Environmental Technology and Development Co., Ltd
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Preface

1. Project Background

Zhuzhou Qingshuitang Industrial Zone (QIZ) is a key and old industrial base invested and built by the state in the 1950s, with leading industries of lead-zinc smelting and heavy chemical industry. Over 60 years' development of metallurgical and chemical industry has turned Qingshuitang Industrial Zone into a brownfield contaminated by heavy-metals. Pollution remediation of Qingshuitang Industrial Zone has become an urgent need for protecting the local people's livelihood and the Xiang River.

During the NPC & CPPCC meetings in 2011, the State Council approved the *Implementation Plan for the Heavy-metal Pollution Remediation in Xiang River Basin*, and listed Qingshuitang Industrial Zone as an advance pilot area for Heavy-metal pollution remediation. The government of Zhuzhou City has paid much attention to the pollution remediation of Qingshuitang Industrial Zone, and has founded the ZREIDC (ZREIDC) in 2009 to specialize in the environment management and re-development of Qingshuitang Industrial Zone. Several small scale remediation projects have been carried out in the QIZ.

2. Project Contents

The implementation area of the project is in the Qingshuitang Industrial Zone, Shifeng District, Zhuzhou City, Hunan Province. It is adjacent to Xiangtian Road in the east and a Beijing-Guangzhou High-speed Railway viaduct in the west, and is close to Zhuzhou Smelter Group Company Limited in the north and faces Xiang River in the south. The total area is 8.48km^2.

Environmental site investigation and risk assessment was conducted during 2011-2014, based on which the project feasibility study has further analyzed the risk assessment results and developed remediation strategy. The project area was categorized into three parts: risk acceptable area, risk controllable area, and remediation area.

- The risk acceptable area: identified as risk acceptable areas in the risk assessment reports, with a size of 2.02km^2.
- The risk controllable area: the residential areas with concrete pavement, the current producing companies, completed remediation areas (Xiawangang Heavy-metal Contamination Remediation Project, Dahu Heavy-metal Contamination Remediation Project; Remediation of Xinqiao waste pile, North waste pile and Dahu waste pile). The size of risk controllable area is 3.73km^2.

The total size of risk acceptable area and risk controllable area is 5.73km^2.

- Remediation area: Identified as risk unacceptable areas in the risk assessment report and not included in the risk controllable area. The size of remediation area is 2.73km^2. The remediation area is the target area of pollution remediation of the project, where activities will be conducted in four aspects:

(1) Soil surface cleaning and polluted site treatment and remediation:

a). Land clearance: The area of soil surface to be cleared is 2.30km^2; the volume of buildings to be demolished is 45,843m^3.

6 closed industrial facilities: Zhuzhou Yongfa Metal Refining Co., Ltd., Zhuzhou Brothers Industry Co., Ltd., Zhuzhou Kangli Smelting Plant, Zhuzhou Tiancheng Chemical Co., Ltd., Zhuzhou Xinda Smelting Co., Ltd., and Zhuzhou Hehua Cement Plant. The area of buildings to be demolished is 9,546.8m^2, the volume of construction debris is 6,532.0m^3, and the area of buildings to be cleaned is 7,710.8m^2.

Residential area to be cleaned: 94 households are required to be relocated, with 372 residents affected mainly ine, Yingfeng Community, Qingxia Community and Jianshe Village. The area of buildings to be demolished is 21,993m^2, and the volume of construction debris is 39,310m^3.

b). Soils exchange: Replace the uncovered soil in the contiguous residential areas in the Xiangshiling area, Qingshi area and Tongtanwan area and around the relocated facilities. The size of soil-replacement area in non-remediation area is about 110,855m^2, and the depth of soil to be replaced is 0.5m. The volume of clean soil to be filled is 55,427.5m^3.

c). Soil treatment of polluted sites

Treatment of site contaminated by heavy metals: refer to relevant specifications in China and the framework of Superfund experiences of US Environmental Protection Agency (USEPA) to determine the treatment method in this project:

- ex-situ stabilization and solidification (S/S): 0.47km^2
- transporting to planned non-sensitive land (landfill as backup): 0.62km^2
- in-situ stabilization + capping: 0.74km^2
- in-situ stabilization + vegetation covers: 0.13km^2
- in-situ phytoremeidation: 0.23km^2
- Bio-interception: apply to 0.10 km^2

For the 6 closed plants to be handled under the project, the total remediation area is 0.13km^2. Heavy metal contaminated soils will be excavated and moved to the project S/S facility for treament. The total volume is 74313m^3.

Treatment of soil subject to organic pollution: The soil subject to organic pollution is in the plant of Zhuzhou Tiancheng Chemical Co., Ltd., with an area of 8,274m^2; the volume of polluted soil is 16,548m^3, which will be transported to Sinoma Zhuzhou Cement Co., Ltd. for incineration.

d). Treatment of waste piles: the waste residue in the project area is distributed in Tongxia area, Hongxin Plant, and sporadic residues along the low discharge channel, with total volume of 84,700m^3, which will be transported to the stabilization/solidification operation site for treatment and will then to the solid waste landfill for filling after treatment.

e). Treatment of sediments in ponds and eclogical restoration along Old Xiawanggang Channel: the total area of the 26 ponds to be treated is 0.17km^2, with total water volume of 259,500m^3 and total volume of polluted sediment of 173,000m^3; The polluted sediment will be transported to the stabilization/solidification operation site for treatment after dewatering. Elogical restoration of 54279m^2 along the Old Xiawanggang Channel.

(2) Construction of treament/disposal works

- To modify existing Xinqiao solid waste facility to a stabilization and solidification facility: land area: 4000m^3, daily treatment capacity: 400m^3/d;
- To rent existing Xiwangang dewatering plant: land area: 5,500m^2, including dewatering field of 4000m^2 and temporary storing yard of 1,500m^2;
- Newly built Dewatering plant (i.e. Xinqiao dewatering site:) land area: about 4,200m^2, including dewatering field of 4,000m^2 and temporary storing yard for sediment of 200m^2;
- Newly built temporary storing field: build a temporary storing field beside the stabilization and solidification operation site with an area of 10,000m^2, the volume of temporarily stored demolition wastes and treated residues is 150,000m^3.
- Newly built temporary road: The main transportation roads of the project are existingTongxia Road, Qingxia Road, the old Tongxia Road, and the Huanbao Avenue which is under construction, and the other village roads are auxiliary transportation roads. By using the existing road, the project is planned to renovate the village roads and build some temporary roads for the purpose of earth transportation. The length of village roads to be renovated is 13,832m, and the length of temporary roads to be built is 1,802m.

(3) Building new solid waste landfill

The project is planned to build a landfill using the abandoned quarry of Zhuzhou Hehua Cement Plant, which has a land area of about 36,265m^2 and the usable volume of the mine is 200,000,000m^3.

(4) Building a new Environmental Information and Demonstration Center: To maximize the demonstration impact of the project, an environmental demonstration center will be established, which will not only serve as an environmental education platform for the public to review the pollution history, display remediation achievements and anticipate the future development of environmental protection; but also a monitoring data center to provide support for environmental management and green development. The center will also provide information on area's redevelopment plans and serve as a center for the affected to file their complaints. Specific activities include a management building with a construction area of 820m2; an environmental protection exhibition center with construction area of 7,150m2, and an experiment/demonstration base with an area of 40,000m^2.

（5）**Studies**

（1）Study on Qingshuitang Brownfield Remediation and Strategic Planning：(i) recommendations for filling the potential gaps between the remediation results and future land use/urban development strategic planning, through defining remedial remediation targets or refining the strategic planning; (ii) a strategic environmental and social impact assessment for the remediation and redevelopment of Qingshuitang core zone that will address among other issues conversion of land use and its impacts on land value and beneficiaries; (iii) application of green remediation in the future remediation practices in Qingshuitang； (iv) policy recommendations for addressing policy, regulation, financing and market issues in the remediation and redevelopment.

（2）Study on the compliance framework for Qingshuitang environmental quality and industrial pollution control： (i) regional groundwater monitoring and modelling; (ii) monitoring of industrial emissions, secondary pollution analysis and data analysis for environmental management.

The total investment of the project is initially planned to be 242 million US dollars, including 150 million US dollars of World Bank loan. The implementation period of the project is from October, 2015 to December, 2022.

3. EA preparation

According to the *Law of the People's Republic of China on Environmental Impact Assessment, Regulations on the Administration of Construction Project Environmental Protection, Notice on Strengthening Environmental Impact Assessment Management of Construction Project Supported by International Financial Organizations*, and the Safeguard Policies of World Bank, as well as the domestic and the World Bank's environmental impact assessment procedures, we have reviewed the positive environmental impacts caused by this project, we have identified, screened, predicted and analyzed the possible negative environmental impacts, and we have proposed specific effective mitigation measures and environmental management plan for the main inevitable negative environmental impacts, so as to provide basis for the independent assessment on the project of World Bank as well as for the decision-making and management of the government and environmental management department.

According to the relevant provisions of the *Law of the People's Republic of China on Environmental Impact Assessment* and the No. 253 State Council Order, an Environmental Impact Assessment Report is required for this project. According to the Notice on Strengthening Environmental Impact Assessment Management of Construction Project Supported by International Financial Organizations, the classification principles for environmental impact assessment specified in OP4.01 of World Bank and the identification of the project type in the activity memo of January 2014 of the Project Identification Mission of World Bank, the project is identified as Type A project. ZREIDC has entrusted Nanjing Guohuan Environmental Technology and Development Co., Ltd to carry out the environmental impact assessment of this project.

Nanjing Guohuan Environmental Technology and Development Co., Ltd is transformed as a whole from the formal "Environmental Impact Assessment and Science and technology Consultation Center" of Nanjing Institute of Environmental Sciences of the Ministry of Environmental Protection. As one of the first institutions that provide environmental impact assessment for construction project, it has Class-A qualification for environmental impact assessment. In addition to environmental impact assessment and consultation service, the company also engages in some scientific research into laws and regulations, standards, policies and technical guidelines in regard to consultation, and it participates in national science projects and research of key research subjects in related fields and provides technical support for the Ministry of Environmental Protection and environmental protection administration departments at all levels.

After accepting the entrustment, the assessment organization established a project group, collected and sorted out related materials, surveyed the environmental conditions of the proposed site of the project and the surrounding areas, made preliminary analysis on the construction type, contents, scale, main pollution factors and possible environmental impacts of the project, and composed the *Environmental Impact Assessment Outline of the World Bank-China Proposed Zhuzhou Brownfield Remediation Project* (TOR) in accordance with the environmental impact assessment technical guidelines in China and the specifications on environmental impact assessment in the safeguard policies of World Bank, in order to guide the preparation of *Environmental Impact Assessment Report of the World Bank-China Proposed Zhuzhou Brownfield Remediation Project* (EIA) and the environmental impact assessment.

From June 2014 to July 2015, World Bank task team provided review and comments to the *Environmental Impact Assessment Report* (Initial Draft) (EIA), the project group supplemented and revised the *Environmental Impact Assessment Report* (Initial Draft) according to the suggestions of the environmental experts of World Bank and made the *Environmental Impact Assessment Report* (Draft for Review) (EIA).

The Environmental Impact Assessment Report (EIA) of this project is the comprehensive analysis and assessment of the project in accordance with the environmental impact assessment technical guidelines in China and the specifications on environmental impact assessment in the safeguard policies of World Bank, and focuses on the following issues:

1) The engineering characteristics of the project and the main possible environmental issues;

2) The positive environmental effects and negative environmental impacts that may arise from the implementation of the project;

3) Assessment on the accumulated environmental impacts on the region;

4) Countermeasures to mitigate the possible negative impacts of the project;

5) Alternative plan analysis;

6) Environment Management Plan (EMP)

In addition to the Environmental Impact Assessment Report, this project has another 3 reports:

(A) Environmental Assessment Report Executive Summary – EA Executive Summary: abbreviated from Environmental Impact Assessment Report (EIA), composed by Nanjing Guohuan Environmental Technology and Development Co., Ltd

(B) Environmental and Social Management Framework:

The ESMF is needed due to the following considerations:

- In the 8.48km^2 project area, there are still industrial facilities in operation. Per domestic regulations, any closure of industrial facilities is subject to site investigation and remediation as necessary;

- There are around 5.75km^2 land plots in the project area have been considered risk acceptable or risk controllable. Nevertheless, risk assessment is based on planned land use which may change. If, for example, a planned industrial land plot is changed to residential use, its risk to human health may become unacceptable and further remediation effort is needed.
- Other remediation or development activities proposed by the ZREIDC, such as the Qingshui Lake Constructed Wetland. Some repaired sites of the project need to be backfilled with clean soil. This soil shall be got from the spoil of Tianyuan District, Zhuzhou City. However, implementation of the project will take 6 years and at the present, we are unable to identify the specific location of the clean soil and its source, and are unable to confirm if we need new a borrow site. For this part of the clean soil, whether it comes from the spoil area or the newly establised soil-taken field, need to meet the domestic laws and regulations, as well as the legal sampling procedures.

Since the specific locations of such potential remediation activity is not known during the project preparation, this ESMF will guide the ZREIDC on the environment and social screening and subsequent assessment of sub projects during implementation, including the relevant sub project-specific plans that have to be developed in compliance with the World Bank policies. Composed by Nanjing Guohuan Environmental Technology and Development Co., Ltd.

(C) *Environmental Management Plan*. *Environmental Management Plan* focuses on environmental impacts, mitigation measures, environmental monitoring plan, organization arrangement, capacity development and training, environmental protection investment estimation etc. It is composed by Nanjing Guohuan Environmental Technology and Development Co., Ltd

1 General

1.1 Objectives of assessment

This project aims to apply for World Bank loan to support the brownfield remediation project in Qingshuitang Industrial Zone, which will help to bring international know-how and best practices and funds to Zhuzhou city and to build a harmonious Zhuzhou.

Meanwhile, World Bank supported project is a carrier of foreign advanced technologies, operation methods and management methods. World Bank supported project is required to adopt competitive tendering and to focus on technical service and follow-up inspection, which helps to introduce advanced management techniques and equipment and to promote the routinization and contractualization of the management of project construction, and will further develop and accumulate experiences for the heavy-metal pollution remediation in the Xiang River basin and lay a good foundation for it.

The objectives of the assessment report are:

a). Conduct analysis and assessment of the current conditions of natural environment, socio-economy of the project area, determine the scope and degree of impacts assessment, and examine the design and execution of environmental protection plan of the project;

b). Assess the positive environmental impacts caused by the implementation of the project and identify, screen, predict and analyze the possible negative environmental impacts;

c). Put forward targeting effective mitigation measures for the main inevitable negative environmental impacts and formulate the environment management and monitoring plan (EMP).

1.2 Assessment factors

Assessment factors are shown in **Table 1.2-1**.

Table 1.2-1 Assessment factors

Type of environment	Assessment factors of current conditions	Assessment factors of impacts	Total quantity control factors
Air environment	TSP, PM_{10}, SO_2, NO_2, fluoride, Hg, Pb and its compounds, arsenide, Cr (6+), Mn and its compounds, TVOC, phenol, ammonia	TSP, ammonia, hydrogen sulfide	—
Water environment	pH, COD, SS, cyanide, ammonia nitrogen, TP, volatile phenols, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+} and Cu	COD, SS , ammonia nitrogen, Cd, Pb, As, Cr6+	—
Noise	Equivalent sound level	Equivalent sound level	—
Groundwater	total dissolved solids, total hardness, pH, ammonia nitrogen, Fe, sulfate, chloride, nitrate nitrogen, nitrite nitrogen, Cu, Zn, Pb, Se, Hg, Cd, Cr (6+), As, Mn, Co, Ni, Ba, Be	volatile phenols, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+}, Se, Be, Sb and Cu	—
Soil	pH, organic matter, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+}, Se, Be, Sb, Ti and Cu	Cd, Hg, Zn, Pb, As, Ni, Cr^{6+}, Se, Be, Sb, Ti and Cu	—
Solid waste	—	—	Total solid waste discharge

1.3Focus of assessment

According to the actual situation of the project, assessment of the project focuses on the following:

(1) Make clear the environmental function and main protection targets to determine assessment standards by investigation into the natural environment and social environment of the proposed construction site.

(2) Identify the pollution conditions of the region by investigation into the pollution sources and due diligence investigation into the industrial facilities in the region; Make clear the environmental quality of the surrounding areas by investigation and monitoring of the current conditions of air, water quality and ambient noise in the region;

(3) Make a detailed survey on the current state of soil pollution in the remediation project and make comprehensive assessment on the current state of pollution, heavy metal composition an so on;

(4) Find out the main pollution sources, main pollutants, emission concentration, emission methods, and emission rules in the project through project analysis. Analyze the effectiveness and feasibility of the treatment process, comprehensively demonstration the economic feasibility, resource reasonability, and environmental protection feasibility of the treatment plan, and put forward measures and suggestions to improve the treatment project;

(5) Analyze the effects of site remediation after the treatment project is completed and discuss on the environmental and social effects of the project; Propose conclusive suggestions for the project construction from the perspective of environmental protection and provide basis for decision-making of competent environmental protection departments;

The environmental impact assessment of this project focuses on project analysis and environmental protection measures.

1.4 Assessment of work levels

The environmental assessment level of the project is defined according to the provisions about classification of environmental assessment project in the Technical Guidelines for Environmental Impact Assessment.

1.4.1 Assessment level of surface water environment

The waste water during construction of the project include sanitary sewage, rainwater, waste water from washing vehicle and machine, waste water from washing buildings in the facilities demolition site which contains heavy metal, waste water from dredging of ponds, and dry ports, and water in the stone-pits at the landfill, which will be discharged for a short term during construction. The waste water during project operation include waste water from sediment dewatering, rain water at all operation sites, and sanitary sewage at the Environmental Information and Demonstration Center, the volume of which will be about 451 tons; the complexity level of water quality is medium level, and the various waste water will be discharged to Xiang River after pre-treatment and treatment by waste water treatment plant. The average flow of Xiang River for years is 1,780m^3/s, indicating that it is a large river. As required by the Technical Guidelines of Assessment for Impacts on Water Environment, the impact on surface water environment in the project is defined as Level III.

1.4.2 Assessment level of groundwater environment

This project is a new environment remediation project, and the classification of the project is shown in **Table 1.4-1**.

Table 1.4-1Classification of project

Project	Type	Standards	Conditions of project site	Classification
Classification of construction project	Type I	Construction project that may cause groundwater pollution after the construction, operation and maintenance period of the project	During the operation of the proposed project, the polluted soils and sediments in the solid waste temporary storing yard, and the leachate of solid waste landfill may affect groundwater quality, which is Type I project.	Type I
	Type II	Construction project that may cause changes to groundwater flow field or groundwater level and result in environmental and hydrogeological problems after the construction, operation and maintenance period of the project		
	Type III	Construction project that have environmental impact of both Type I project and Type II project		

According to *Technical Guide of Environmental Impact Assessment for Underground Water* (HJ610-2011), Classification of groundwater assessment of Type I construction project

The thickness of single-layer aeration zone in the project site is 1~13.45m≥1.0m; the main type of soil is clayey soil; permeability coefficient is 10^{-6}cm/s<K≤10^{-5}cm/s, showing poor permeability; the aquifers are mainly loose rock pore water aquifers and bedrock fissured aquifer, and the hydraulic connection between each aquifer is of ordinary level; there are no centralized groundwater supply sources or other groundwater reserves, nor scattered drinking water sources in the area; besides, the area is not in the supply runoff area of drinking water source; the volume of waste water discharge is 451m^3/d; in the waste water the number of pollutants≥2, and the predicted water quality index<6. According to the classification basis for assessment level of Type I construction project specified in the *Technical Guide of Environmental Impact Assessment for Underground Water* (HJ610-2011), the groundwater assessment is level III.

1.4.3 Assessment level of air environment impact

The waste gas during operation of the project mainly include dust produced in stirring and screening in stabilization, stench produced in sediment dewatering and stabilization and solidification (ammonia, hydrogen sulfide), and dust from landfill, which are all exhausted without control. The maximum ground concentration ratio Pi, and the longest distance D10% when the ground concentration of pollutant i reaches the standard limit 10% are calculated.

Pi is defined as:

$$P_i = \frac{C_i}{c_{0i}} \times 100\%$$

Where P_i--------The maximum ground concentration ratio of pollutant i, %;

C_i--------The maximum ground concentration of pollutant i calculated in estimation mode, mg/m^3;

C_{oi}--------The standard concentration specified in air environment quality standard of pollutant i, mg/m^3.

C_{oi} is generally the allowable concentration for single sampling in Class II standards in GB3095-2012.

The classification basis for air environment impact assessment are shown in **Table 1.4-2**.The calculated maximum ratio P_{max} is below 10% for all factors (as summarized in **Table 1.4-3**), therefore, the air environment impact assessment level of this project is defined to be Level III.

Table 1.4-2 Air environment impact assessment level

No.	Assessment level	Classification basis data
1	Level I	P_{max}≥80% and $D_{10\%}$≥5km
2	Level II	Other
3	Level III	P_{max}<10%,or $D_{10\%}$<shortest distance from pollution source to the plant

Table 1.4-3 Estimated P_{max} of each factor

Pollution source	Pollutant	Max. ground concentration (ug/m^3)	Max. concentration point (m)	Assessment standard (ug/m^3)	Ratio (%)	D10% (m)	Assessment level
Xinqiao S/S operation site	Ammonia	6.71	284	200	3.35	0	III
	Hydrogen sulfide	0.56	284	10	5.62	0	
	Dust	70.04	284	900	7.78	0	
Xinqiao dewatering site	Ammonia	4.38	285	200	2.19	0	
	Hydrogen sulfide	0.32	285	10	3.16	0	
Xiawangang dewatering site	Ammonia	3.32	320	200	1.66	0	
	Hydrogen sulfide	0.26	320	10	2.63	0	
Landfill	TSP	53.18	347	900	5.91	0	
All pollution sources	All pollutants	70.04	284	-	7.78	0	

1.4.4 Noise assessment level

The noises in the project are mainly produced by construction machines and transportation vehicles; after the project is completed, the noise level will not increase much. Therefore, the noise assessment level of the project is Level III.

1.4.5 Assessment level of ecological environment impact

The project is located in an industrial area and the land area of the project is 8.48km^2; the sensitivity of ecological environment is of ordinary level.

According to the *Technical Guide of Ecological Environmental Impact Assessment* (HJ19-2011), the assessment level of ecological environment impact of this project is Level III, as shown in **Table 1.4-4**.

Table 1.4-4Assessment level of ecological environment impact

Ecological sensitivity of affected area	Land (water) area of project		
	Area: ≥20km^2 Or length: ≥100km	Area: 2km^2~20km^2 Or length: 50km~100km	Area: ≤2km^2 Or length: ≤50km
Area with special ecological sensitivity	Level I	Level I	Level I
Area with important ecological sensitivity	Level I	Level II	Level III
Area with ordinary ecological sensitivity	Level II	Level III	Level III

1.5Main targets of environmental protection and pollution control

1.5.1 Targets of environmental protection

After field survey and investigation, in consideration of the environmental impacts of the project and the distribution of sensitive points in the assessment area, the distribution of environmental protection targets of this project is identified.

1.5.1.1 Targets of social environment protection

The targets of social environment protection include the socioeconomic development, land use, and the compliance of life quality of relocated and land-expropriated residents with the plan in the area.

1.5.1.2 Targets of ecological environment protection

The targets of ecological environment protection include the arable land outside the remediation area, vegetation in the project area, and water and soil conservation facilities and so on, as detailed in **Table 1.5-1**.

Table 1.5-1Targets of ecological environment protection in the surrounding areas of the project

No.	Sensitive target	Location	Main targets
1	Natural vegetation	Permanent occupied land and temporarily occupied land	Natural vegetation
2	Water and soil conservation	Surface excavation, temporary storing yard	Water and soil loss
3	Aquatic animals and plants	interception and dredging of ponds in the remediation area	Aquatic animals and plants in the ponds in the remediation area, not involving rare fishes and the "overwintering field, spawning field and feeding field" of fishes

1.5.1.3 Targets of surface water environment protection

Table 1.5-2Targets of surface water environment protection in the surrounding areas of the project

Sensitive place	**Relationship with the project area**	**Function**	**Targets of protection**	**Overview**
Xiang River	Close to the south of project area	mixed area, industrial and agricultural water, landscape water	The section of Xiang River from 1000m upstream the water intake of No. 2 water plant to 100m downstream the water intake of No. 3 water plant is the drinking water source protection zone, which is subject to Class II standards in GB3838-2002; the section from 100m downstream the water intake of No. 3 water plant to 2000m downstream Xiawangang is a mixed area, which is subject to Class V standard of the *Environment Quality Standard of Surface Water* (GB3838-2002); the left and middle shore area and the section from 2000m downstream Xiawangang to Majiahe are landscape and recreation water area, which is subject to Class III standard.	Xiang River is the main river in the project area which originates at Haiyang Mountain in Guangxi and is one of the main tributaries of Yangtze River. It flows from the south to the north through Hunan and affluxes into Yangtze River. The total length of the river is 856km. The Zhuzhou section of Xiang River is 500~800 meters wide and 2.5 ~ 3.5 meters deep, and the hydraulic gradient is 0.102 ‰. The average flow for years is 1,780 m^3/s.
New Xiawangang	Inside project area	/	Implement Class-V standards in GB3838-2002	New Xiwan Channel originates from the dry pond in the northwest of the urban area of Zhuzhou, and flows from the north to the south through Qinshuitang District and affluxes to Xiang River. The total length of the channel is 6km. It is the class-I tributary of Xiang River, with a basin area of about 11.8 square meters.
Old Xiawangang	Inside project area	/		The old Xianwan Channel is located in Shifeng District, northwest Zhuzhou. It originates at Xinjichong and branches into two streams at Pianshichang, one on the left and one on the right, and affluxes into the planned Qingshui Lake. The whole basin of Xiawangang is a dustpan-shaped area, where the ground is high on three sides and inclines to the west. There are many hills in the upper and middle reaches, while the lower reach is in the Hegu Plain of Xiang River basin. The original channel passes through the big fish pond in Jianshe Village. In the 1960s and 1970s it was transformed to the No. 1 branch and No. 2 branch of the current old Xiawangang. The channel is 3km

				long in total and has an average annual flow of less than 10 million cubic meters.
Xinqiao low discharge channel	Inside project area	/	Implement Class-Ⅳ standards in GB3838-2002	Xinqiao low discharge channel is located in the center of the Zhuzhou Qingshuitang Industrial Zone. It originates at Datangchong, flows through Xinwuwan and Caomen Wuchang, and affluxes into Xiang River. The basin of Xinqiao low discharge channel is high in the west and north and low in the east and south, and it is in the Hegu Plain of Xiang River basin. The channel is 8.70km long in total. The terrain along the channel is flat and inclines to the west. Water quality in the upper and middle reaches is good.

1.5.1.4 Targets of groundwater environment protection

Table 1.5-3Targets of groundwater environment protection

Type of protection	Target of protection	Location	Function	Basic conditions	Objective of protection
Groundwater environment	Groundwater in the assessment area	In the project area	/	/	Requirements for Type III groundwater

1.5.1.5 Targets of air environment protection

According to field survey, the targets of air environment protection of the project is shown in Table 1.5-4, the distribution of sensitive targets of environmental protection in the project area is shown in **Figure1.5-1**, and the distribution of sensitive targets of environmental protection outside the project area is shown in **Figure10.1-2**. Overview of Surrounding Environment within 500m from Xinqiao Solidification/Stabilization Ground 、 Xinqiao Dewatering site 、 Xiawan Dewatering site and Landfil are shown in Table 1.5-5 and **Figure1.5-2**～**Figure1.5-5**.

The project area is divided into seven sub-areas.

1.5.1.6 Targets of acoustic environment protection

According to field survey, the targets of acoustic environment protection are shown in Table 1.5-4 and **Figure1.5-1**.

1.5.2 Targets of pollution control

(1) Control and mitigate water and soil loss and the damage to vegetation of the project, and protect the ecological environment;

(2) Solve the social and economic impacts resulted from the project properly and ensure the environmental quality does not drop;

(3) Strengthen construction management and prevent the pollution of dusts from construction site to the air environment;

(4) Ensure the emission of all pollutants conforms to emission standards and prevent

noises. The treatment methods of all pollutants should meet the requirements of urban plan and environmental management.

Table 1.5-4Sensitive targets of air and acoustic environment protection

Content of protection	Targets of protection	Location	Fuction	Basic information	Objective of protection
Air environment	Xiawan New Village	Qingshui sub-area	Urban residential area	1115 households, 4300 persons	GB3095-2012 Ambient Air Quality Standard Class II
	Jianshe Village	Tongxia sub-area and outside the project area	Urban residential area	490 households, 1580 persons	
	Yingfeng Community	Tongxia sub-area and outside the project area	Urban residential area	486 households, 1980 persons	
	Qingxia Community	Tongxia sub-area and outside the project area	Urban residential area	518 households, 1680 persons	
	Qingshuitang Community	Qingshi sub-area	Urban residential area	2756 households, 6522 persons	
	Dingshan Community	Xiangshiling sub-area and outside the project area	Urban residential area	5465 persons	
	Zhushan Community	Qingshi sub-area and outside the project area	Urban residential area	586 households, 1974 persons	
	Tongtanwan Community	Qingshi sub-area	Urban residential area	2163 households, 7152 persons	
	Yanggulao Community	Outside project area, NE, 100m	Urban residential area	About 2200 households, 7030 persons	
	Tianxin Subdistrict	Outside project area, NE, 500m	Urban residential area	About 2500 households, 7921 persons	
	Xinjian Village Community	Outside project area, NE, 500m	Urban residential area	About 2100 households, 6895 persons	
Acoustic environment	Xiawan New Village	Inside remediation area (Qingshui)	Urban residential area	1115 households, 4300 persons	GB3096-2008 Environmental Quality Standard for Noise Class II
	Jianshe Village	Inside remediation area (Tongxia)	Urban residential area	490 households, 1580 persons	
	Yingfeng Community	Inside remediation area (Tongxia)	Urban residential area	486 households, 1980 persons	
	Qingxia Community	Inside remediation area (Tongxia)	Urban residential area	518 households, 1680 persons	
	Qingshuitang Community	Inside remediation area (Qingshi)	Urban residential area	2756 households, 6354 persons	
	Dingshan Community	Inside remediation area (Xiangshiling)	Urban residential area	5465 persons	
	Zhushan Community	Inside remediation area (Qingshi)	Urban residential area	586 households, 1974 persons	

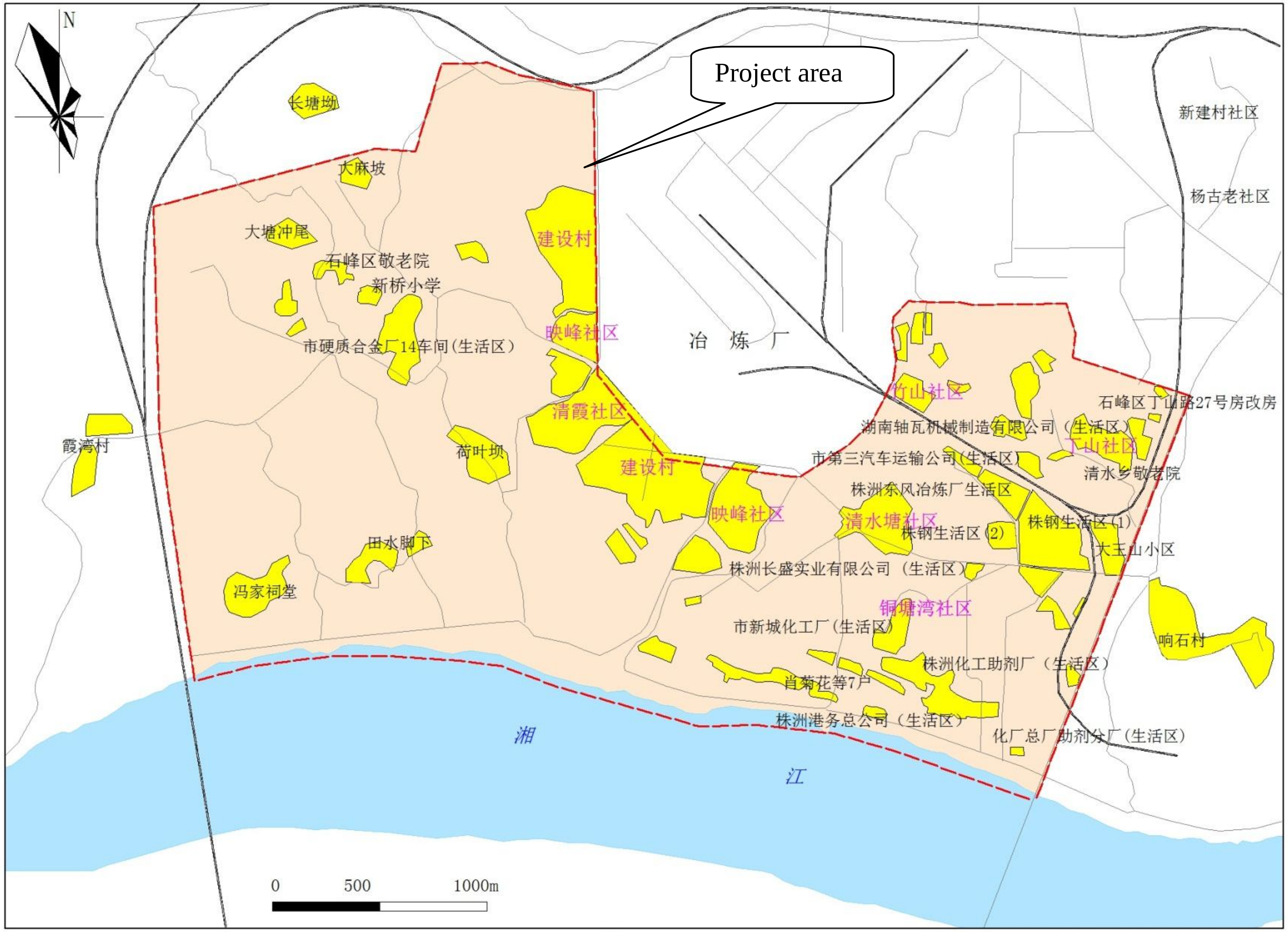


Figure1.5-1 Location of sensitive targets of air and acoustic environment protection

Table 1.5-5 Protective targets sensitive of atmospheric environment within 500m of each station

Protection type	Station	Environmental protection targets	Location	Basic situation	Sensitive receptors
Air environment	Xinqiao stabilization / solidification treatment plant	Qingxia community	E, 25-100m Range	About 9 families	Secondary standard of the *Ambient Air Quality Standard* (GB3095-2012)
			N, E, 100-500 m Range	About 300 families	
		Lotus dam	W, 400m	About 25 families	
	Xinqiao dehydration plant	Xinqiao village	N, 200m-500m Range	About 40 families	
		Lotus dam	E, 350m	About 25 families	
		At the foot of Tianshui	S, 400m	About 3 families	
		Fengjia ancestral hall	S, 400m	About 15 families	
		Xinwuli	W, 45m	About 5 families	
	Xiawan dehydration plant	Qingxia community	N, 30-50 m Range	About 5 families	
			N, 50-500 m Range	About 50 families	
		Leejia village	SE, 200m	About 10 families	
		Yijia village	S, 125m	About 20 families	
		Mayuan	SW, 125m	About 15 families	
		Xiawan street	SW, 400m	About 15 families	
		Lijiaping	W, 125m	About 25 families	
	Landfill site	Lianzichong (external)	N, 60-500m Range	About 150 families	
		12th Middle School of Zhuzhou City (external)	N, 200m	About 400 people	
		Jianshe village	E, 40-50m Range	About 4 families	
			E, 50-500m Range	About 80 families	
		Xichongwan (Jianshe village)	S, 200m	About 100 families	
		Qingcaochong	W, 200m	About 20 families	
		Dongtangpo	W, 200m	About 15 families	

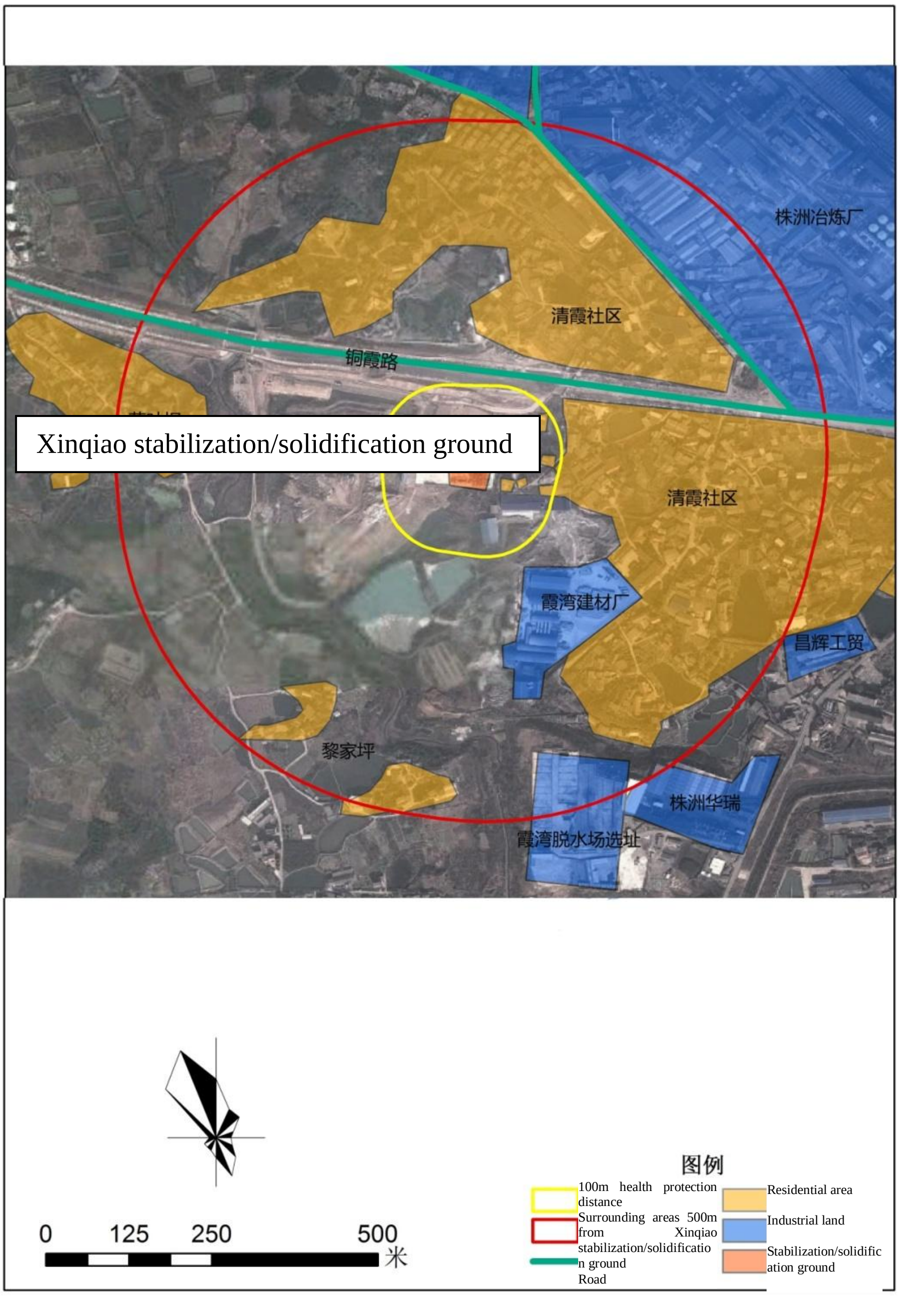


Figure1.5-2Overview of Surrounding Environment within 500m from Xinqiao Solidification/Stabilization Ground and 100m Health Protection Distance Legend

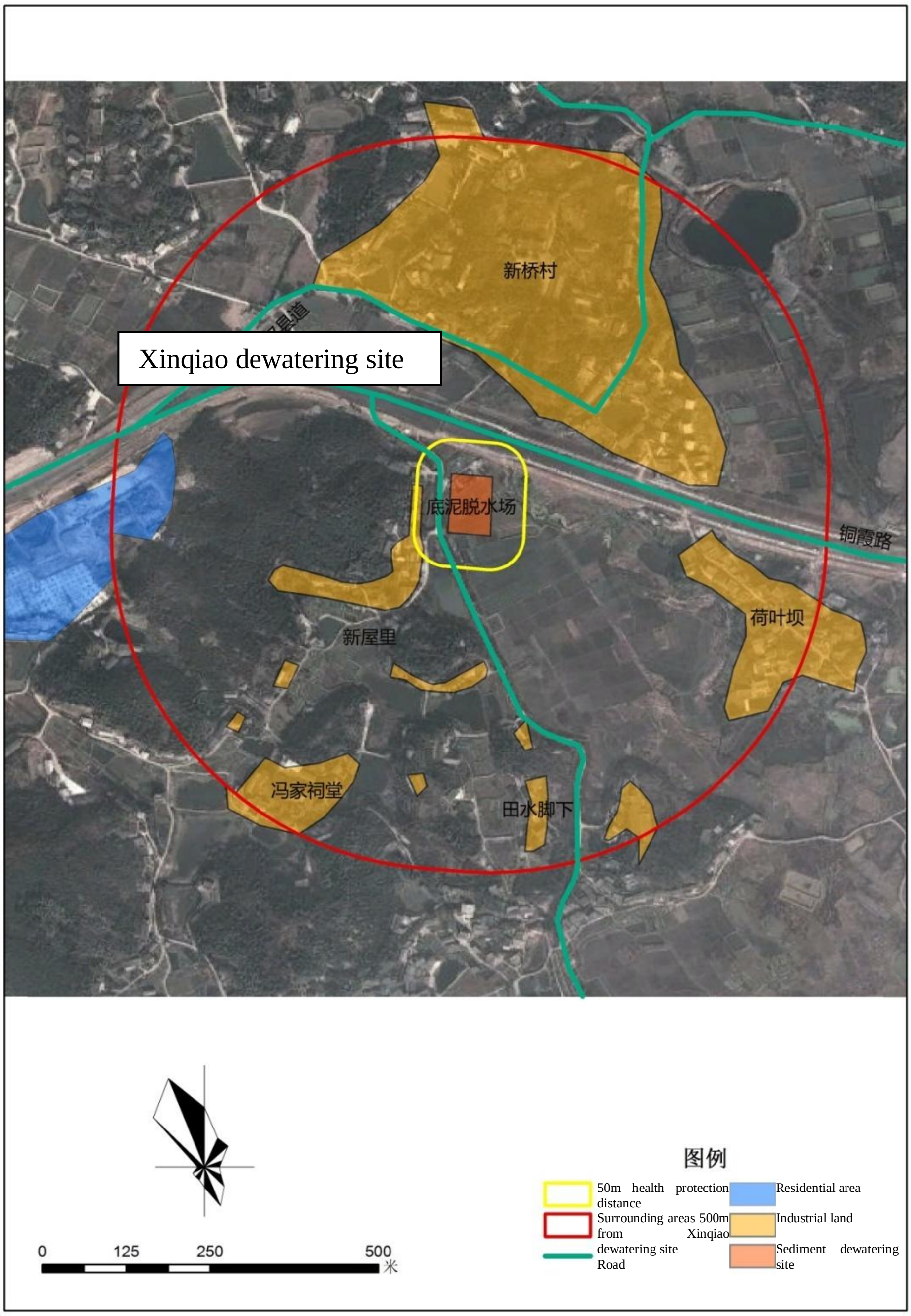


Figure1.5-3 Overview of Surrounding Environment within 500m from Xinqiao Dewatering site and 50m Health Protection Distance
Legend

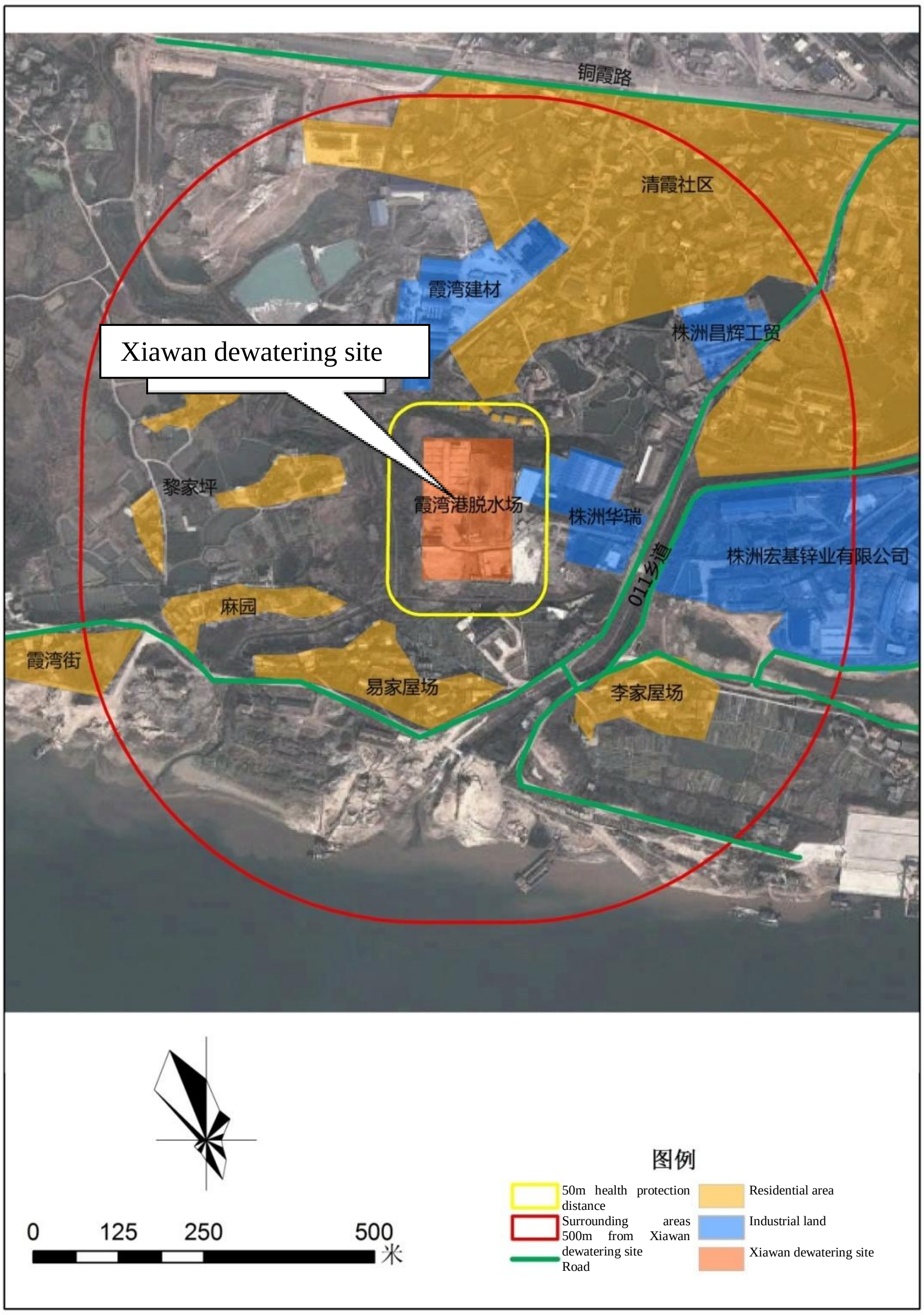


Figure1.5-4 Overview of Surrounding Environment within 500m from Xiawan Dewatering site and 50m Health Protection Distance
Legend

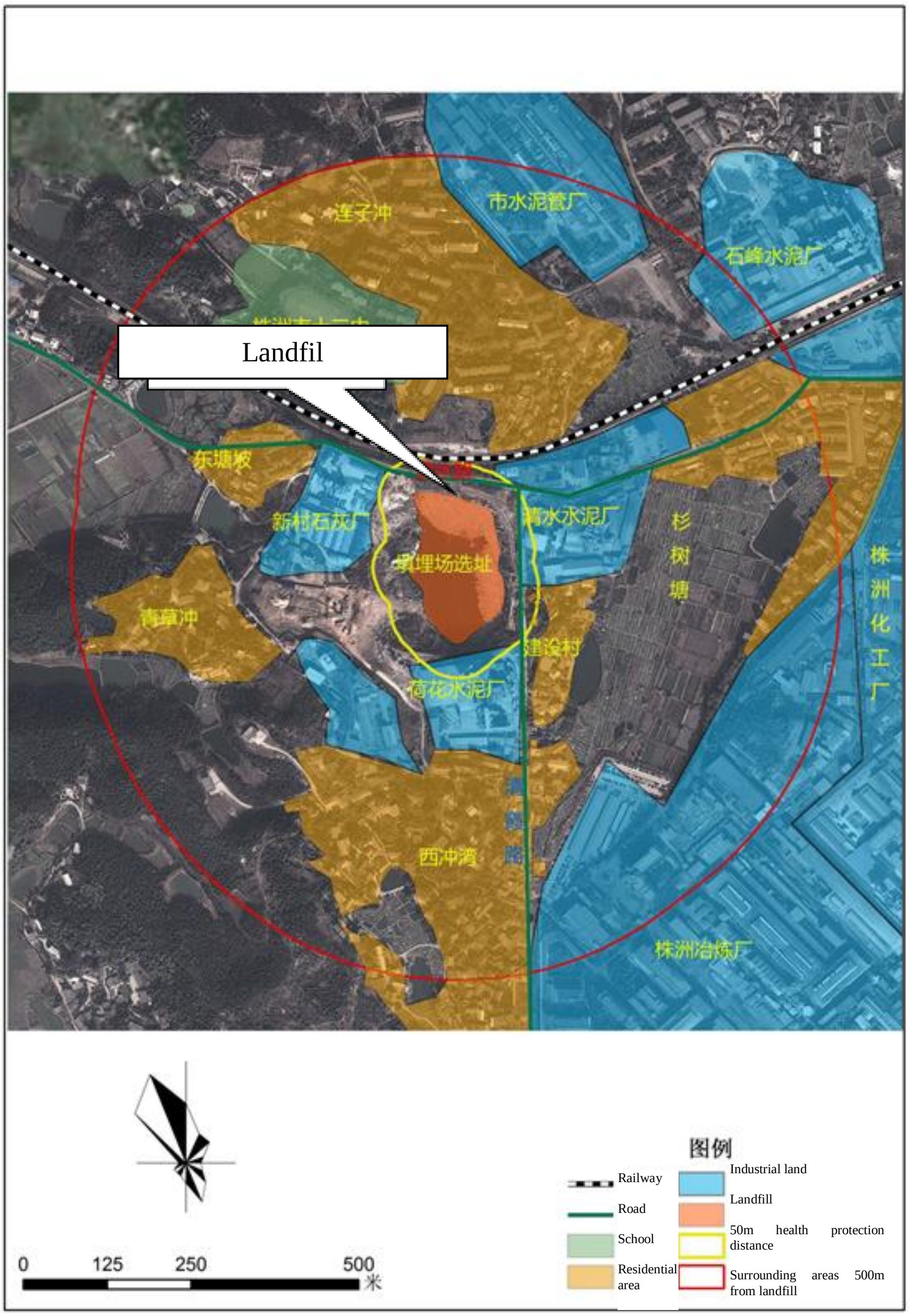


Figure1.5-5 Overview of Surrounding Environment within 500m from Landfill and 50m Health Protection Distance
Legend

1.6 Evaluation scope and evaluation period

1.6.1 Evaluation scope

1.6.1.1 Evaluation scope of the project

According to the aforementioned evaluation classes, environmental features of the region, and the principle of OP4.01 environmental evaluation policy of World Bank, the environmental impact evaluation shall cover all the potential scope of impact of the project. The evaluation scope is finally determined as following:

(1) Ambient air： The scope extending outward for 6 km from the boundary line of the project area (Qingshuitang Industrial Zone is within the scope). Organic-contaminated soil of the project is entrusted to Sinoma (Zhuzhou) Cement Co., Ltd. for treatment. The atmospheric evaluation scope of the organic-contaminated soil is 3km around Sinoma (Zhuzhou) Cement Co., Ltd., which can be seen in **Figure1.6-1**;

(2) Surface water: the evaluation scope is from 1000m upstream of Xiawangang outlet to the downstream Majiahe River (in the boundary of Xiangtan, Zhuzhou) covering a scope of about 7.0km, as shown in **Figure1.6-2**;

(3) Underground water: the evaluation scope is 50km^2 around the location of the project, as shown in **Figure1.6-3**;

(4) Noise environment: 200m around the boundary line of the project;

(5) Social environment: Shifeng District of Zhuzhou City, the house-demolished residents of this project are mainly resettled in Xiawan Resettlement Community Phase 1, and Tongtangwan Resettlement Community Phase 1, which are in the scope of 8.42 km^2 of the project, so the evaluation scope is contained in the aforementioned Shifeng District.

1.6.1.2 Evaluation scope of induced impact and accumulated impact

The evaluation of induced impact and accumulated impact will not only consider the environmental impact of the project itself, but also review the environmental impact of the established area of the development zone, as well as predict the environmental impact of the development activity in the future.

Evaluation scope: for short-term, the scope of central area of Qingshuitang Industrial Zone, which covers about $15.17km^2$; for long-term, Zhuzhou Qingshui Lake Ecological New City, which covers about $47km^2$.

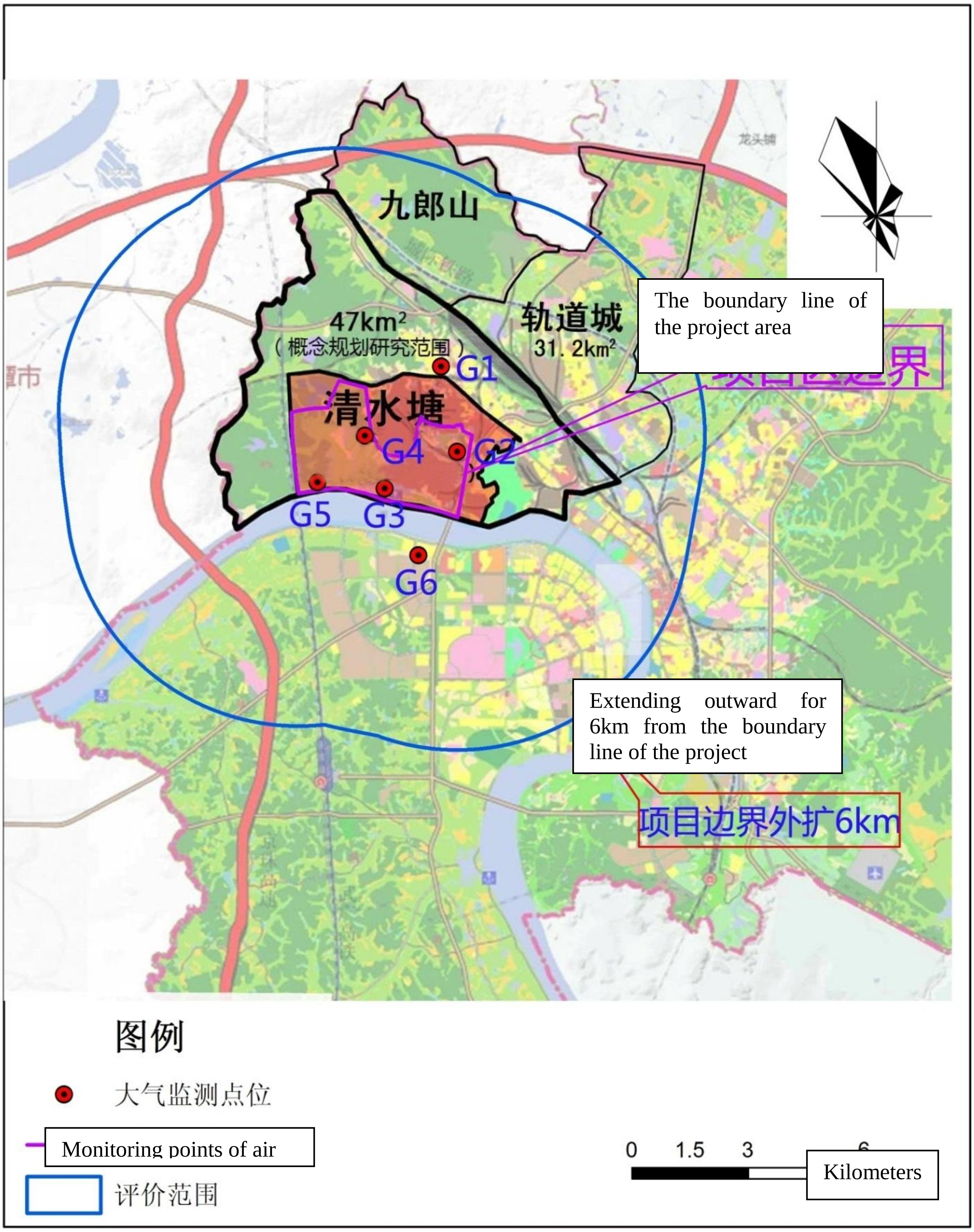


Figure1.6-1Evaluation scope of air and status monitoring points distribution

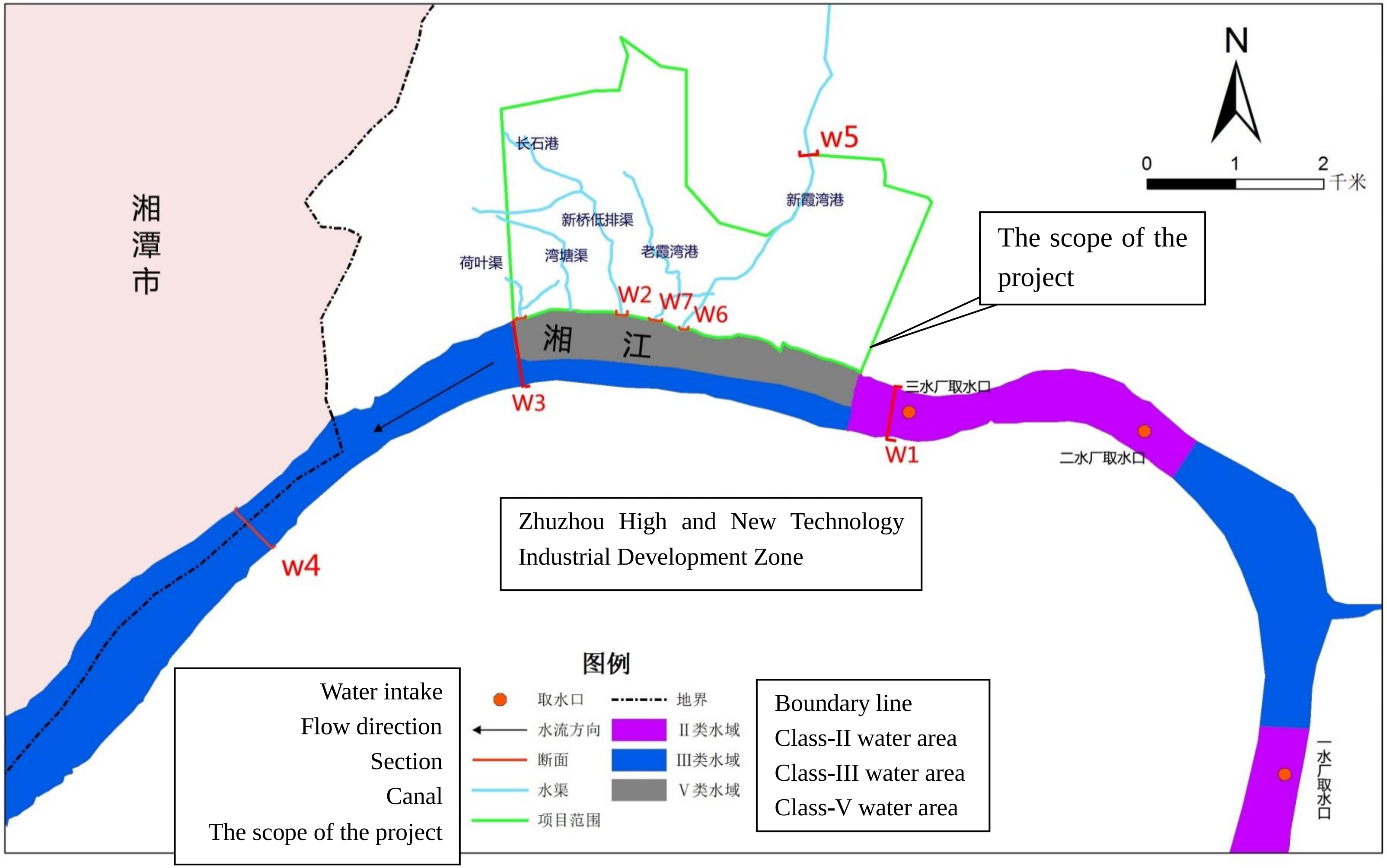


Figure1.6-2The evaluation scope and status monitoring points distribution of surface water

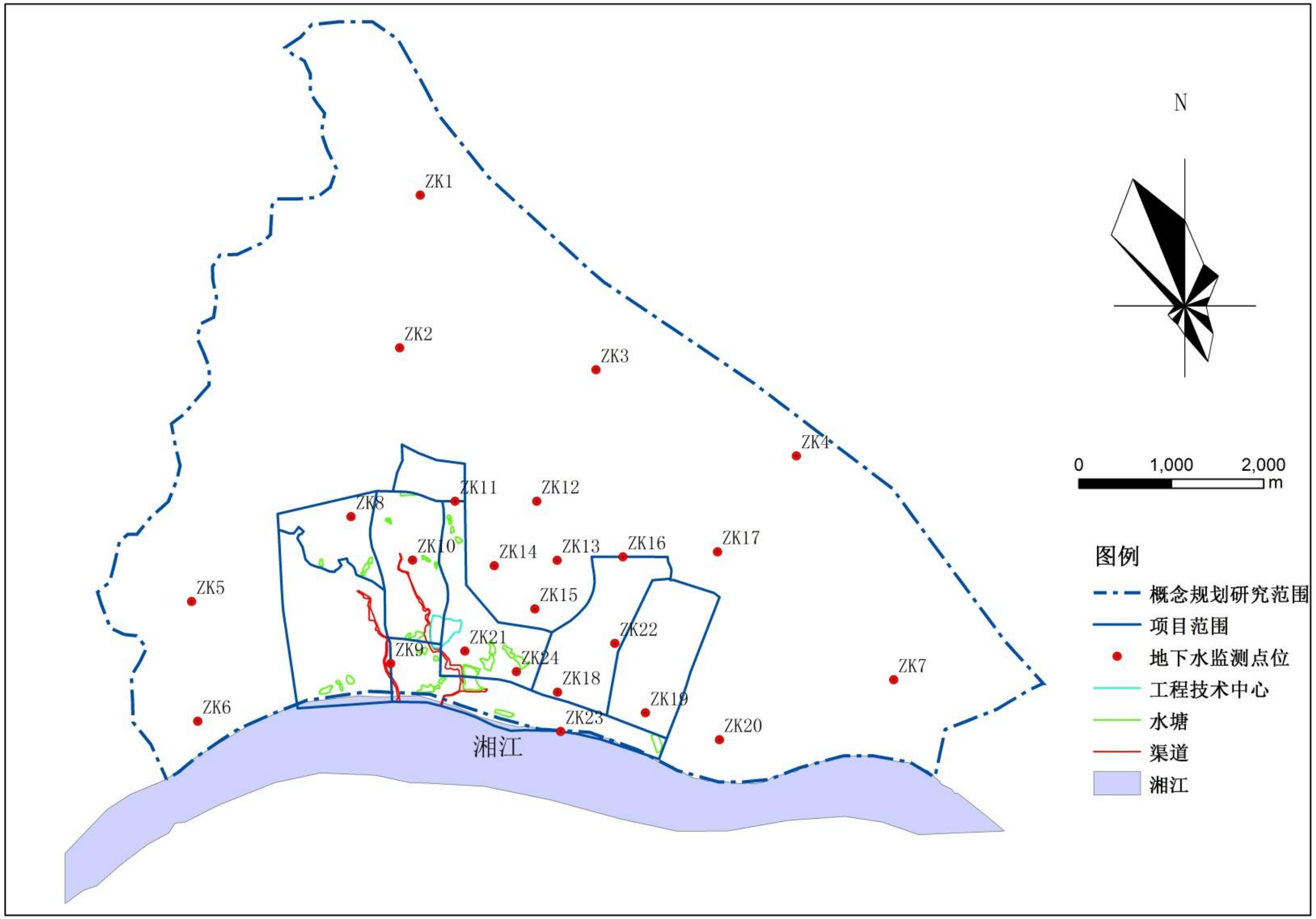


Figure1.6-3 The evaluation scope and status monitoring points distribution of underground water

1.6.2 Evaluation period

Construction period: including soil treatment within the project scope (October, 2015 to December, 2019); construction of dewatering site (November, 2015 to April, 2017), construction of temporary storage site (O, 2016 to April, 2017), construction of landfill site (July, 2016 to April, 2018) , construction of Environmental Information and Demonstration Center (July, 2016 to December, 2017; January, 2021 to December, 2021); excavation of soil to be treated, interception and drainage of ponds, dredging dand restoration(January, 2016 to December, 2021).

Operation period: ex-situ soil remediation; dewatering of waste residue and sediment; stabilization and solidification project (January, 2016, to December, 2021); landfill project at landfill site (the landfill project of solid waste of this project is from April, 2017 to December, 2021; the final service period will be as of December, 2026).

Remediation acceptance, later period and landfill site closure period: remediation acceptance, later period (from January, 2022); landfill site closure period (December, 2026 to June, 2027).

1.7Evaluation standard

The remediation target values of soil, ponds and canals have been confirmed by Zhuzhou Environmental Protection Bureau, and the replying letter can be seen in appendix; the executed standards of environmental quality and contamination discharge have been confirmed by Environmental Protection Bureau of Shifeng District, and the standard confirmation letter provided by which can be seen in appendix.

1.7.1 The remediation target values of soil and ponds

The remediation of contaminated site in this project includes soil remediation, waste residue treatment, sediment treatment of ponds, etc., and different treatment technologies are adopted for different treatment targets. Thus, targeted, practical and reliable acceptance standards should be adopted in acceptance of the project.

For heavy mental polluted soil which is suitable for acceptance as per total concentration after soil remediation, according to *Replying Letter on Implementing Standards of Soil, Ponds, Canals Remediation of Qingshuitang Industrial Zone* by Environmental Protection Bureau of Zhuzhou City, the concentration of Lead, Cadmium, Arsenic should reach the remediation target values of **Table 1.7-1**.

Table 1.7-1Remediation target values of heavy mental in soil

Unit: mg/kg

Contamination of soil	**Soil remediation target value**	
	Sensitive land (Residential land)	**Non-sensitive land (non-residential land)**
Cd	10	30
As	30	60
Pb	400	600

For the soil with contamination of heavy mental which is suitable for acceptance by leaching concentration after soil remediation, the stability will be analyzed with *Solid Waste-Extraction Procedure for Leaching Toxicity-Horizontal Vibration Method* (HJ557-2010) . The concentration of heavy mental in the soil leachate after remediation shall be no more than the maximum allowable discharge concentration value in *Integrated Wastewater Discharge Standard* (GB8978-1996) . The standards of leaching concentration are as shown in **Table 1.7-2**.

Table 1.7-2The acceptance standard of leaching concentration of heavy mental contamination in soil

Unit: mg/L

No.	**Soil contamination**	**Leaching concentration**
1	As	0.5
2	Cd	0.1
3	Pb	1.0

For the land in former Zhuzhou Tiancheng Chemical Factory, there is not only contamination of heavy mental such as Cadmium, Arsenic, Lead, but also contamination of nickel and organic contaminations, and the planned land use is residential land. As the amount of land with organic contamination is small, for this part of contaminated soil, the target values of contamination clearance are determined based on the Approval of *Risk Evaluation Report on Contaminated Field of Former Zhuzhou Tiancheng Chemical Factory issued by Zhuzhou Environmental Protection Bureau*, as shown in **Table 1.7-3**.

Table 1.7-3Remediation target value of other contaminations in land of Tiancheng Chemical Factory

Concerned contamination	Remediation target value mg/kg
	Sensitive land (planned residential land)
Nickel	90
Benzo a-pyrene	0.3

The contaminated sediment of ponds as well as waste residue left over by history will all be treated through stabilization/solidification technology; the stability of sediment and waste residue after treatment will be analyzed through *Solid Waste-Extraction Procedure for Leaching Toxicity-Horizontal Vibration Method* (HJ557-2010) . The concentration of heavy mental in the leachate of soil after treatment shall be no more than the maximum allowable discharge concentration value in *Integrated Wastewater Discharge Standard* (GB8978-1996) . The standards of leaching concentration are as shown in table 1.7-2.

According to the standard confirmation letter provided by Environmental Protection Bureau, the surface water of ponds, etc. of the area will refer to the class-V standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) , so the concentration indexes of all items of surface water after treatment shall be no more than the values listed in **Table 1.7-4**.

Table 1.7-4Class-V Standard of Environmental Quality Standards for Surface Water (GB3838-2002)

Unit: mg/L

Contamination factor	COD	Cd	Cr^{6+}	Cu	Zn	As	Pb
Standard value	40	0.01	0.1	1.0	2.0	0.1	0.1

1.7.2 Environmental quality standards

1.7.2.1 Surface water

According to Water Environmental Functional Demarcation For Hunan Main Surface Water (DB43/023-2005) , from 500m upstream of Shifeng Bridge of Xiang River to 100m downstream of water intake of the Third Water Factory, the Class-II standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) will be executed; while from 100m downstream of water intake of the Third Water Factory to right bank of 2000m downstream of Xiawangang which is a mixing area, the class-V standard of *Environmental*

Quality Standards for Surface Water (GB3838-2002) will be executed; and from the left and middle bank area and 2000m downstream of Xiawangang to Majiahe River is landscape and entertainment water area, Class-II I standard will be executed.

For Xinqiao Low Discharge Channel, Old Xiawangang and New Xiawangang in the area which have not been classified by water environmental function, the class-V standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) will be referred to be executed.

Table 1.7-5 List of standard values of environmental quality of surface water

Unit: mg/L except pH

Item		**Class-Ⅱ**	**Class-Ⅲ**	**Class-Ⅳ**	**Class-Ⅴ**
pH value (dimensionless)		6~9	6~9	6~9	6~9
chemical oxygen demand (COD)	≤	15	20	30	40
SS[1]	≤	25	30	60	150
NH_3-N	≤	0.5	1.0	1.5	2.0
Total phosphorus (Calculated by P)	≤	0.1	0.2	0.3	0.4
Cu	≤	1.0	1.0	1.0	1.0
Zn	≤	1.0	1.0	2.0	2.0
As	≤	0.05	0.05	0.1	0.1
Hg	≤	0.00005	0.0001	0.001	0.001
Cd	≤	0.005	0.005	0.005	0.01
Cr(hexavalent)	≤	0.05	0.05	0.05	0.1
Pb	≤	0.01	0.05	0.05	0.1
cyanide	≤	0.05	0.2	0.2	0.2
volatile phenol	≤	0.002	0.005	0.01	0.1
Ni[2]	≤	0.02	0.02	0.02	0.02

[1]: SS standard refers to *Quality Standards for Surface Water Resources* (SL63-94) of the Ministry of Water Resources;

[2]:Ni standard refers to Table 3 of *Environmental Quality Standards for Surface Water* (GB3838-2002) .

1.7.2.2 Air

For the air environment, the Class-II standard of *Ambient Air Quality Standard* (GB3095-2012) will be executed; for the factors not involved in it, the *Hygienic Standards for the Design of Industrial Enterprises* (TJ36-79) will be executed.

Table 1.7-6 Ambient air quality standard

Contamination factor	**Ambient air quality standard (mg/m^3)**			**Basis**
	Average of an hour	**Average of 24 hours**	**Average**	
SO_2	0.50	0.15	0.06	Class-II standard of *Ambient Air Quality Standard* (GB3095-2012)
NO_2	0.20	0.08	0.04	
PM10	——	0.15	0.07	
TSP		0.3	0.2	
CO	10	4	——	
O_3	0.2	Average of a day for 8 hours at the maximum 0.16	——	
TVOC	0.6 (average of 8 hours)	——	——	Indoor Air Quality Standards GB/T18883-2002
NH_3	0.2 (value for one time)	——	——	*Hygienic Standards for the Design of Industrial Enterprises* (TJ36-79)
H_2S	0.01 (value for one time)			
Hg	——	0.0003	——	
Fluoride (converted to F)	0.02	0.007	——	
Arsenide (converted to As)	——	0.003	——	
phenol	0.02 (once)	——	——	
Lead and its inorganic compound (converted to Pb)	——	0.0007	——	
Cr (hexavalent)	0.0015 (once)	——	——	
Mn and its compound (converted to MnO_2)	——	0.01	——	

1.7.2.3 Noise

For ambient noise of the mixing area of residence and industry, class-2 standard of Environmental Quality Standard for Noise (GB3096-2008) will be executed; while for ambient noise of industrial area, class-3 standard will be executed, and for artery traffic and its two sides, class-4a standard will be executed.

Table 1.7-7 Quality standard of acoustic environment

Acoustic environment	**Class-2**	day	dB (A)	60
		night	dB (A)	50
	Class-3	day	dB (A)	65
		night	dB (A)	55
	Class-4a	day	dB (A)	70

1.7.2.4 Underground water

For the environmental quality of underground water, the Class-II I standard of *Quality Standard of Underground water* (GB/T14848-93) will be adopted.

Table 1.7-8 Quality standard of underground water (mg/L)

Item	**pH**	**Ammonia nitrogen**	**Fluoride**	**Hexavalent chromium**	**Cu**	**Zn**	**Pb**	**permanganate index**
Class-III	6.5～8.5	0.2	1.0	0.05	1.0	1.0	0.05	3.0
Item	Mn	Ni	Hg	As	Se	Cd	volatile phenols (calculated by phenol)	
Class-III	0.1	0.05	0.001	0.05	0.01	0.01	0.002	

1.7.2.5 Soil

For the environmental quality of soil, Class-II standard of Environmental Quality Standards for Soils (GB15618-1995) will be adopted.

Table 1.7-9 Environmental quality standard of soil (Unit：mg/kg)

Level	**Cd**	**Hg**	**Pb**	**Cr**	As	**Cu**	Zn	**Ni**
Level-2 (pH<6.5)	0.30	0.30	250	250	30	50	200	40
Level-2 (pH6.5－7.5)	0.30	0.50	300	300	25	100	250	50
Level-2 (pH>7.5)	0.60	1.0	350	350	20	100	300	60

1.7.3 Pollutants discharge standard

1.7.3.1 Waste water

The waste water from washing vehicle during the construction period and flushing demolished structures of enterprises will be recycled after treatment without discharge;

The tail water from dredging of ponds, as well as waste water from sediment dewatering, after treatment by mobile sewage treatment facility to meet the level-1 standard in table-4 of *Integrated Wastewater Discharge Standard* (GB8978-1996) ,will be discharged into Xiawangang;

For the gathered water in landfill pit, the level-1 standard of table-4 in *Integrated Wastewater Discharge Standard* (GB8978-1996) is required to be implemented after treatment.

The water used for daily washing and bathing and other domestic waste water as well as a small number of domestic sewage of Environmental Information and Demonstration Center, after gathering and retexturing to meet *Reuse of Recycling Water for Urban, Water Quality Standard for Urban Miscellaneous Water Consumption* (GB/T 18920— 2002) , will be used for cleaning floor, watering flower, flushing toilet and other usage not directly contacted by human body. Other waste water from toilet flushing will go through pipes to Xiawan Sewage Treatment Plant for treatment.

Table 1.7-10Water quality standards of *Reuse of Recycling Water for Urban, Water Quality Standard for Urban Miscellaneous Water Consumption*

No.	Items	Toilet flushing	Road cleaning	Urban greening
1	pH	6.0~9.0		
2	Color (degree) ≤	30		
3	Smell	No uncomfortable sense		
4	Turbidity (NTU) ≤	5	10	10
5	Total dissolved solids (mg/L) ≤	1500	1500	1000
6	Five-day biochemical oxygen demand (BOD_5) (mg/L)≤	10	15	20
7	Ammonia nitrogen (mg/L) ≤	10	10	20
8	Anionic surfactant (mg/L) ≤	1.0	1.0	1.0
9	Fe (mg/L) ≤	0.3	—	—
10	Mn (mg/L) ≤	0.1	—	—
11	Dissolved oxygen (mg/L) ≥	1.0		
12	Total residual chlorine (mg/L)	After contact for 30min ≥1.0, the end of pipe≥0.2		
13	Total coliform group (unit/L) ≤	3		

The leachate of landfill site will flow to Qingshuitang Industrial Waste Water Treatment and Recycle Plant through pipes for treatment.

For the tail water of Qingshuitang Industrial Waste Water Treatment and Recycle Plant and Xiawan Sewage Treatment Plant, level-1 B standard of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant* (GB18918-2002) will be executed.

Table 1.7-11 Discharge standard of sewage

Standard	pH	COD	BOD_5	Total phosphorus	Ammonia nitrogen
Level-1 standard of table-4 in *Integrated Wastewater Discharge Standard (GB8978-1996)*	6-9	100	20	0.5	15
Level-1 B standard of Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB18918-2002)	6-9	60	20	1	8 (15)

1.7.3.2 Waste gas

For the discharge of dust and waste gas created by soil excavation and classification, as well as benzopyrene waste gas from excavation of soil with organic contamination, the level-

2 standard in table 2 of *Integrated Emission Standard of Air Pollutants* (GB16297-1996) and non-organization emission monitoring concentration limiting value will be executed.

Table 1.7-12 Integrated Emission Standard of Air Contamination

Contamination	Non-organization emission monitoring concentration limiting value	The maximum allowable discharge concentration (mg/m^3)	The maximum allowable discharge speed (kg/h)	Standard source
Particulate matter	1.0 mg/m^3	120	—	Level-2 standard of table-2 of *Integrated Emission Standard of Air Pollutants* (GB16297-1996)
Benzopyrene	0.008ug/m^3	—	—	

For the waste gas emission of the soil with organic contamination which was entrusted to Sinoma (Zhuzhou) Cement Co., Ltd. for treatment, *Standard for Pollution Control on Co-processing of Solid Wastes in Cement Kiln* (GB 30485-2013) will be executed.

For the stench emitted from the dredging sediment and soil stabilization storage reaction, *Emission Standards for Odor Pollutants* (GB14554-1993) will be executed.

Table 1.7-13Standard value of odor pollutants at factory boundary

Controlling item	Unit	Grade-2
NH_3	mg/m^3	1.5
H_2S	mg/m^3	0.06

1.7.3.3 Noise

For the noise at boundary of stabilization/solidification site, landfill site, dewatering site, and temporary storage site, class-3 standard of *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008) will be executed. For the area of 50m from the two sides of road and main line, class-4a standard will be executed, and sudden noise at night shall not exceed the standard value of 15dB(A) ; while for some living facilities in the living area, *Emission Standard for Community Noise* (GB 22337-2008) will be executed. The details can be seen in Table 1.8-23.

Table 1.7-14Emission standard for community noise (dB(A))

Class	1	2	3	4
Day	55	60	65	70
Night	45	50	55	55

For the construction field, *Emission Standard of Environment Noise for Boundary of Construction Site* (GB12523－2011) will be executed, which is 70dB(A) for day, and 55 dB(A) for night.

1.7.3.4 Solid waste

For disposal of general solid waste, *Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Waste* (GB18599-2001) as well as *Announcement on issuing Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Waste (GB18599-2001) and other two national pollutant control standard modification sheets (No.36 Announcement in 2013)* will be executed.; while for hazardous solid waste, *Standard for Pollution Control on Hazardous Waste Storage* (GB18597-2001) and *Standard for Pollution Control on the Security Landfill Site for Hazardous Wastes* (GB18598-2001) will be executed.

1.8Functional attributes of the regional environment

Table 1.8-1List of functional attributes of the regional environment of the project

No.	Name of environment functional regions	The class of evaluation area
1	Whether or not in the “basic ecological controlling line ”	No
2	Whether or not in “protected region of drinking water source”	No
3	Surface water environment functional region	According to Water Environmental Functional Demarcation For Hunan Main Surface Water (DB43/023-2005) , the functional demarcation of water area of Qingshuitang area is as following: it’s protected region of drinking water source from 1000m upstream of water intake of the Second Water Factory, to 100m downstream of water intake of the Third Water Factory of Xiang River, and the Class-II standard of GB3838-2002 will be executed; while it’s a mixing area from 100m downstream of water intake of the Third Water Factory to right bank of 2000m downstream of Xiawangang, and the class-V standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) will be executed; and it is landscape and entertainment water area from 100 m downstream of the Third Water Factory to the left and middle bank of 2000m downstream of Shengangjiang exit of Xiawangang, and from 2000m downstream of water intake of Xiawangang to Majiahe River, Class-II I standard of GB3838-2002 will be executed.
4	Ambient air functional region	Class-2
5	Ambient noise functional region	Class-3
6	Underground water environment functional region	Class-III
7	Whether or not related to basic farmland conservation area	No
8	Whether or not related to natural preservation areas	No
9	Whether or not related to scenic spot reserves	No
10	Whether or not related to cultural relics protection units	No
11	Water catchment range of municipal wastewater treatment plant	Xiawan Sewage Treatment Plant, Qingshuitang Industrial Waste Water Treatment and Recycle Plant

1.9Technical methods of evaluation

1.9.1 Technical methods

According to the nature of the project, this evaluation adopts Pattern Prediction Method to conduct the prediction and evaluation of air and noise, and survey and analogy analysis method to conduct evaluation of ecological environment, social environment, and environment of surface water and underground water.

1.9.2 Working procedure of evaluation

The detailed working procedure is as shown in **Figure1.9-1**:

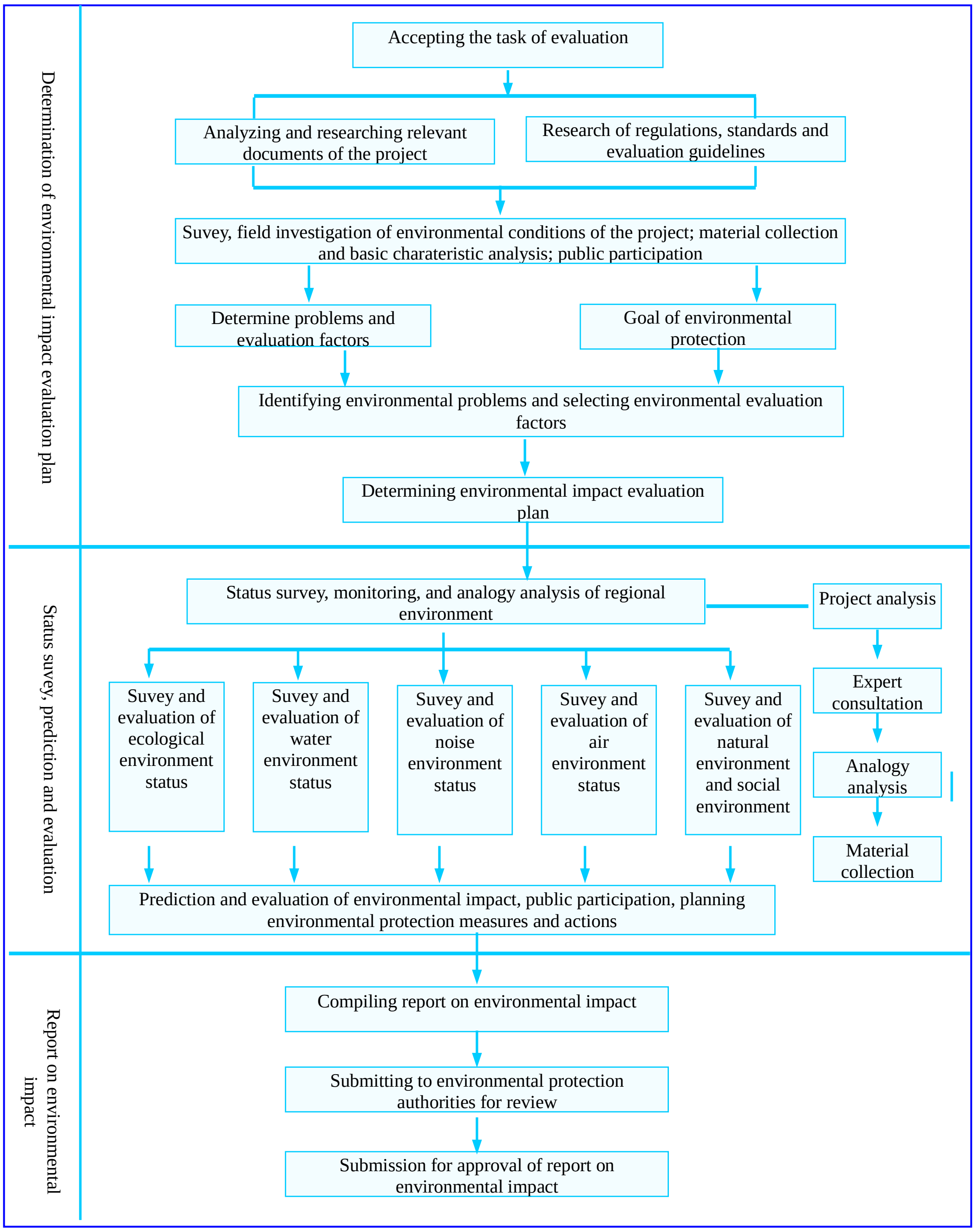


Figure1.9-1Working procedure of the environmental evaluation

2 Policy, Regulation and Management Framework

The project conforms to the provisions of domestic laws and regulations on environmental impact assessement and relevant technical guidelines, and also meet the requirements of the World Bank's Security Policy.

2.1Domestic Laws and Regulations

2.1.1 Domestic laws and regulations on environmental protection

(1) Environmental Protection Law of the People's Republic of China (April 24, 2014);
(2) Atmospheric Pollution Prevention Law of the People's Republic of China (February 28, 2008);
(3) Water Pollution Prevention Law of the People's Republic of China (revised on February 28, 2008);
(4) Cleaner Production Promotion Law of the People's Republic of China (revised on February 29, 2012);
(5) Land Administration Law of the People's Republic of China (January 1, 1999);
(6) Soil and Water Conservation Law of the People's Republic of China (December 25, 2010);
(7) Forest Law of the People's Republic of China (January 1, 1985);
(8) Water Law of the People's Republic of China (October 1, 2002);
(9) Urban and Rural Planning Law of the People's Republic of China (January 1, 2008);
(10) Solid Waste Pollution Prevention Law of the People's Republic of China (revised on June 29, 2013);
(11) Cultural Relics Protection Law of the People's Republic of China (revised on June 29, 2013);
(12) Environment Impact Assessment Law of the People's Republic of China (September 1, 2003);
(13) Circular Economy Promotion Law of the People's Republic of China (January 1, 2009);
(14) Ordinance on Administration for Environmental Protection of Construction Projects,

253th Order of the State Council (November 29, 1998);

(15) Classification Catalogue for Environmental Impact Assessement of Construction Projects, Ministry's Order No. 33 (April 20, 2015);

(16) Notice on Issuing Interim Measures for Public Participation in Environmental Impact Assessement (HF[2006]No. 28), State Environmental Protection Administration, February 14, 2006;

(17) Catalogue for Guiding Industrial Restructuring (2011 Version), Decision of the National Development and Reform Commission on Amending the Relevant Entries under the Catalogue for Guiding Industrial Restructuring (2011 Version);

(18) Policy for Solid Waste Pollution Prevention Technique;

(19) Management Measures for Transfer of Hazardous Waste (October 1, 1999);

(20) Notice on Implementing Measures for Environmental Pollution Prevention during Relocation Process of Enterprises (HB [2004] No. 47);

(21) Measures for Prevention and Control of Pollution from Discarded Hazardous Chemicals (Order of SEPA No. 27, 2005);

(22) Opinions on Strengthening Soil Pollution Prevention and Control (HF[2008]No. 48);

(23) Notice on Guaranteeing Environmental Safety at the Re-developed Sites of Industrial Enterprises (HF[2012]No.140);

(24) Opinions of the State Council on Strengthening the Focus of Environmental Protection Work (GF[2011]No. 35);

(25) Notice on Enhancing the Management on Environmental Impact Assessment of Construction Projects Financed by International Financial Organizations (June 21, 1993);

(26) Announcement on Issuing the Guidelines for Environmental Assessment and Restoration at the Sites of Industrial Enterprises (Trial) (Ministry of Environmental Protecton, Announcement No. 78, 2014);

(27) Notice on Enhancing Pollution Control during Shut-down, Relocation and Original Site Redevelopment of Industrial Enterprises (HF[2014] No. 66);

2.1.2 Local Regulations and Documents on Environmental Protection

(1) Regulations on Environmental Protection Management of Hunan Province (May 27, 2013);

(2) Measures for Environmental Protection Management of Construction Projects in Hunan Province (October 1, 2007);

(3) Regulation for Water Pollution Control in Xiang River River Basin of Hunan Province;

(4) Measures for Environmental Protection of Eco-economy Zone at Changsha, Zhuzhou and Xiangtan Section of Xiang River River (September 1, 2013);

(5) Division of Surface Water Environmental Function Area for Main Water Systems in Hunan Province (DB43/023-2005);

(6) Decision of People's Government in Hunan Province on the Implementing the Scientific Outlook on Development and Strengthening Environmental Protection (XZF[2006]No. 23);

(7) Opinions of CPC Hunan Provincial Committee and People's Government in Hunan Province on Vigorously Developing Circular Economy and Building Resource-saving and Environment-friendly Society (XF [2006]No. 14);

(8) Decision of People's Government in Hunan Province on Announcing the Catalogue of Cancelled, Decentralized and Reserved Administrative Licensing Items at the Provincial Level, Order No. 271 of People's Government of Hunan Province;

(9) Notice of Zhuzhou Environmental Protection Bureau on Issuing Relevant Provisions for Environmental Management of Construction Projects in Zhuzhou (ZHB[2015]No. 12);

(10) Water Environmental Function Zoning in Zhuzhou (ZZF[2003]No. 8, June 4, 2003);

(11) Ambient Air Quality Function Zoning in Zhuzhou (ZZF[1997]No. 46, March 18, 1997);

(12) Notice of Zhuzhou Environmental Protection Bureau on Issuing Acoustic Environmental Function Zoning in the Downtown Area of Zhuzhou (ZHB[2013]No. 125, November 4, 2013);

(13) Notice of People's Government of Zhuzhou City on Issuing the Management Measures for Drinking Water Source Protection in Zhuzhou Urban Section of Xiang River River (ZZBF [2011]No. 17, February 25, 2011)

2.1.3 Relevant Planning for Social, Economic Development, Environmental Protection and Heavy Metal Pollution Control

(1) The "Twelveth Five-Year Plan" for Comprehensive Prevention and Control of Heavy Metal Pollution;

(2) Regional Planning of Chang-Zhu-Tan City Cluster (2012~2020);

(3) Implementation Scheme for Circular Economy of Qingshuitang Industrial Zone in Zhuzhou (August 2009);

(4) Comprehensive Planning for Environmental Pollution Control in Qingshuitang Industrial

Zone (2008~2010);

(5) Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City (China Academy of Urban Planning and Design, Shanghai Branch, June 2009);

(6) Special Planning for Heavy Metal Pollution Control in Xiang River River Basin, November 2009;

(7) Implementation Plan for Heavy Metal Pollution Control in Xiang River River Basin, March 2011;

(8) Urban Master Planning for Zhuzhou City (2006~2020);

(9) Conceptural Planning for New Ecological Town in Qingshui Lake of Zhuzhou City;

(10) Regulatory Planning for Core Zone of Qingshuitang Ecological Industrial Town of Zhuzhou City (2012);

(11) The "Twelveth Five-Year Plan" for Environmental Protection in Zhuzhou City (2011~2015);

(12) The "Twelveth Five-Year Plan" for Soil Environmental Protection in Zhuzhou City (2011~2015);

2.1.4 Technical Guidelines and Specifications

(1) Technical Guidelines for Environmental Impact Assessment – General (HJ2.1-2011);

(2) Technical Guidelines for Environmental Impact Assessment –Atmospheric Environment (HJ2.2-2008);

(3) Technical Guidelines for Environmental Impact Assessment –Surface Water Environment (HJ/T2.3-93);

(4) Technical Guidelines for Environmental Impact Assessment –Acoustic Environment (HJT2.4-2009);

(5) Technical Guidelines for Environmental Impact Assessment – Ecological Environment (HJ19-2011);

(6) Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ/T169-2004);

(7) Technical Guidelines for Environmental Impact Assessment – Underground Water (HJ610-2011);

(8) Technical Guidelines for Hazardous Waste Disposal (HJ 2042-2014);

(9) Terms for Contaminated Sites (HJ 682-2014);

(10) Technical Guidelines for Site Environmental Survey (HJ 25.1-2014);

(11) Technical Guidelines for Site Environmental Monitoring (HJ 25.2-2014 replacing HJ/T 25-1999);

(12) Technical Guidelines for Risk Assessment of Contaminated Sites (HJ 25.3-2014 replacing HJ/T 25-1999);

(13) Technical Guidelines for Soil Remediation of Contaminated Sites (HJ 25.4-2014 replacing HJ/T 25-1999);

(14) Technical Specification for Solid Waste Disposal Coordinated by Cement Kiln (HJ 662-2013)

2.1.5 Other Documents

(1) Power of Attorney;

(2) Feasibility Study Report of World Bank Financed Zhuzhou Brownfield Remediation Project, prepared by Hunan International Engineering Consulting Center and Hunan New World Science & Technology Co., Ltd.;

(3) Environmental Survey Report of Xiangshiling Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2012, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(4) Environmental Survey Report of Qingshi Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2012, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(5) Environmental Survey Report of Tongtangwan Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2012, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(6) Shall groundwater quality investigation report of Qingshuitang industrial area (2012, Nanjing Institute of Soil Science, Chinese Academy of Sciences)

(7) Soil Pollution Survey Report of Tongxia Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2011, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(8) Soil Pollution Survey Report of Qingshui Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2011, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(9) Soil Pollution Survey Report of Yingfeng Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(10) Soil Pollution Survey Report of Qingshui Lake Sub-region Zone I in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(11) Soil Pollution Survey Report of Qingshui Lake Sub-region Zone II in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(12) Special Report for Groundwater Environment Impact Assessement of Qingshuitang Circular Economy Industrial Zone in Zhuzhou City (2014, Coalfield Geology Bureau of Hunan Province);

(13) Soil Pollution Risk Assessment Report of Tongxia Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2012, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(14) Soil Pollution Risk Assessment Report of Qingshui Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2012, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(15) Soil Pollution Risk Assessment Report of Yingfeng Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(16) Soil Pollution Risk Assessment Report of Qingshui Lake Sub-region Zone I in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(17) Soil Pollution Risk Assessment Report of Qingshui Lake Sub-region Zone II in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection);

(18) Soil Pollution Risk Assessment Report of Xiangshiling Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(19) Soil Pollution Risk Assessment Report of Tongtangwan Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(20) Soil Pollution Risk Assessment Report of Qingshi Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (2014, Nanjing Institute of Soil Science, Chinese Academy of Sciences);

(21) Approval of Soil Pollution Risk Assessment Report of Tongxia Sub-region in

Qingshuitang Industrial Zone of Zhuzhou City (XHH [2012]No. 104);

(22) Approval of Soil Pollution Risk Assessment Report of Qingshui Sub-region in Qingshuitang Industrial Zone of Zhuzhou City (XHH [2012]No. 105);

(23) Reply Letter of Zhuzhou Environmental Protection Bureau on Standards for Remediation of Soil, Pond and Channel in Qingshuitang Industrial Zone;

(24) Zhuzhou Municipal Environmental Protection Bureau, Approval of Tiancheng Chemical Plant Risk Assessnent Report

2.2 Safeguards Policies of World Bank

(1) OP/BP4.01 Environmental Assessment;

(2) OP/BP4.04 Natural Habitats;

(3) OP/BP4.11 Physical Cultural Resources;

(4) OP/BP4.12 Involuntary Resettlement.

2.3 Compliance Analysis

2.3.1 Ten Safeguards Policies of World Bank and Compliance Analysis

The World Bank has formulated 10 safeguard policies in aspects of society and environment. According to the nature and layout of this construction project, as well as evaluation scope and field survey of this environmental impact assessment, those policies involved in this project have been screened out, as shown in **Table 2.3-1**.

Table 2.3-1Compliance analysis of this project to the safeguard policies of the World Bank

No.	Safeguard policies	Applicable	Compliance
1	OP/BP4.01 Environmental Assessment	Yes	- Category A project; - The Environmental Impact Assessment and Environmental Management Plan, including an ESMF has been prepared. - As a part of the environmental impact assessment, two rounds of public consultations have been carried out;
2	OP/BP4.04 Natural Habitat	Yes	This policy is applicable to this project. The construction and operation of this project have potential negative effects on terrestrial and aquatic ecosystems in the project area.
3	OP/BP4.36 Forest	No	This policy is not applicable. The project will not subsidize those activities causing significant change or degradation of important forest areas or natural habitats defined in this policy.
4	OP/BP4.09 Pest Management	No	This policy is not applicable. The project will not purchase any pesticides, nor lead to increased pesticide usage. According to this policy, we do not need to take relevant measures.
5	OP/BP4.11 Physical Cultural Resources	Yes	The project area has graves, Dawang Temple, Wuniang Temple and other cultural resources. The graves and Dawang Temple are located in several hills of the project area, and the Wuniang Temple is outside the restoration area. The already designed project activities will not impact these resources. For precautionary purpose and other potential remediatiopn activities that are covered by the ESMF, the policy is triggered. Relevant measures to avoid any impacts have been incorporated into the Environmental Management Plan. The chance-finds procedures have been included in the Environmental Management Plan.
6	OP/BP4.37 Dam Safety	No	This policy is not applicable. No dams exists in the project area.
7	OP/BP4.10 Indigenous peoples	No	No indigenous people lives in the project area, or this project has no impacts on indigenous people.
8	OP/BP4.12 Involuntary Resettlement	Yes	The resettlement policy is applicable, and Resettlement Action Plan has been prepared.
9	OP/BP7.50 Projects on International Waterways	No	This policy is not applicable. This project does not involve any international waterways.
10	OP/BP7.60 Projects in Disputed Area	No	This policy is not applicable. This project does not involve any disputed area.

2.3.2 Compliance analysis of this project to WBG Guidelines for Environment, Health and Safety

The Guidelines for Environment, Health and Safety of the World Bank also applies to this project. Mitigation measures included in the Environmental Management Plan of this project are in full compliance with the requirements of the above Guidelines (particularly those contents related to construction management). It should be noted that the contents of Guidelines are consistent with Chinese laws, regulations, policies and construction management guidelines.

Table 2.3-2Compliance analysis of this project to Guidelines for Environment, Health and Safety of the World Bank

Guidelines for Environment, Health and Safety of the World Bank	Compliance of Environmental Impact Assessment or Environmental Management Plan
Dust or particulate matter (PM) are the most common pollutants in unorganized emissions. Certain operations (such as transport and open-air storage of solid materials) and uncovered soil surface (including non-paved roads) will release particulate matter. The recommended prevention and control techniques for these emission sources include: taking measures to control the dust, such as coverage, water spray, or increasing the moisture content of outdoor material stack, or adopting dust-control equipment, including the use of bag-type dust collector or cyclone dust collector for air extraction and processing at material handling sites, e.g. conveyors or material warehouse; spraying water to control the dust produced by material delivery on paved or unpaved roads. It is not recommended to use oil and oil by-products to control road dust.	During the construction and operation of this project, appropriate measures will be taken to control the dust, such as coverage, water spray, or increasing the moisture content of outdoor material stack, spraying water to control the dust produced by material delivery on paved or unpaved roads. These measures are in compliance with the Guideline.
Industrial wastewater: relevant process and engineering measures should be taken to minimize the phase transfer of pollutants, such as transfer from liquid to air, soil or underground. If rainwater treatment is needed to protect the water quality, it is necessary to give priority to the management and treatment of initial rainwater runoff, because initial runoff often contains large amounts of potential contaminants.	This project will take measures to pretreat wastewater generated by the project, deliver unrecyclable wastewater to the sewage treatment plant. Anti-seepage measures will be taken for pipelines and processing facilities, so as to reduce the transfer of pollutants. This project will collect the initial rainwater at the curing yard during construction period.
If the noise generated by project facilities or construction activities at the most sensitive point of reception is expected to exceed the relevant noise standards, then noise prevention and control measures should be adopted.	This project will select low-noise equipment and install vibration isolation devices in mechnical equipment; The operation time of particular equipment or operations will be restricted, especially the mobile noise sources in the community;
Project construction and demolition: during the process of new project development, completion of the project life cycle and expansion or modification of existing project facilities, the impact of this project on the health and safety of the community should be avoided and controlled.	The impacts of project construction and demolition have been listed in the Environmental Management Plan and mitigation measures.
EHS guieline on Solid Waste Management Faciliteis	Design, construction and operation of project solid waste management faciliteis have into account the guidelines

2.3.3 Compliance analysis of this project to national laws, regulations and industrial policies

The Environmental Impact Assessment document is prepared in full accordance with national laws regulations and guidelines. The compliance of this project to relevant domestic legislations is shown in **Table 2.3-3**.

Table 2.3-3Compliance of this project to national laws and regulations

Chinese laws and regulations	Relevant provisions	Compliance
Environment Impact Assessment Law of the People's Republic of China	The environmental impact assessment shall be conducted in accordance with this law on the projects that may affect the environment and be built in the territory of the People's Republic of China and other sea areas under the jurisdiction of the People's Republic of China.	A complete EIA report has been prepared by qualified institutions and approved by Zhuzhou Shifeng Environmental Protection Bureau. Two rounds of public consultations have been carried out.
Environmental Protection Law of the People's Republic of China	Article 50: People's governments at various levels shall allocate funds in the budget to support environmental protection work, such as drinking water source protection in rural areas, domestic sewage and other waste disposal, pollution control of livestock and poultry breeding and slaughter, soil pollution prevention and rural industrial pollution control, etc. Article 32: The country shall enhance the protection of air, water and soil, establish and improve relevant survey, monitoring, evaluation and restoration system. Article 33: Governments at all levels shall strengthen the protection of agricultural environment, promote the use of new technologies for agricultural environmental protection, enhance the monitoring and early warning of agricultural pollution, coordinate relevant departments to take measures to prevent ecological disruption, such as soil pollution, land desertification, salinization, impoverishment, stony desertification, land subsidence, vegetation destruction, soil erosion, eutrophication, water depletion and species extinction, and also promote comprehensive prevention and control of plant pests.	The project includes the remediation of contaminated soil, and conforms to the provisions for soil remediation and pollution prevention stipulated in Environmental Protection Law of the People's Republic of China.
Cultural Relics Protection Law of the People's Republic of China	Article 32:In the course of construction of a project or agricultural production, all units and individuals that discover cultural relics shall keep the scene intact and immediately report to the local administrative department for cultural relics; after receiving the report, the department shall, except under special circumstances, rush to the scene within 24 hours and put forth its proposals on the handling of the matter within seven days. The administrative department for cultural relics may report to the local peoples government; requesting it to inform the public security organ of the matter and to seek its assistance in keeping the scene intact; and where important cultural relics are discovered, the matter shall immediately be reported to the administrative department for cultural relics under the State Council, which shall put forth its proposal on the handling of the matter within 15 days after receiving the report.	The project area has graves, Dawang Temple, Wuniang Temple and other cultural resources. The graves and Dawang Temple are located in the mountain area of the project site, and Wuniang Temple is also outside the restoration area. The project construction does not involve these physical cultural resources, and relevant measures to avoid its impact have been incorporated into the Environmental Management Plan. The procedures for accidental discovery have been established in the Environmental Management Plan.

Chinese laws and regulations	Relevant provisions	Compliance
Notice on Enhancing the Management on Environmental Impact Assessment of Construction Projects Financed by International Financial Organizations	When preparing the environmental impact assessment of financed project, attention shall be paid to the connection of domestic and overseas procedures in time sequence. The preparation and approval of EIA Outline shall be completed during the preparation stage of the project loaned by international financial organizations. While submitting the EIA Outline to the environmental protection department, construction unit shall simutaneously submit the EIA Outline to relevant international financial organization for suggestions, and timely submit the feedback to the environmental protection department that is responsible for approving the report of this project.	The EIA Report and Environmental Management Plan conform to the safeguard policies of the World Bank.
Opinions on Strengthening Soil Pollution Prevention and Control (HF[2008]No. 48)	Risk assessment and remediation system shall be established for contaminated soil. If the original site after relocation of polluting enterprises and other potentially contaminated land will be redeveloped and utilized, the environmental protection department shall urge the responsible units or individuals to carry out a risk assessment of contaminated soil, confirm the responsible unit and technical requirements of soil remediation measures, supervise soil remediation on the contaminated site, and reduce the risk of land reuse, especially reuse as residential land, to human health. The original production and operation units shall be responsible for remediating soil and groundwater pollution caused by remaining pollutants and restoring soil functions. Supervision and inspection shall be enhanced on key industries and enterprises, such as chemical, electroplating, oil storage industries. Any soil pollution problem shall be timely handled. If regional or centralized industrial land will be changed into other uses, the local environmental protection department shall urge the relevant units to conduct risk assessment on the contaminated sites, and use the risk assessment conclusions as an important basis for EIA. Meanwhile, relevant departments shall carry out environmental impact assessment in accordance with the law, and inspect the environmental impact assessment documents according to established procedures. With respect to those sites that fail to pass the environmental impact assessment in accordance with the law, the environmental protection department shall not approve the environmental impact assessment document of the project site.	The project has carried out risk assessment of contaminated soil in accordance with the relevant provisions, and conducted soil remediation in line with the provisions of this document.

Chinese laws and regulations	Relevant provisions	Compliance
Notice on Guaranteeing Environmental Safety at the Re-developed Sites of Industrial Enterprises (HF[2012]No.140)	Fourthly, the contaminated sites shall be restored. Local environmental protection departments at all levels shall coordinate with relevant departments under the leadership of the local government to conduct remediation work on contaminated sites based on local conditions, and give priority to those contaminated sites with significant threats to living environment and safe drinking water; urge responsible personnel to take quarantine measures to prevent the spread of contaminants at contaminated sites. Only after the contaminated sites remediation is completed and can meet environmental requirements, the site can be put into use. Those contaminated sites without remediation are prohibited to be redeveloped and constructed with any projects expect for soil remediation.	The Qingshuitang industrial area where the project locates is listed as the pilot area of national heavy metal pollution remediation program in the Implementation Plan for Heavy Metal Pollution Remediation in the Xiang River River Basin. The contaminated soil in the project area is redeveloped after remediation, which is in line with Notice on Guaranteeing Environmental Safety at the Re-developed Sites of Industrial Enterprises (HF[2012]No.140).
Catalogue for Guiding Industrial Restructuring (Revised in 2013)	-	This project does not belong to the encouraged, restricted and eliminated projects defined in the Catalogue. This project is in line with Catalogue for Guiding Industrial Restructuring (Revised in 2011).
Implementation Plan for Heavy Metal Pollution Control in Xiang River River Basin	This Implementation Plan covers a total of 927 projects, with a total investment of 59.5 billion yuan. Of all these projects, 17 projects are located in Qingshuitang industrial area, including Qingshuitang industrial wastewater treatment and utilization project, comprehensive control project of waste residue containing heavy metals, and soil remediation project at heavy metal contaminated sites, etc.	This project belongs to soil remediation project at heavy metal contaminated sites in the key area included in the Implementation Plan.
The “Twelveth Five-Year Plan” for Environmental Protection in Zhuzhou City	In accordance with the “Twelveth Five-Year Plan for Comprehensive Prevention and Control of Heavy Metal Pollution” approved by the State Council and “Implementation Plan for Heavy Metal Pollution Control in Xiang River River Basin”, the comprehensive control of heavy metal pollution shall be enhanced, and detailed implementation plan for key control area shall be prepared. Focus shall be given to Zhuzhou Smelter Group’s project of Kivcet direct lead smelting process in place of sintering blast lead smelting process, comprehensive control project of air pollution caused by heavy metals, heavy metal sediment control project in Qingshuitang Industrial Zone, comprehensive control project of waste gas and wastewater produced by heavy metal enterprises in Chaling Youxian, comprehensive control project of heavy metals prduced by ceramic pigment industry in Liling, resident resettlement project in areas polluted by heavy metals, so as to gradually eliminate risks of heavy metal pollution and ensure environmental safety.	This project belongs to heavy metal sediment control project in Qingshuitang Industrial Zone, and conforms to the “Twelveth Five-Year Plan” for Environmental Protection in Zhuzhou City.

3 Site Investigation

3.1Land use types of the project area

The project area is located in the southern part of Qingshuitang Industrial Zone (QIZ) in the Shifeng District, with an area of approximately 8.48 km^2.

The project area has a total of 19 land use types, among which urban construction land is mainly in the eastern and northern parts of the project area, woodland and grassland are mainly located in the western part of the project area, as shown in **Table 3.1-1** and **Figure3.1-1**.

Table 3.1-1Proportion of each land use type in the project area

No.	Land type	Area(m^2)	Proportion (%)
1	Mining site	237824	2.80
2	Urban area	3171502	37.40
3	Village	1354398	15.97
4	Scenic spots and special land	1354	0.02
5	Highway land	99948	1.18
6	Ditch	62662	0.74
7	Dry land	315022	3.71
8	River	9906	0.12
9	Pond	255112	3.01
10	Uncovered land	70702	0.83
11	Inland beach	8551	0.10
12	Other grassland	1150860	13.57
13	Other woodland	220319	2.60
14	Land for hydraulic construction	171334	2.02
15	Paddy field	89446	1.05
16	Railway land	2728	0.03
17	Woodland	1079612	12.73
18	Fruit garden	609	0.01
19	Marshland	178290	2.10
Total		**8480181**	**100.00**

Combining the general layout of land use provided by Land and Resources Bureau of Zhuzhou City and the actual site situation, we have divided the 19 land use types within the perspective of environmental governance into five broad categories: this is to facilitate the drawing up & implementing of sampling programs, to simplify subsequent description of follow-up relevant chapters, and to optimize the selection of governance roadmap.

(1) Industrial land: 1,536,220m^2, accounting for 18.1% of the total land;

(2) Residential land: 3,501,516 m^2, accounting for 41.3% of the total land;

(3) Farmland and wasteland: 1,626,639 m^2, accounting for 19.2 of the total land;

(4) Woodland: 3,501,516 m^2, accounting for 15.3% of the total land;

(5) Water area: 514,521 m^2, accounting for 6.1% of the total land.

According to the No.748 Letter sent by the Ministry of Land and Resources in November 2008, the contaminated land in Qingshuitang area is not suitable for crop planting, and it is required to change land classification, and the members in the collective economic organization in the land shall be correspondingly relocated and compensated. According to the document published by the Ministry of Land and Resources in 2009, the agricultural land within the range of 6.7 square kilometers in the core zone of Qingshuitang area shall be transformed into construction land in one time, the residents in the communities and villages governed by Tongtangwan Office shall be changed into urban residents and be brought into the network of urban resident employment and social security, and the land contracted by the original economic organization hasn't been the income source of the residents in the area.

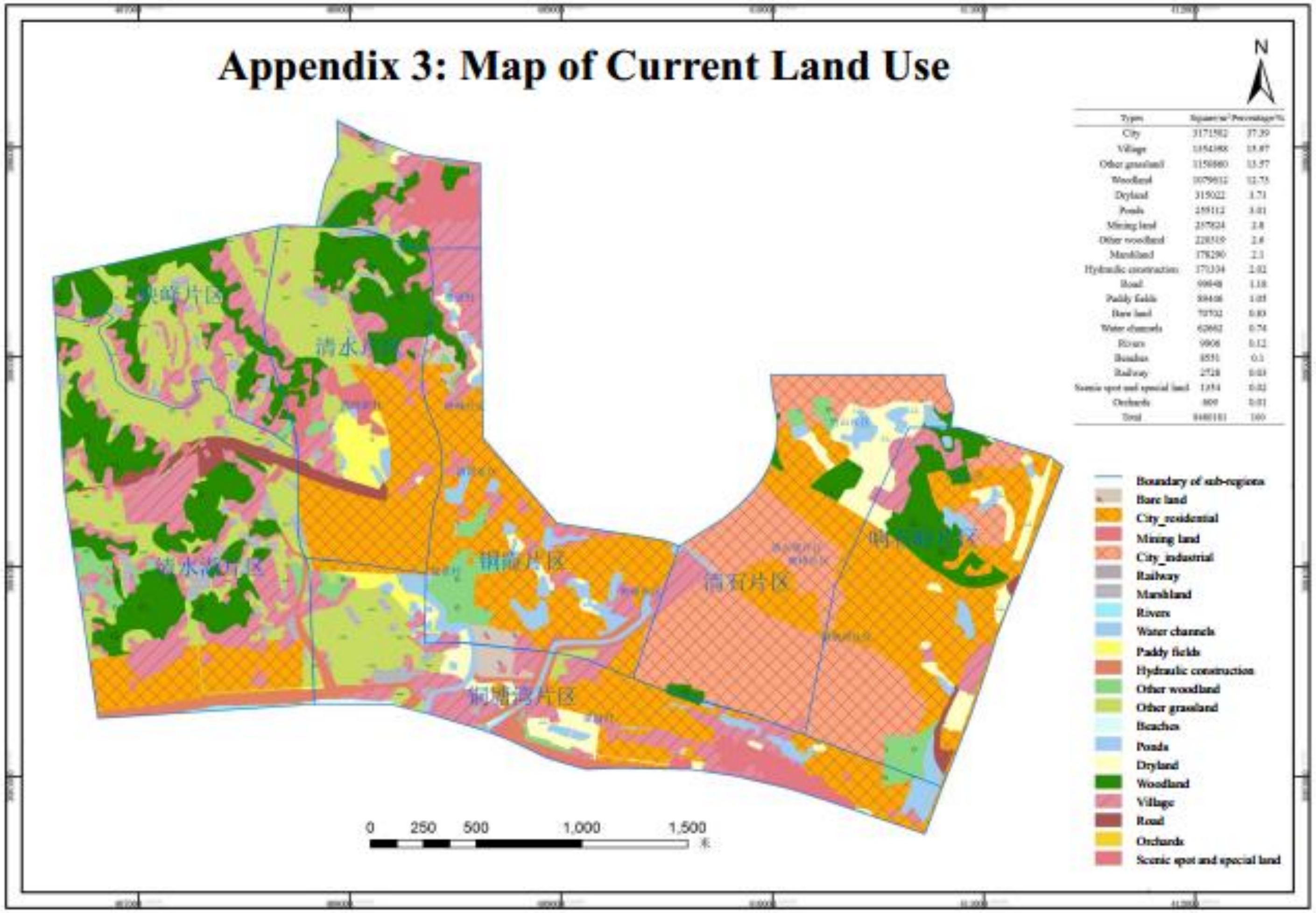


Figure3.1-1Map of current land use in the project area

During the preparation stage of the project, we carried out detailed land utilization survey and environmental site investigation . According to the overall planning and administrative division of QIZ, the project area is divided into seven sub-regions, including Xiangshiling, Qingshi, Tongtangwan, Tongxia, Qingshui, Yingfeng, and Qingshui Lake. The sub-region division is shown in **Figure5.2-1**.

During the period of 2011~2012, the Engineering Technology Research Center for Ecological Restoration of Contaminated Sites, Nanjing Institute of Soil Science, Chinese Academy of Sciences conducted environmental surveys on farmland soil, agricultural products, shallow groundwater, surface water and sediment in Tongtangwan, Xiangshiling and Qingshi Sub-regions of QIZ in Zhuzhou, and completed the preparation of the following reports:

- Environmental Survey Report of Tongtangwan Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Environmental Survey Report of Xiangshiling Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Environmental Survey Report of Qingshi Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Environmental Survey Report of Shallow Groundwater in Qingshuitang Industrial Zone

During the period of 2011~2014, the Center for Survey, Assessment and Remediation of Contaminated Sites, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection conducted soil surveys in Tongxia, Qingshui, Yingfeng, Qingshui Lake No. I and Qingshui Lake Sub-region Zone IIs of QIZ, and completed the preparation of the following reports:

- Soil Pollution Survey Report of Tongxia Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Soil Pollution Survey Report of Qingshui Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Soil Pollution Survey Report of Yingfeng Sub-region in Qingshuitang Industrial Zone of Zhuzhou City;
- Soil Pollution Survey Report of Qingshui Lake Sub-region Zone I in Qingshuitang Industrial Zone of Zhuzhou City;
- Soil Pollution Survey Report of Qingshui Lake Sub-region Zone II in Qingshuitang

Industrial Zone of Zhuzhou City

In 2014, the project owner and the project FSR consultant Hunan New World Science & Technology Co., Ltd. conducted detailed land use survey on the projevct area. Further environmental survey was carried out on closed enterprises, pond (channels), waste piles and open soil in residential area of the project area. The survey's sampling process is in strict accordance with Technical Guidelines for Site Environmental Survey (HJ 25.1-2014), Technical Guidelines for Site Environmental Monitoring (HJ 25.2-2014), Technical Specifications for Soil Environmental Monitoring (HJ/T166-2004) and Technical Specifications for Surface Water and Wastewater Monitoring (HJT 91-2002).

In December 2014, the project EIA unit, i.e. the EIA Center of Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection entrusted Changsha Environmental Protection College to monitor the surface water environment of the project area, and collect the monitoring data of water intake section at No. 3 Water Plant during the period of 2012-2014 and monitoring data of Xiawan (control section) at Zhuzhou section of Xiang River River during the period of 2010-2013 from Zhuzhou Environmental Monitoring Center Station, as shown in Status quo of Surface Water Environment in Section 9.4.2.

In October 2014, Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province conducted a survey on groundwater environment in the project area and prepared Special Report for Groundwater Environment Impact Assessement of Qingshuitang Circular Economy Industrial Zone in Zhuzhou City.

This section will present the survey data and conclusions of the above survey units.

3.2 Current Land Use in the Project Area

3.2.1 Current Land Use in Xiangshiling Sub-region

Xiangshiling Sub-region covers a total area of 1.24 km^2, located in the easternmost part of the project area. The location of this sub-region is shown in **Figure3.2-1**. The main land types in Xiangshiling Sub-region are plant site and residential area. The plant site covers an area of 0.57km^2, accounting for 50% of the total sub-region area. The most area is occupied by Zhuzhou Iron and Steel Co., Ltd. in the southern part and Yujiaping Oil Depot in the north of Changsha-Zhuzhou-Xiangtan International Logistics Railway. The residential area is 0.35km^2, concentrated in the central and northern parts of the sub-region. Tongxia Road passes through the central residential area from east to west. The site photos of this sub-region are shown in **Figure3.2-2**.

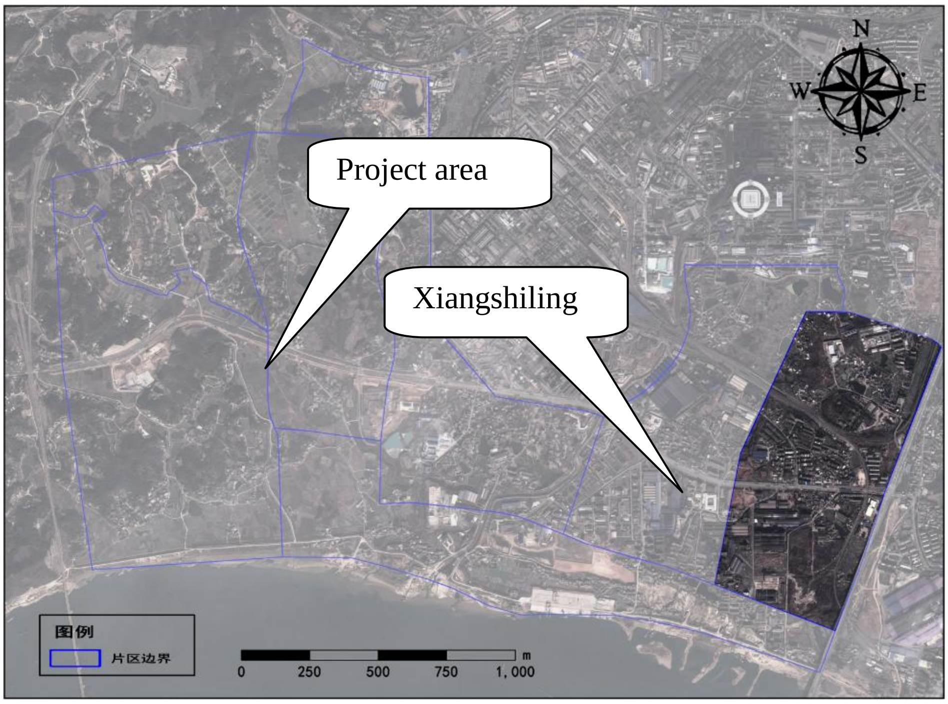


Figure3.2-1Map of Xiangshiling Sub-region

a. Vegetable field in Xiangshiling Sub-region

b. Pond in Xiangshiling Sub-region

c. Residential area in Xiangshiling Sub-region

d. Part of Tongda Smelting Plant

e. Drilling core of Tongda Smelting Plant

f. Part of Tiancheng Chemical Plant

g. Drilling core of Tiancheng Chemical Plant

i. Excavated section of Tiancheng Chemical Plant

Figure3.2-2Site photos of Xiangshiling Sub-region (2014)

3.2.2 Current Land Use in Qingshi Sub-region

Qingshi Sub-region covers a total area of 1.21 km^2, located in the eastern part of the QIZ. The location of this sub-region is shown in **Figure3.2-3**. The western and northern boundaries of this sub-region are close to Zhuzhou Smelter Group Co., Ltd., Zhuzhou Chemical Plant (closed) and Liuhua Guicheng Chemical Co., Ltd. (the original Zhicheng Company), and the eastern boundary is adjacent to Xiangshiling Sub-region. This sub-region is an industrial cluster for metallurgical, chemical and building material industries in the QIZ. The site photos of this sub-region are shown in

Figure3.2-4.

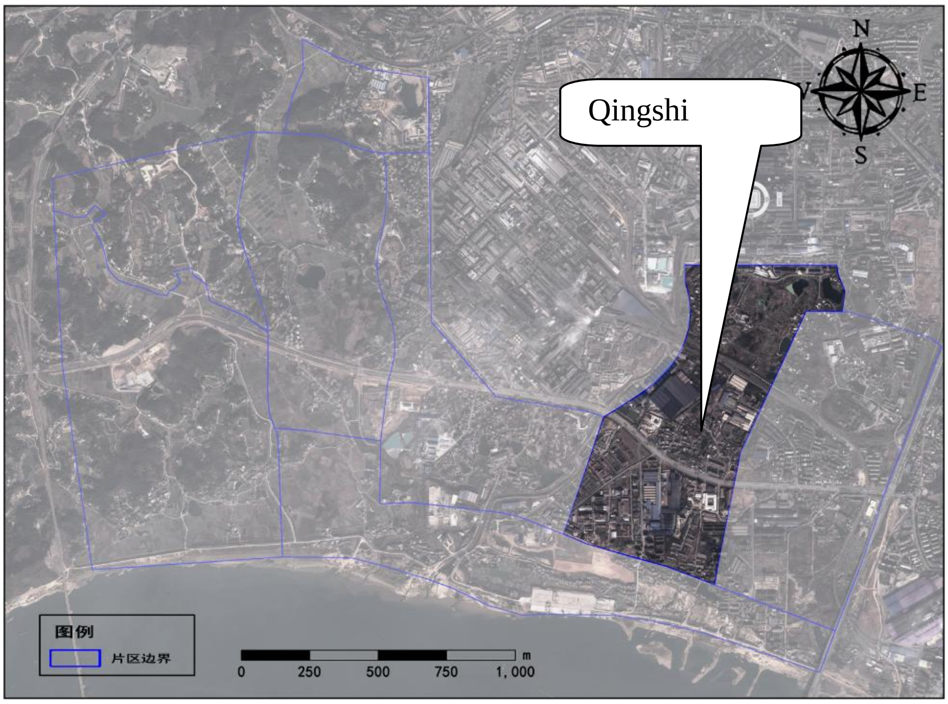


Figure3.2-3Map of Qingshi Sub-region

a. Vegetable field in Qingshi Sub-region

b. Pond in Qingshi Sub-region

c. Waste residue in Qingshi Sub-region

d. Drilling core of waste pile

e. Excavated section of waste pile

f. Part of Dongtai Industry Co., Ltd.

g. Excavated section of Dongtai Industry Co., Ltd.

i. Water well in residential area

Figure3.2-4Site photos of Qingshi Sub-region (2014)

Qingshi Sub-region is a region dominated by metallurgical, chemical and building material industries. The industrial enterprises are concentrated in the region, covering an area of about 0.71 km^2. The treatment of waste pile in the central area of the region has been completed. The residential area is about 0.16 km^2, concentrated in the central and northwestern parts of the region. Water ponds are scattered in the surrounding area of the plant and residential buildings.

3.2.3 Current Land Use in Tongtangwan Sub-region

Tongtangwan Sub-region covers a total area of 1.23 km^2, located in the southern part of the QIZ and adjacent to Xiang River River. The location of this sub-region is shown in **Figure3.2-5**. The southern boundary of this sub-region is Xiang River Dyke, and northern boundary is adjacent to Qingshui, Tongxia, Qingshi and Xiangshiling sub-regions. The entire sub-region is in the shape of horizontal strip. Its western boundary is adjacent to Qingshui Lake Sub-region. The Xiawan Xinqiao Low Discharge Channel passes through the southwest corner of the sub-region and flows into Xiang River River. The eastern boundary is Xiangtian West Road. The site photos of this sub-region are shown in **Figure3.2-6**.

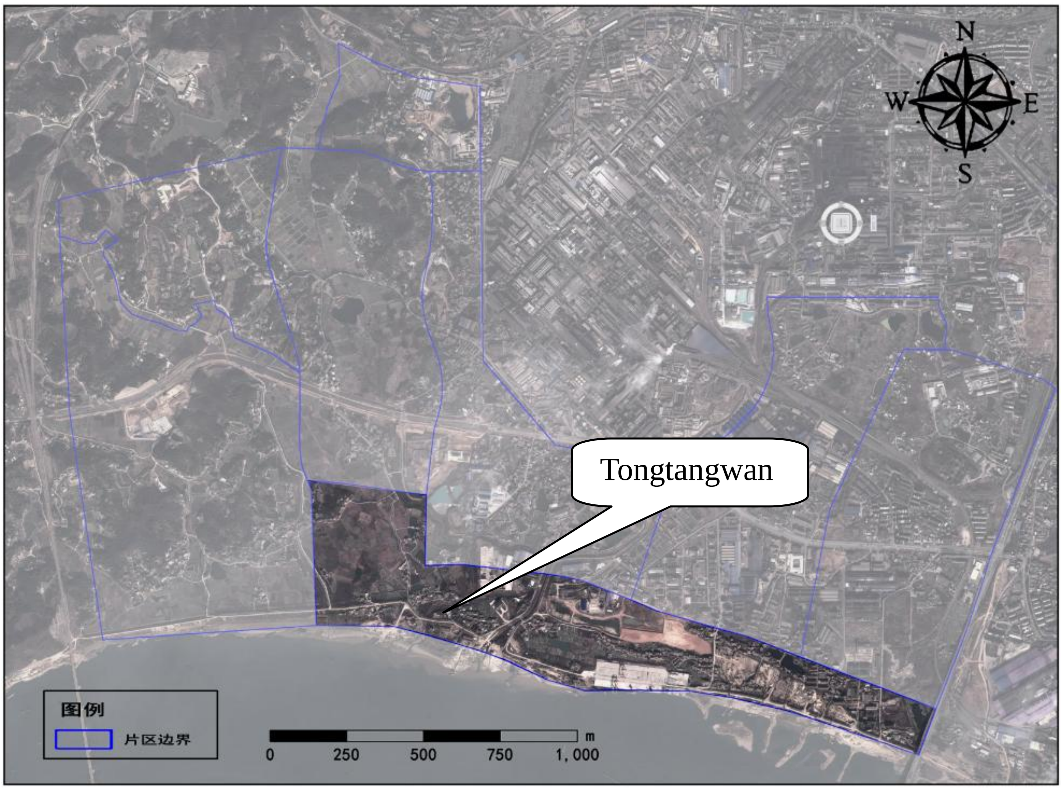


Figure3.2-5Map of Tongtangwan Sub-region

a. Vegetable field in Tongtangwan Sub-region

b. Pond in Tongtangwan Sub-region

c. Drilling core

d. Residential area

Figure3.2-6 Site photos of Tongtangwan Sub-region (2014)

Tongtangwan Sub-region is covered by a large area of farmland and residential buildings, among which the residential area is about 0.23 km^2 and concentrated in the central area near Dahu Zone and northeastern area near Zhuzhou Steel & Iron Co., Ltd. A number of water ponds covering an area of about 0.09 km^2 are scattered in the residential area, covering a total area of 0.14 km^2 along with vegetable field and wasteland. These fields are concentrated in the western part of the sub-region and generally left uncultivated. Since Tongtangwan Sub-region is adjacent to Xiang River River, this sub-region has many sandpits. The central part of the sub-region is a Dahu. Site remediation field, Dahu treatment site and Xiawan treatment site have been estalished in the sub-region.

3.2.4 Current Land Use in Tongxia Sub-region

Tongxia Sub-region covers a total area of 1.05 km^2. The location of this sub-region is shown in **Figure3.2-7**. This sub-region is generally covered by mountains, houses, vegetables, factories, mines and water ponds. Houses cover an area of 0.27km^2, accounting for 25.72% of the total area of the sub-region and mainly concentrated in the southern part; the waters cover an area of 0.14km^2, accounting for 13.33% of the total area of the sub-region and scattered in southwestern and southeastern parts; mountains cover an area of 0.09km^2, accounting for 8.57% of the total area and mainly concentrated in the northern part; vegetable field and idle land cover an area of 0.55km^2, accounting for 52.38% of the total area. The site photos of this sub-region are shown in **Figure3.2-8**.

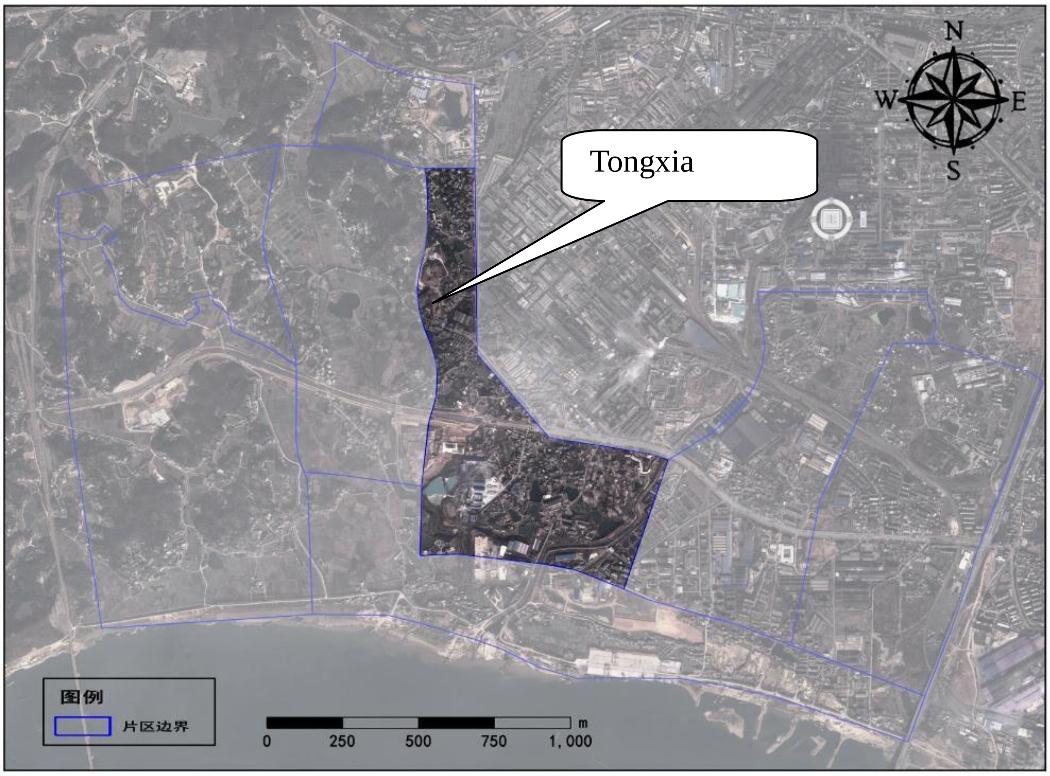


Figure3.2-7Map of Tongxia Sub-region

a. Vegetable field in Tongxia Sub-region **b. Villages in Tongxia Sub-region**

c. Roadside ditches and sporadic vegetable field in Tongxia Sub-region

d. Industrial residue pile

e. Yingfeng community

f. Heavy metal pollution remediation base besides the cement brick plant

g. Bare mountainous area

i. Wasteland in Tongxia Sub-region (in the north of Xinqiao waste pile)

j. Wasteland in the southwest of Tongxia Sub-region

h. Bank of Xiawangang (remote area is Hongji Zinc Plant)

Figure3.2-8Site photos of Tongxia Sub-region (2011)

3.2.5 Current Land Use in Qingshui Sub-region

Qingshui Sub-region covers a total area of 1.06 km^2, located in the western part of the QIZ. The location of this sub-region is shown in **Figure3.2-9**. This sub-region is an area that is concentrated with industrial enterprises, and also a transition area from industrial zone to agricultural land. The southern part of Qingshui Sub-region is adjacent to Tongxia Sub-region, its eastern boundary is about 300 m away from Zhuzhou Smelter Group, northern boundary is about 500 m away from the railway, western boundary is about 1200 m away from the railway, and southern boundary is about 800 m from the north bank of Xiang River River. The sub-region and the surrounding area are mainly rural residential area, along with farmland, ponds, woodlands and a few small businesses. The area between the eastern boundary and Zhuzhou Smelter Group is mainly rural residential area, scattered with industrial land, mines, vegetable field, ponds and woodland. The southern, northern and western parts of the sub-region have simple land use types, mostly farmland and mountain (forest) land.

Houses cover an area of 0.09km^2, accounting for 8.49% of the total area of the sub-region and mainly concentrated in the southwestern part; the waters cover an area of 0.10km^2, accounting for 9.43% of the total area of the sub-region; mountains cover an area of 0.25km^2, accounting for 23.58% of the total area and mainly concentrated in the northern and western parts; vegetable field and idle land cover an area of 0.62km^2, accounting for 58.49% of the total area. In addition, a limestone open-pit mine is located in the center of the sub-region, covering an area of 0.0224 km^2. The mountainous area in the eastern boundary of the sub-region is mining area, and the southeastern corner of this sub-region is Xinqiao waste pile. The site photos of this sub-region are shown in **Figure3.2-10**.

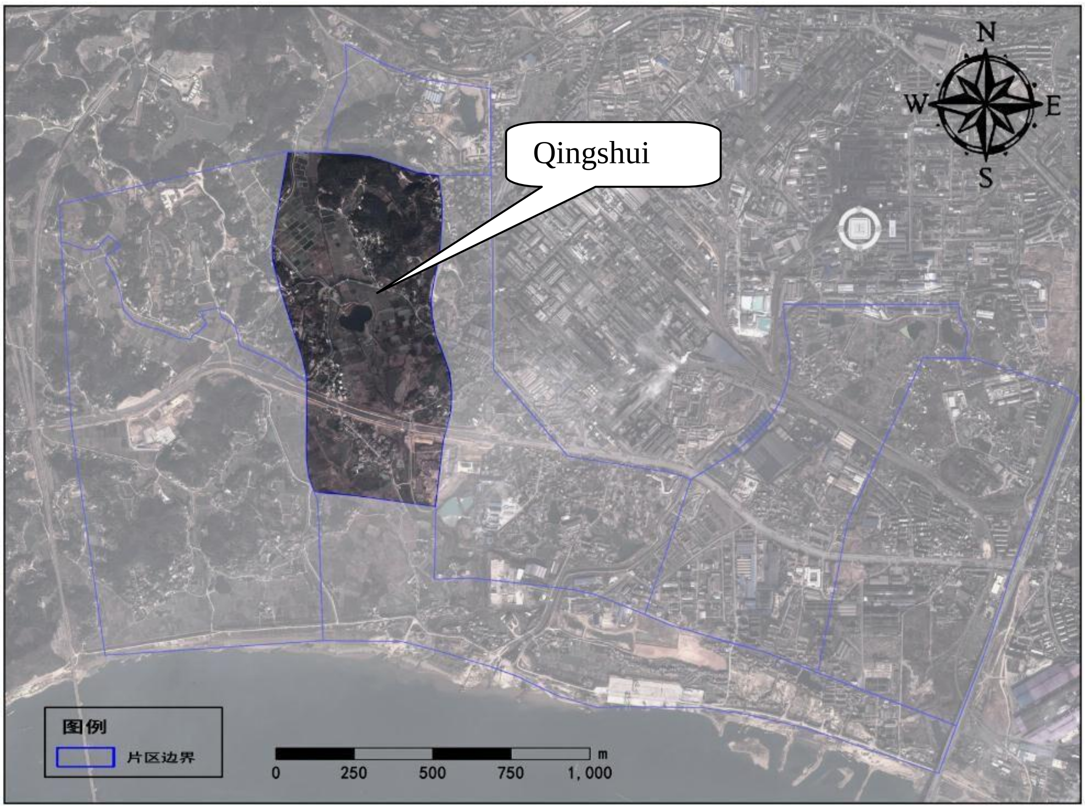


Figure3.2-9Map of Qingshui Sub-region

a. Paddy field in the center of Qingshui Sub-region

b. Marshland in the mid-south of Qingshui Sub-region

c. Vegetable field in the southeast of Qingshui Sub-region

d. Wasteland of Qingshui Sub-region (remote area is Zhuzhou Smelter)

e. Vegetable field in the north of Qingshui Sub-region

f. Wasteland in the mid-south of Qingshui Sub-region

g. Abandoned field besides Tongxia Road

h. Rural residential area in Qingshui Sub-region

Figure3.2-10 Site photos of Qingshui Sub-region (2011)

3.2.6 Current Land Use in Yingfeng Sub-region

Yingfeng Sub-region covers a total area of 0.90 km^2. Yingfeng Sub-region is divided into zone A and zone B. The location of this sub-region is shown in **Figure3.2-12**. Zone A is in the northern part of the QIZ (**Figure3.2-11**). The northern part of this zone is adjacent to Wuhan-Guangzhou high-speed rail, and the northern boundary is about 50m from the railway. The southern part of this sub-region is adjacent to Qingshui Sub-region and Tongxia Sub-region. The eastern boundary is Tongxia Road passing from north to south, while western boundary is irrigation canals with outside woodland. Zone B is in the westernmost part of the QIZ. The eastern part of this zone is adjacent to Qingshui Sub-region, and an irrigation canal is in the south of eastern boundary. The western boundary is about 100m from Wuhan-Guangzhou high-speed rail, and the area between western boundary and Wuhan-Guangzhou high-speed rail is mainly woodland, vegetable field and some rural residential area. The southern part of this zone is near vegetable fields. The main land use types of the northern part of zone B are woodland, ponds and rural residential area, as well as a waste pile. The site photos of this sub-region are shown in **Figure3.2-13**.

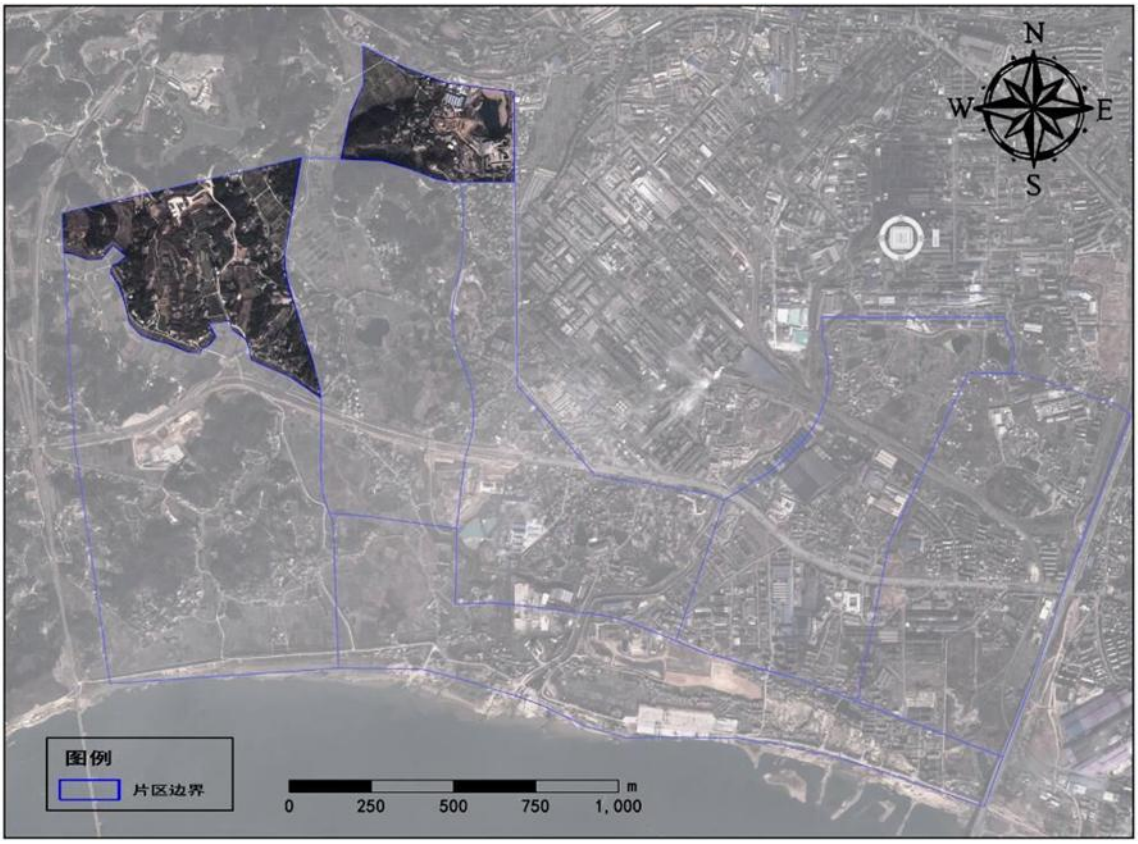


Figure3.2-11Map of Yingfeng Sub-region

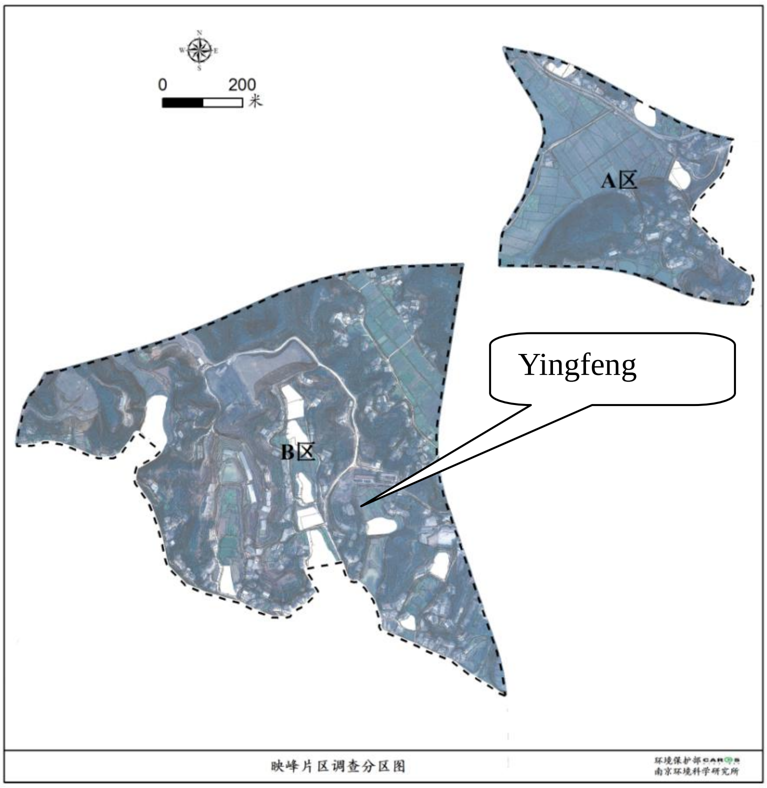


Figure3.2-12 Partition map of Yingfeng Sub-region

(1) Zone A

A half of zone A is paddy field, which is distributed in western and northern flat regions.

Qingxia Road passes through the northern part of the paddy field. The other half is woodland, rural residential area and water ponds, which are located in the eastern and southern hilly areas. Rural residential area is at the foothills, while water ponds are distributed in low-lying areas. Its eastern part is a cement plant and quarry (**Figure3.2-13** a). Due to limited sampling conditions, this quarry is not included in the survey scope. Zhuzhou Smelter Group is in the east of the quarry. The woodland is well covered by vegetation and thickly growing grass. The mountain topsoil is generally covered with vegetation, dry branches, fallen leaves and humus (**Figure3.2-13** b).

(2) Zone B

The land use types of zone B are mainly woodland, rural residential area, grassland, ponds and waste pile. The northern part of this zone is well covered by vegetation (**Figure3.2-13**c)., with thickly growing grass, fallen leaves and humus covered on topsoil. The rural residential area is distributed surrounding mountainous region. Most buildings are 2-3 storey houses built by rural residents themselves. The central part of this zone is col, along with water ponds and vegetable fields. A waste pile enclosed by fence is in the northern mountainous region of this zone. Beyond southern fence of the waste pile is a water pond (**Figure3.2-13**d). .

a) Cement plant in the eastern part of zone A (the building belongs to the cement plant)

b) Mountainous region in the eastern part of zone A

c) Mountainous region in the northern part of zone B

d) Southern part of waste pile in zone B (Waste pile is on the left side)

Figure3.2-13Site photos of Yingfeng Sub-region (2014)

3.2.7 Current Land Use in Qingshuihu Sub-region

The Qingshuihu Sub-region is divided into zone I and zone II. The location of this sub-region is shown in**Figure3.2-14**.

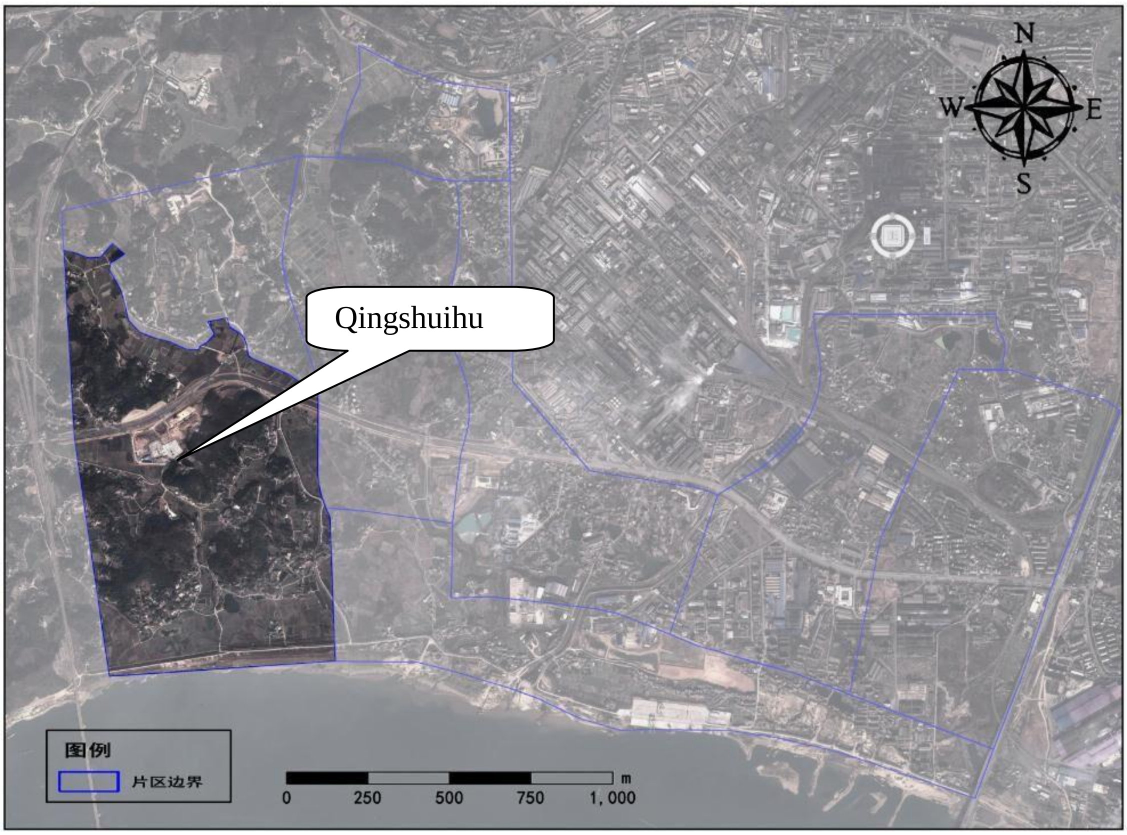


Figure3.2-14Map of Qingshuihu Sub-region

3.2.7.1 Qingshuihu Zone I

Qingshuihu Zone I is located in the middle of western part of the QIZ. Its eastern boundary is adjacent to Qingshui Sub-region, while the western boundary is about 100m from the Wuhan-Guangzhou high-speed rail. The area between western boundary and Wuhan-Guangzhou high-speed rail is mainly woodland, farmland and some rural residential area. The southern boundary is near Qingshuihu Zone II. The northern boundary is close to Yingfeng Sub-region. The main land-use types of Qingshuihu Zone I are farmland and woodland, surrounded by rural residential areas. Its eastern boundary is Tongxia Road from south to north, while western boundary is an irrigation canal that is about 600m from memorial park surrounded by woodland. The total area of Qingshuihu Zone I is 0.72km^2.

The division of Qingshuihu Zone I is shown in **Figure3.2-15**.

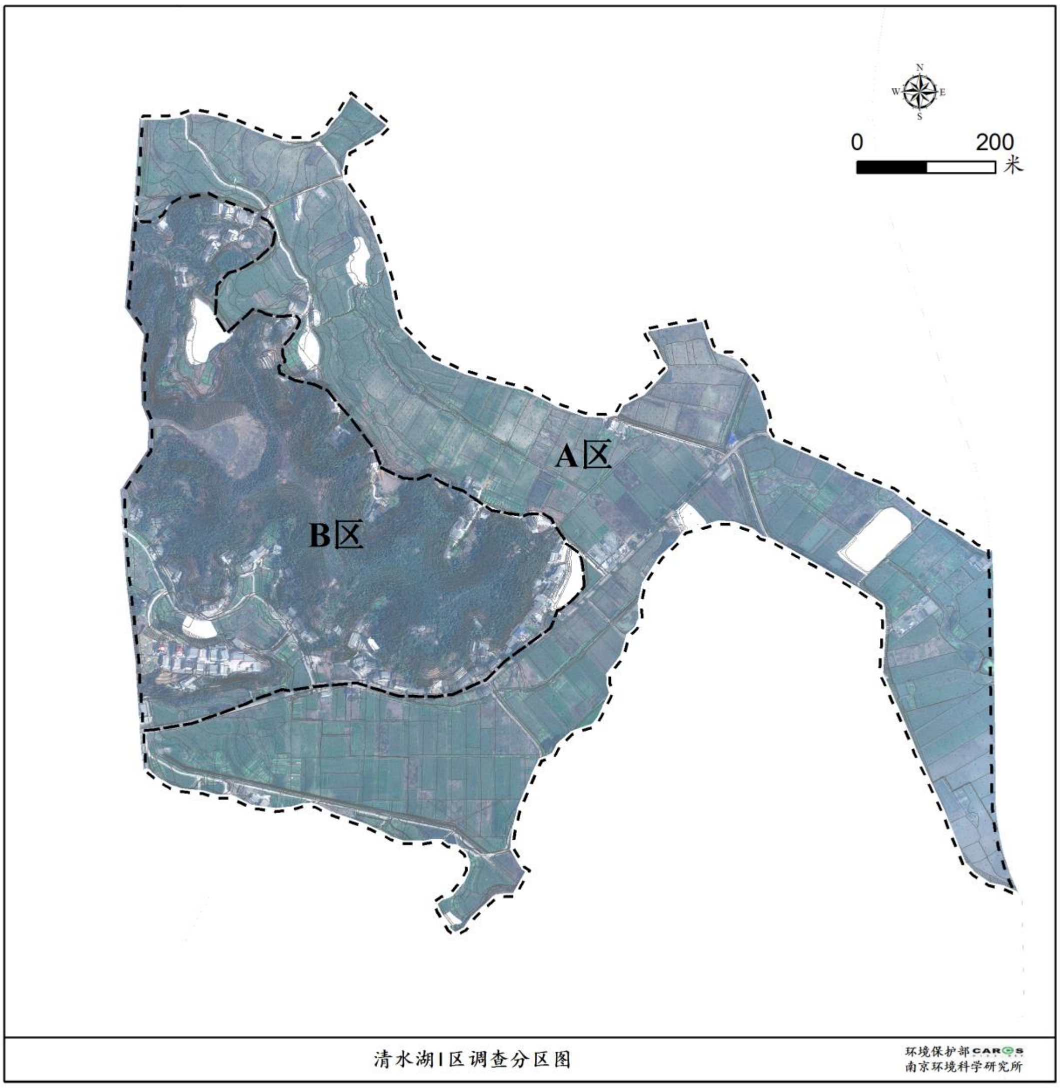


Figure3.2-15Partition map of Qingshuihu Zone I

During the survey, Qingshuihu Zone I is divided into 2 sub-zones, i.e. sub-zone A and subzone B. Sub-zone A covers an area of 0.45 km^2, and sub-zone B covers an area of 0.27 km^2.

(1) Sub-zone A

Sub-zone A is a narrow strip in the northern, western and southern mountainous regions. It is in the northern part of the Qingshuihu Zone I, with relatively flat terrain and slight high elevations in the north and west. The land use types are generally paddy field (**Figure3.2-16** a)., scattered with two or three water ponds. During the survey, the paddy field has not been sown and accumulated with water. XB07 county road passes through the sub-zone. The sub-zone is surrounded by paddy field in the east, and rural residential areas around the mountains in other directions (**Figure3.2-16** b). .

(2) Sub-zone B

Sub-zone B is a mountainous area in the western zone. The western boundary of this sub-zone is adjacent to Wuhan-Guangzhou high-speed rail (**Figure3.2-16**c), while the southern boundary of this sub-zone is XB07 County Road. The main land use types of this sub-zone are woodland and rural residential area. The woodland is well covered by vegetation, and rural residential buildings are mainly built in the foothills of the southern part (**Figure3.2-16**d) along XB07 County Road. This sub-zone has a small number of water ponds and sporadic vegetable fields.

a). Paddy fields in Sub-zone A

b). Residential buildngs around mountains in Sub-zone A

c). Mountainous area in the western part of Sub-zone B (adjacent to Wuhan-Guangzhou high-speed rail)

d). Residential buildings in the foothills of the southern part of Sub-zone B

Figure3.2-16Site photos of Qingshuihu Zone I (2014)

3.2.7.2 Qingshuihu Zone II

Qingshuihu Zone II is located in the westernmost part of the QIZ. Its eastern boundary is adjacent to Qingshui Sub-region, and an irrigation canal is in the south of eastern boundary. The western boundary is about 100m from Wuhan-Guangzhou high-speed rail, and the area between western boundary and Wuhan-Guangzhou high-speed rail is mainly woodland, farmland and some rural residental area. The southern part of this zone is adjacent to Xiang River River, and the northern boundary is Qingshuihu Zone I. The main land use types of this zone are woodland, vegetable fields, rural residential area and water ponds. Farmland is distributed along the Xiang River River.

Qingshuihu Zone II covers a total area of 1.12km^2, as shown in **Figure3.2-17**.

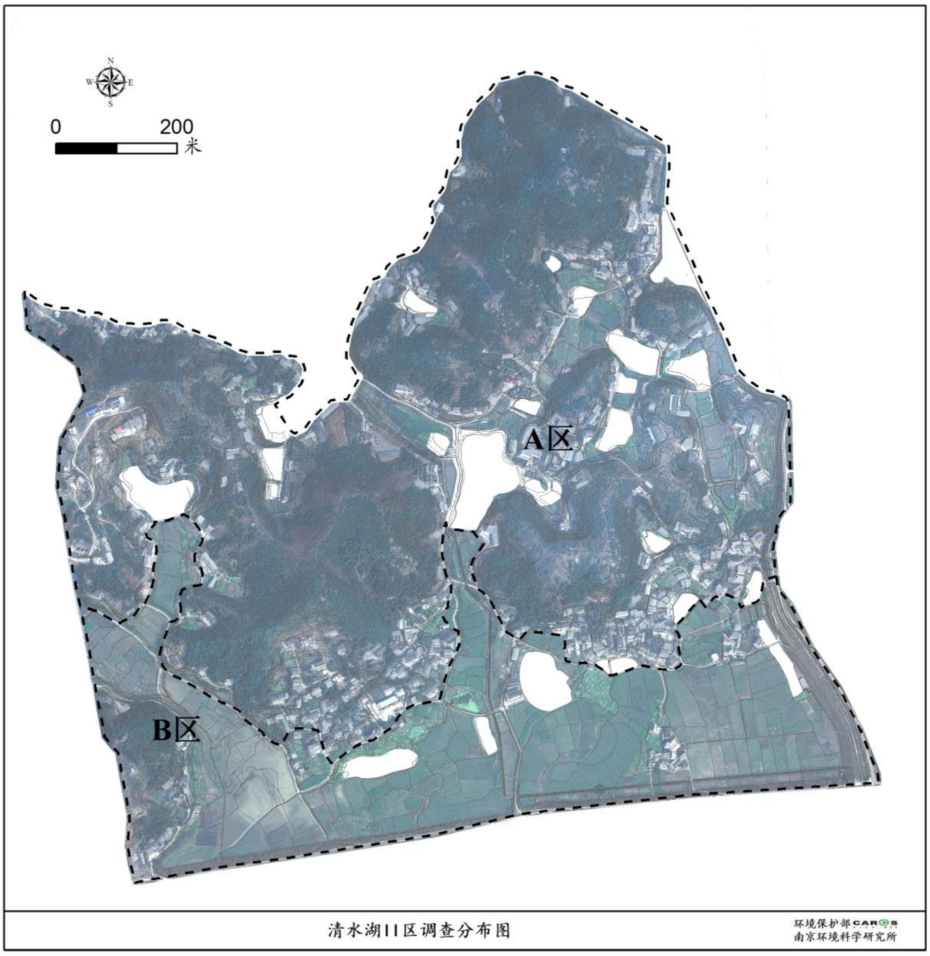


Figure3.2-17 Partition map of Qingshuihu Zone II

During the survey, Qingshuihu Zone II is divided into 2 sub-zones, i.e. sub-zone A and sub-zone B. Sub-zone A covers an area of 0.77 km^2, and sub-zone B covers an area of 0.35 km^2.

(1) Sub-zone A

Sub-zone A is a mountanous region in the southern part of Qingshuihu Zone II. Its western boundary is adjacent to Wuhan-Guangzhou high-speed rail, and eastern boundary is an irrigation canal (**Figure3.2-18** a). . The main land-use types of this sub-zone are woodland and rural residential area. The col is distributed with water ponds and vegetable fields (**Figure3.2-18** b). . The woodland is well covered by vegetation (**Figure3.2-18** c). . Most rural residential buildings are distributed in the foothills of the southern part of this sub-zone, and other rural residential buildings are distributed sporadically around mountains.

(2) Sub-zone B

Sub-zone B is in the southernmost part of Qingshuihu Zone II. Its eastern boundary is an irrigation canal, western boundary is Wuhan-Guangzhou high-speed rail, southern boundary is Xiang River Dyke (**Figure3.2-18** d), and northern boundary is adjacent to sub-zone A. The main land use type of this sub-zone is paddy field. During the survey, the paddy field has not been sown, accumulated with water and grown with weed. A hill in the western part of this sub-zone is adjacent to Wuhan-Guangzhou high-speed rail. This sub-zone also has a small number of water ponds, vegetable fields and sporadic rural residential buildings (**Figure3.2-18**e).

a). **Irrigation canal at eastern boundary of sub-zone A**

b). **Water ponds and vegetable fields around rural residential buildings in sub-zone A**

c). **Mountainous region in the southern part of sub-zone A**

d). **Paddy field in sub-zone B (near Wuhan-Guangzhou high-speed rail and Xiang River Dyke)**

e). Paddy fields in the eastern part of sub-zone B

Figure3.2-18 Site photos of Qingshuihu Zone II

3.3 Site contamination investigation

3.3.1 Site survey and monitoring scheme

3.3.1.1 Soil pollution survey

Soil sampling survey has been conducted in the 7 sub-regions, i.e. Yingfeng, Qingshuihu, Qingshui, Tongxia, Tongtangwan, Qingshi and Xiangshiling sub-regions. The sampling points and number of samples in 7 sub-regions are shown in **Table 3.3-1**.

Table 3.3-1 Soil sampling points and number of samples in 7 sub-regions

No.	Sub-region	Points/number	Number of samples/number
1	Xiangshiling	12	26
2	Qingshi	26	58
3	Tongtangwan	55	117
4	Qingshui	29	83
5	Tongxia	17	53
6	Yingfeng	91	270
7	Qingshuihu	177	537
Total		407	1144

The soil sampling points of each sub-region are shown in the following figures.

Yingfeng Sub-region has 91 soil sampling points, including 36 points in woodland, 9 points in paddy field, 23 points in vegetable fields and 23 points in wasteland. The soil sampling depth is generally 0.6m, and the samples are taken in three layers (0-20cm, 20-40cm and 40-60cm). The sampling points are shown in **Figure3.3-1**.

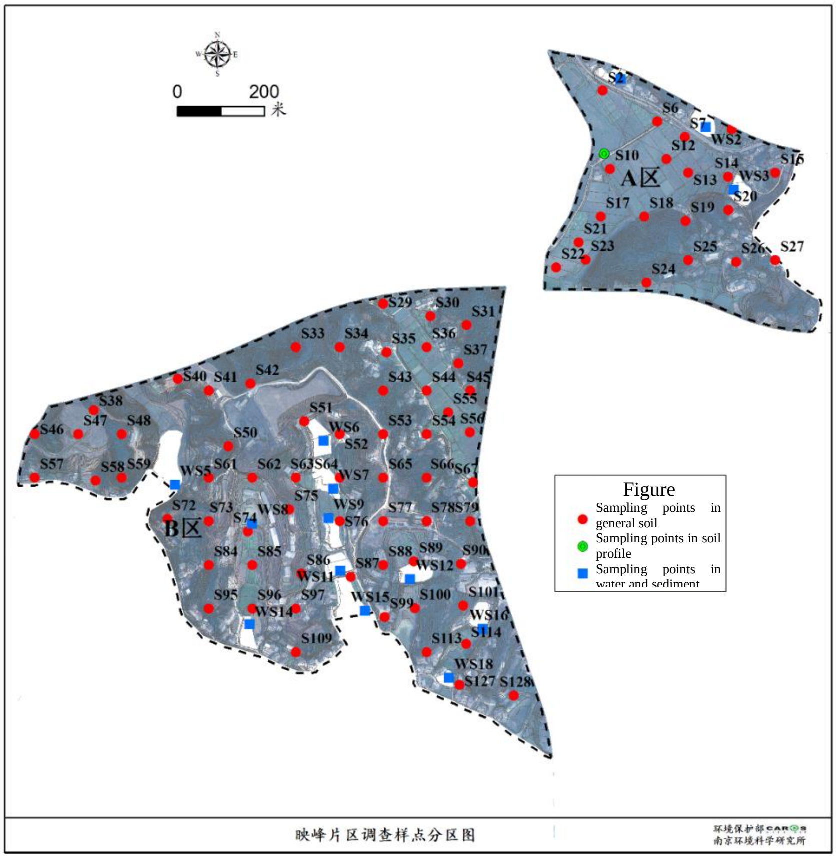


Figure3.3-1Soil sampling points in Yingfeng Sub-region

Soil survey in Qingshui LakeQingshuihu Sub-region is carried out in Qingshuihu Zone I and Qingshuihu Zone II respectively.

Qingshui LakeQingshuihu Zone I has 76 soil sampling points, including 18 points in woodland, 56 points in paddy field and 2 points in vegetable fields. The soil sampling depth is generally 0.6m, and the samples are taken in three layers (0-20cm, 20-40cm and 40-60cm). The sampling points are shown in **Figure3.3-2**.

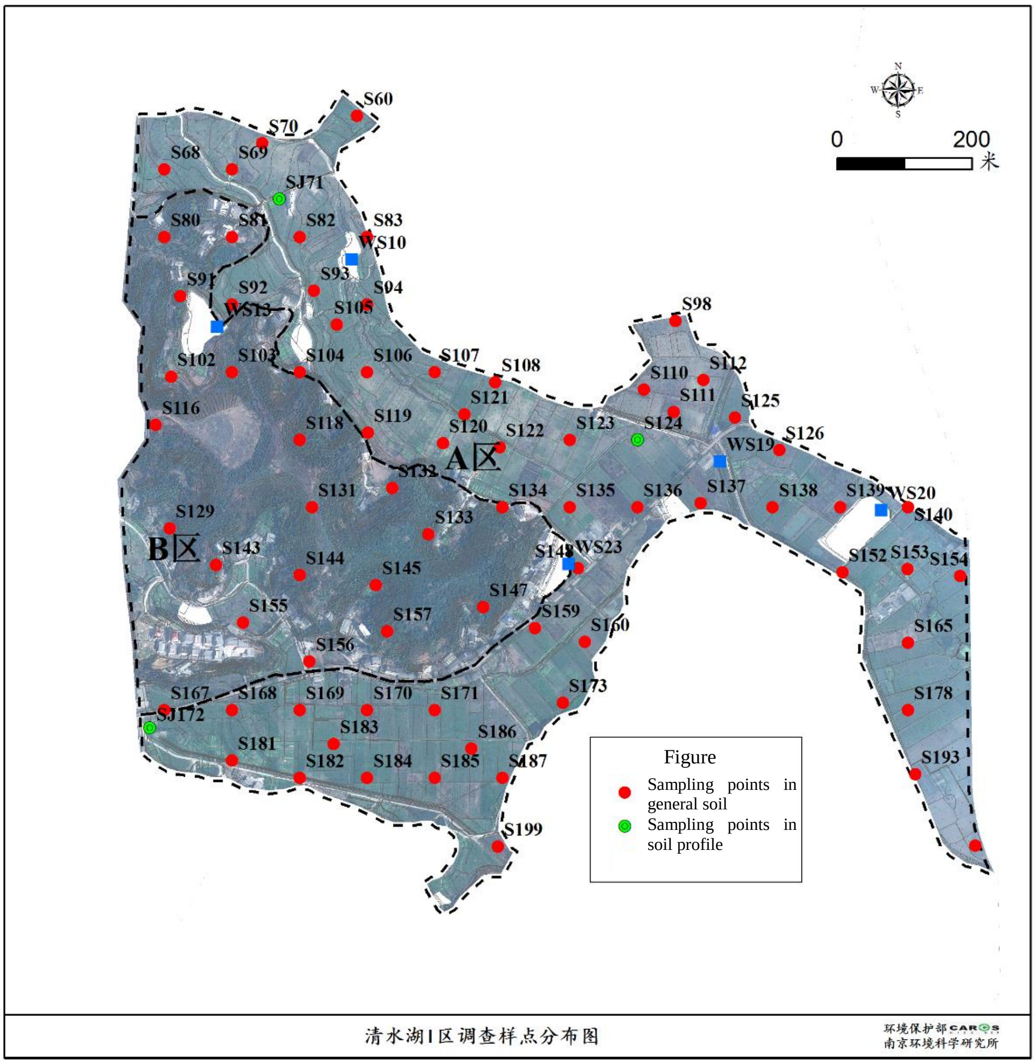


Figure3.3-2Soil sampling points in Qingshuihu Zone I

Qingshui LakeQingshuihu Zone II has 101 soil sampling points. The soil sampling depth is generally 0.6m, and the samples are taken in three layers (0-20cm, 20-40cm and 40-60cm). The sampling points are shown in **Figure3.3-3**.

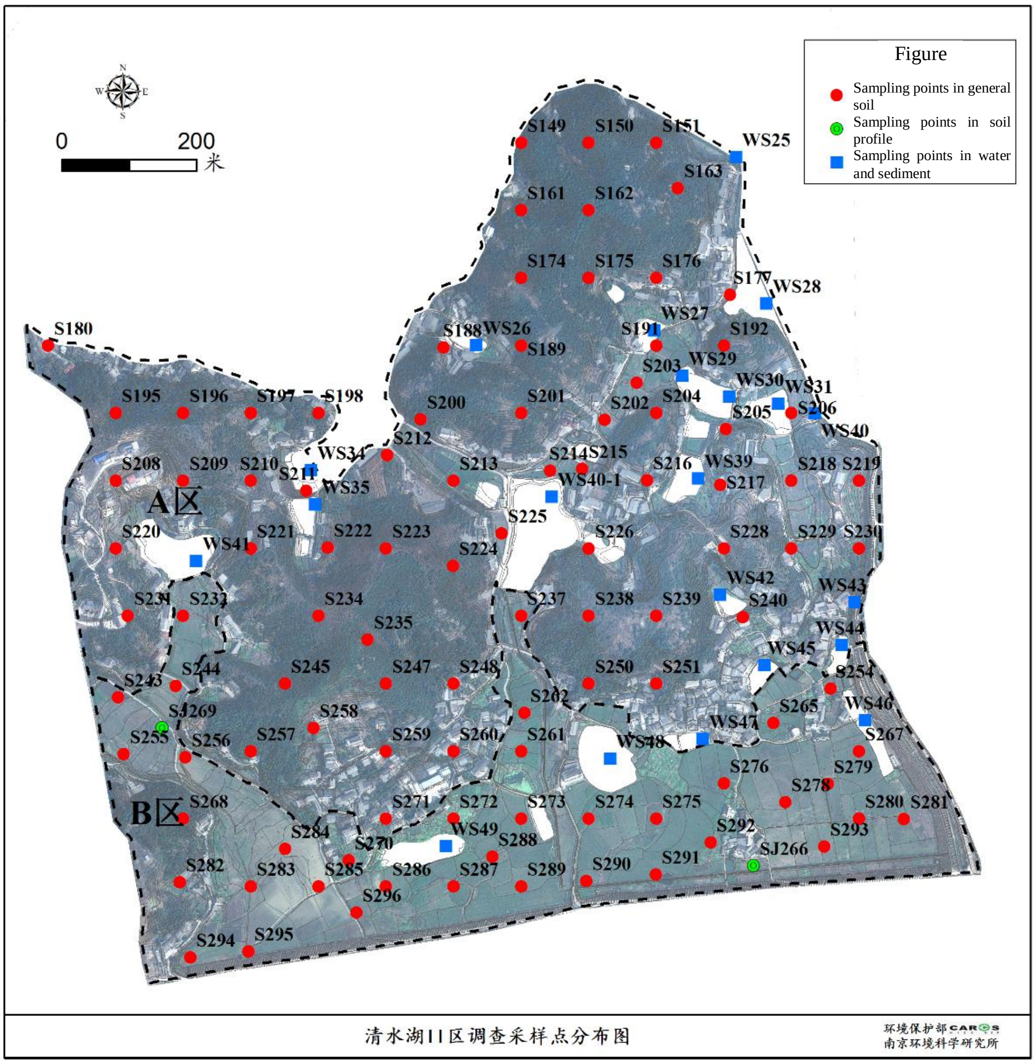


Figure3.3-3Soil sampling points in Qingshuihu Zone II

The soil sampling points of Qingshui Sub-region are concentrated in paddy fields. The soil sampling depth is generally 0.6m, and the samples are taken in three layers (0-20cm, 20-40cm and 40-60cm). The soil sampling depth in mountainous region is generally at 0-5cm at the surface of the soil, and soil samples are taken every 20cm below the surface soil. Qingshui Sub-region has a total of 29 sampling points and 83 soil samples. The soil sampling points are shown in **Figure3.3-4**.

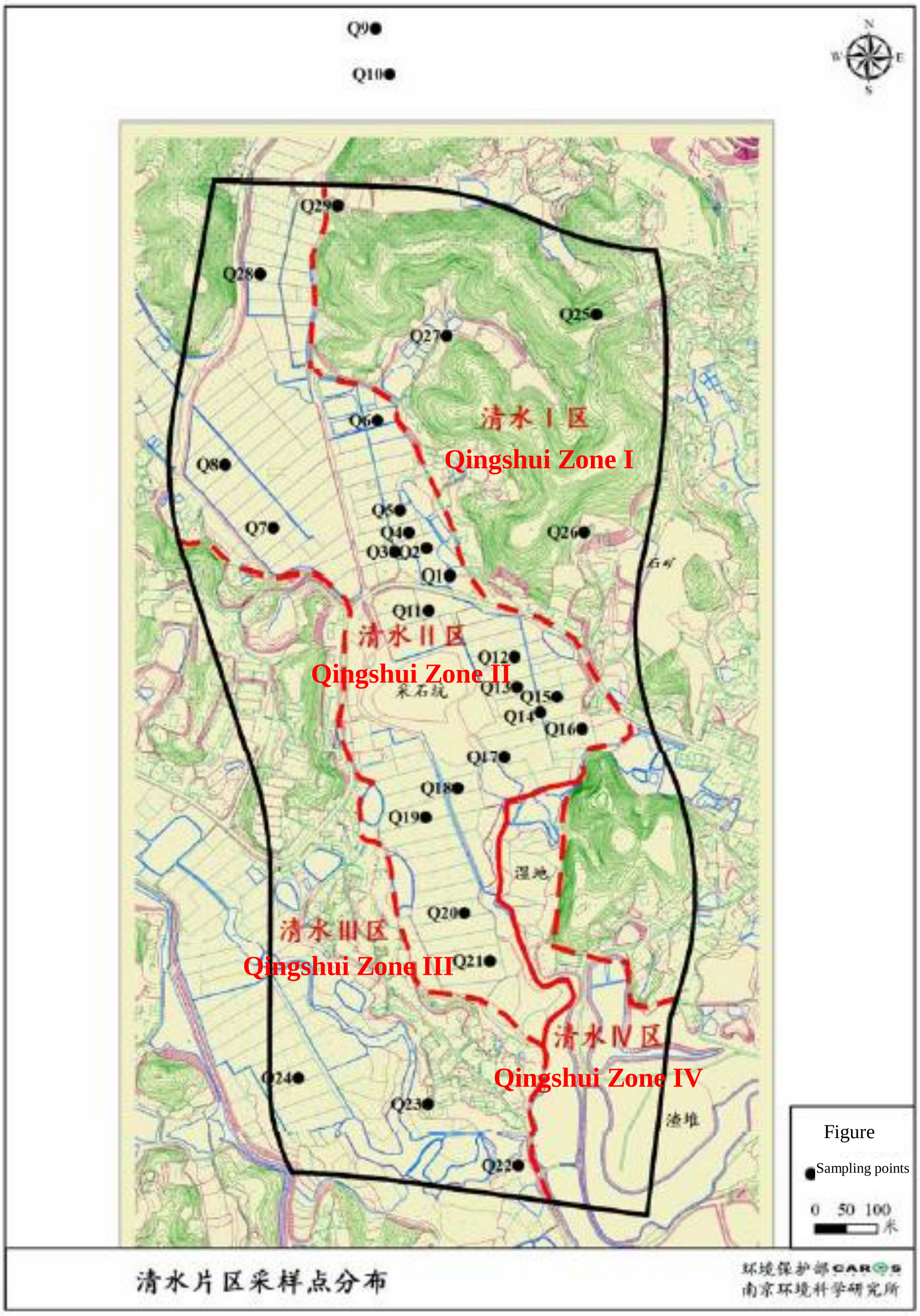


Figure3.3-4 Soil sampling points in Qingshui Sub-region

In terms of soil sample collection in Tongxia Sub-region, the soil sampling depth in paddy fields is generally at 0.6m, and the samples are taken in three layers (0-20cm, 20-40cm and 40-60cm). The soil sampling depth in mountainous region is generally at 0-5cm at the surface of the soil, and soil samples are taken every 20cm below the surface soil. Tongxia Sub-region has a total of 17 sampling points and 53 soil samples. The soil sampling points are shown in **Figure3.3-5**.

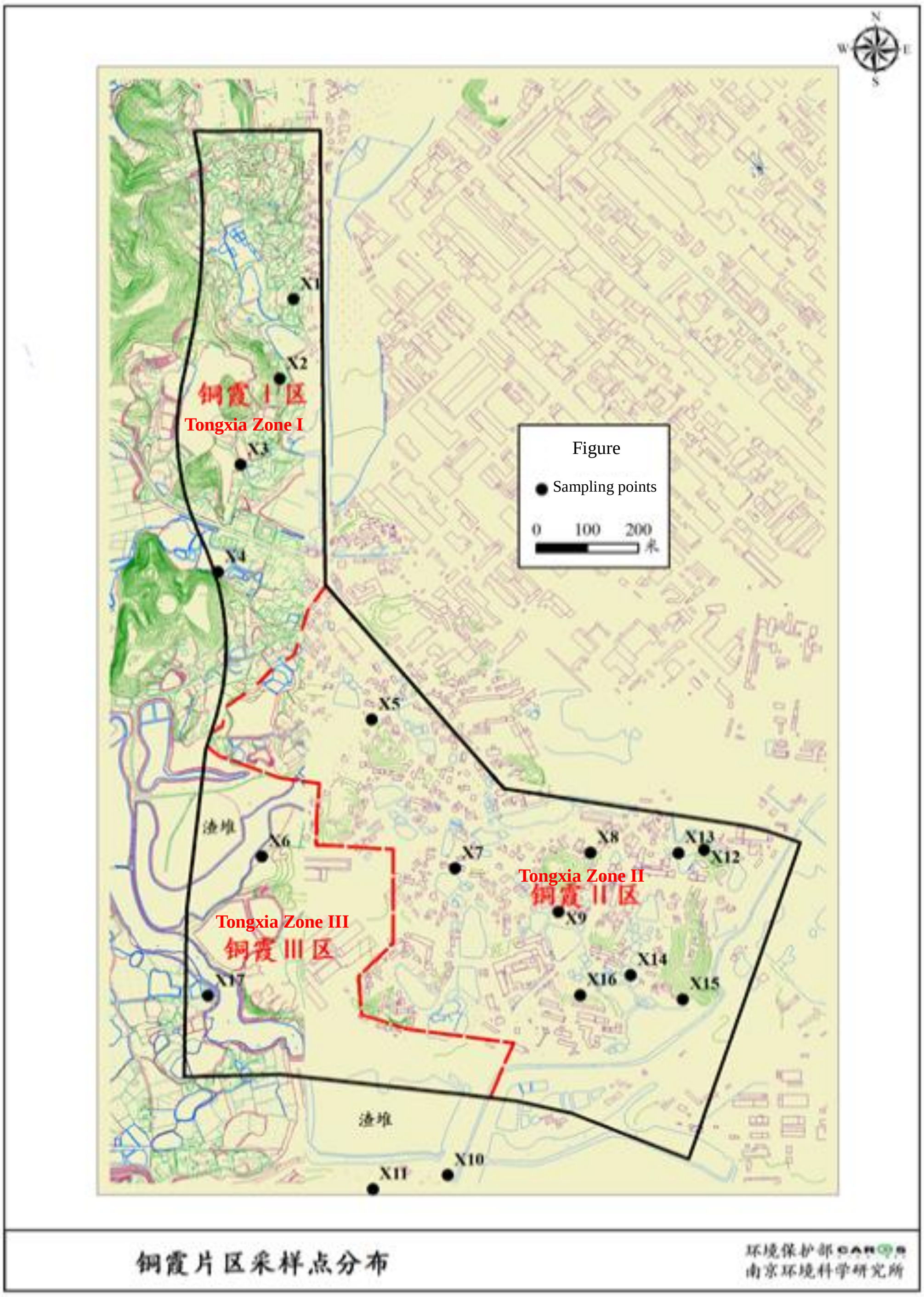


Figure3.3-5 Soil sampling points in Tongxia Sub-region

Tongtangwan Sub-region has a total of 55 soil sampling points, including 39 points in farmland sampled in two layers of 0～20 cm and 20～50 cm, 8 points in surface soil sampled in two layers of 0～20 cm and 20～50 cm, and 8 points in soil profiles sampled in four layers of 0～20 cm, 20～50 cm, 70～80 cm and 90～100 cm. A total of 117 soil samples have been obtained. The soil sampling points are shown in **Figure3.3-6**.

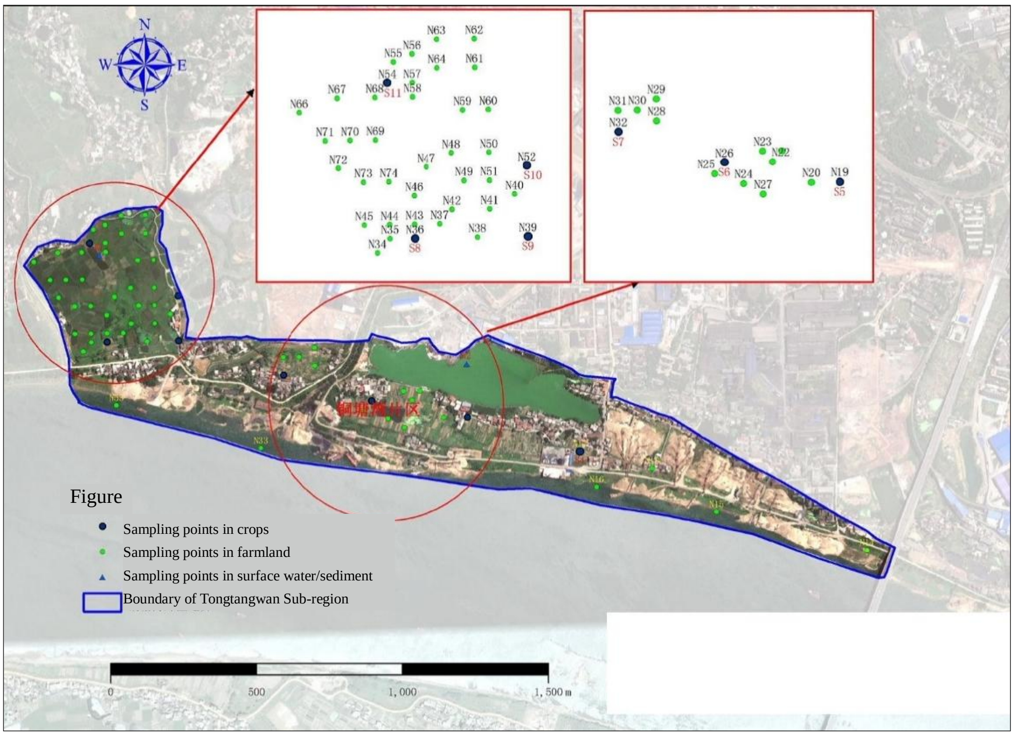


Figure3.3-6Soil sampling points in Tongtangwan Sub-region

Qingshi Sub-region has a total of 26 soil sampling points, including 17 points in farmland sampled in two layers of 0～20 cm and 20～50 cm, 5 points in surface soil sampled in two layers of 0～20 cm and 20～50 cm, and 4 points in deep soil sampled in four layers of 0～20 cm, 20～50 cm, 70～80 cm and 90～100 cm. A total of 58 soil samples have been obtained. The soil sampling points are shown in **Figure3.3-7**.

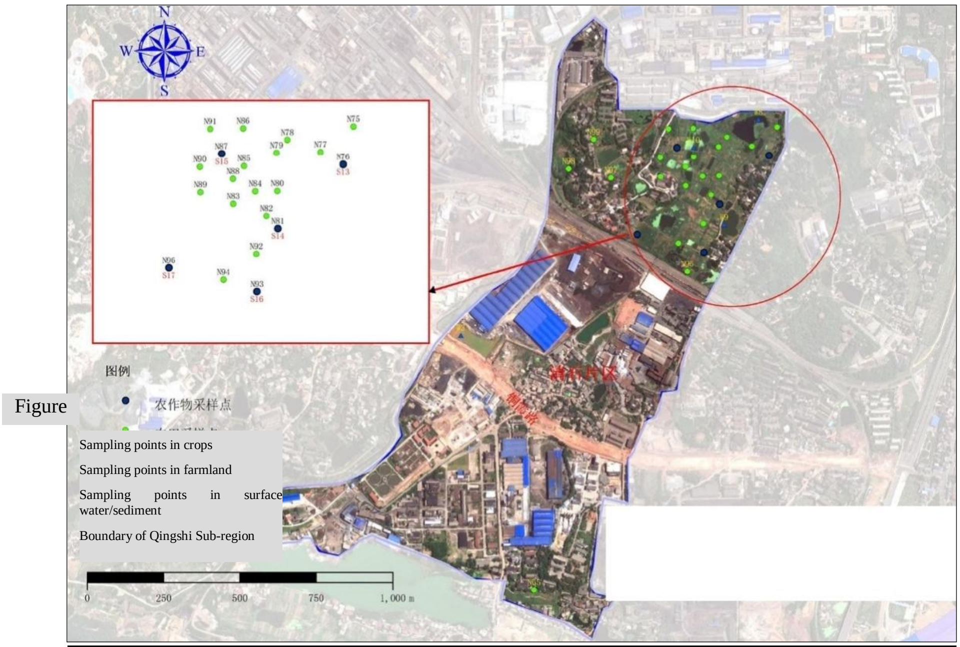


Figure3.3-7 Soil sampling points in Qingshi Sub-region

Xiangshiling Sub-region has a total of 12 soil sampling points, including 8 points in farmland sampled in two layers of 0～20 cm and 20～50 cm, 2 points in surface soil sampled in two layers of 0～20 cm and 20～50 cm, and 2 points in deep soil sampled in four layers of 0～20 cm, 20～50 cm, 70～80 cm and 90～100 cm. A total of 26 soil samples have been obtained. The soil sampling points are shown in **Figure3.3-8**.

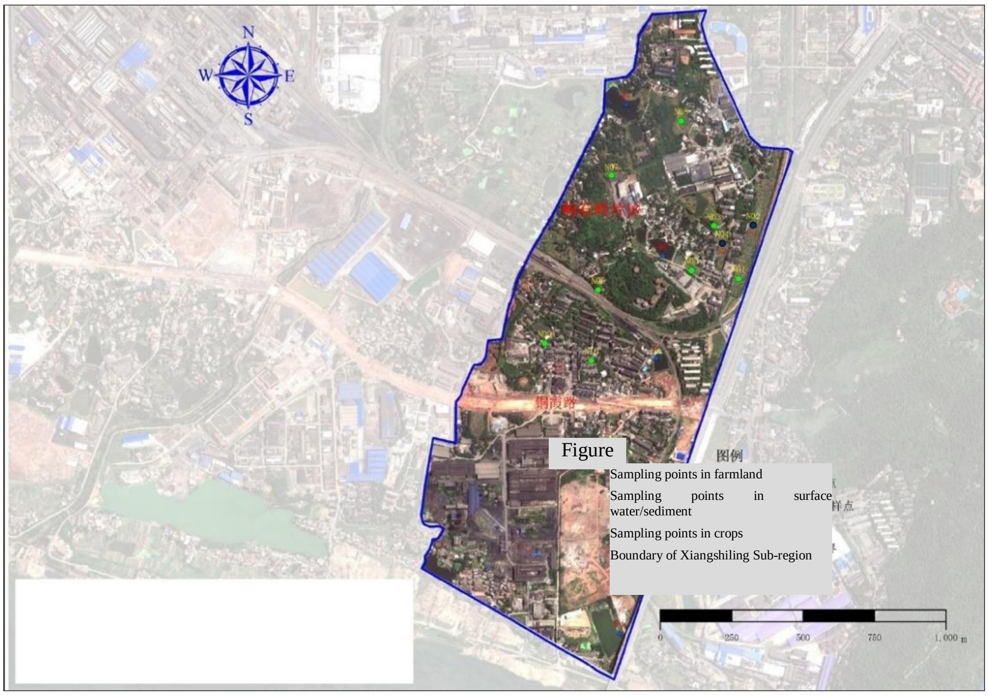


Figure3.3-8 Soil sampling points in Xiangshiling Sub-region

3.3.1.2 Pond and Channel Pollution Survey

The pond and channel pollution survey mainly covers the Old Xiawangang Channel, Xinqiao Low Discharge Channel, water ponds in Tongtangwan sub-region, water ponds in Qingshui sub-region and water ponds in Tongxia sub-region. Since the remediation of Xiawangang Channel and Dahu has been completed, these waters are outside the survey scope of this project. The details of sampling points are shown in **Table 3.3-2**.

Table 3.3-2Basic information of ponds and channels

No.	Name	Length/Area	Sampling points	Location
1	Old Xiawangang	2.6 km	13	Qingshui, Tongxia and Tongtangwan sub-regions
2	Xinqiao Low Discharge Channel	1.45 km	23	Qingshuihu and Tongtangwan sub-regions
3	Water ponds in Tongtangwan sub-region	83314 m^2	5	Tongtangwan sub-region
4	Water ponds in Qingshui sub-region	63335 m^2	5	Qingshui sub-region
5	Water ponds in Tongxia sub-region	68165 m^2	5	Tongxia sub-region

(1) Old Xiawangang

9 sampling points are located in main channel and branch channel of the Old Xiawangang, including 7 points from which 21 sediment samples were collected and 2 points located on cement dyke of branch channel and with 2 sediment samples collected. A total of 4 sampling points are in the downstream deposition area, and 4 mixed sediment samples were collected. The sampling points are shown in **Figure3.3-9**.

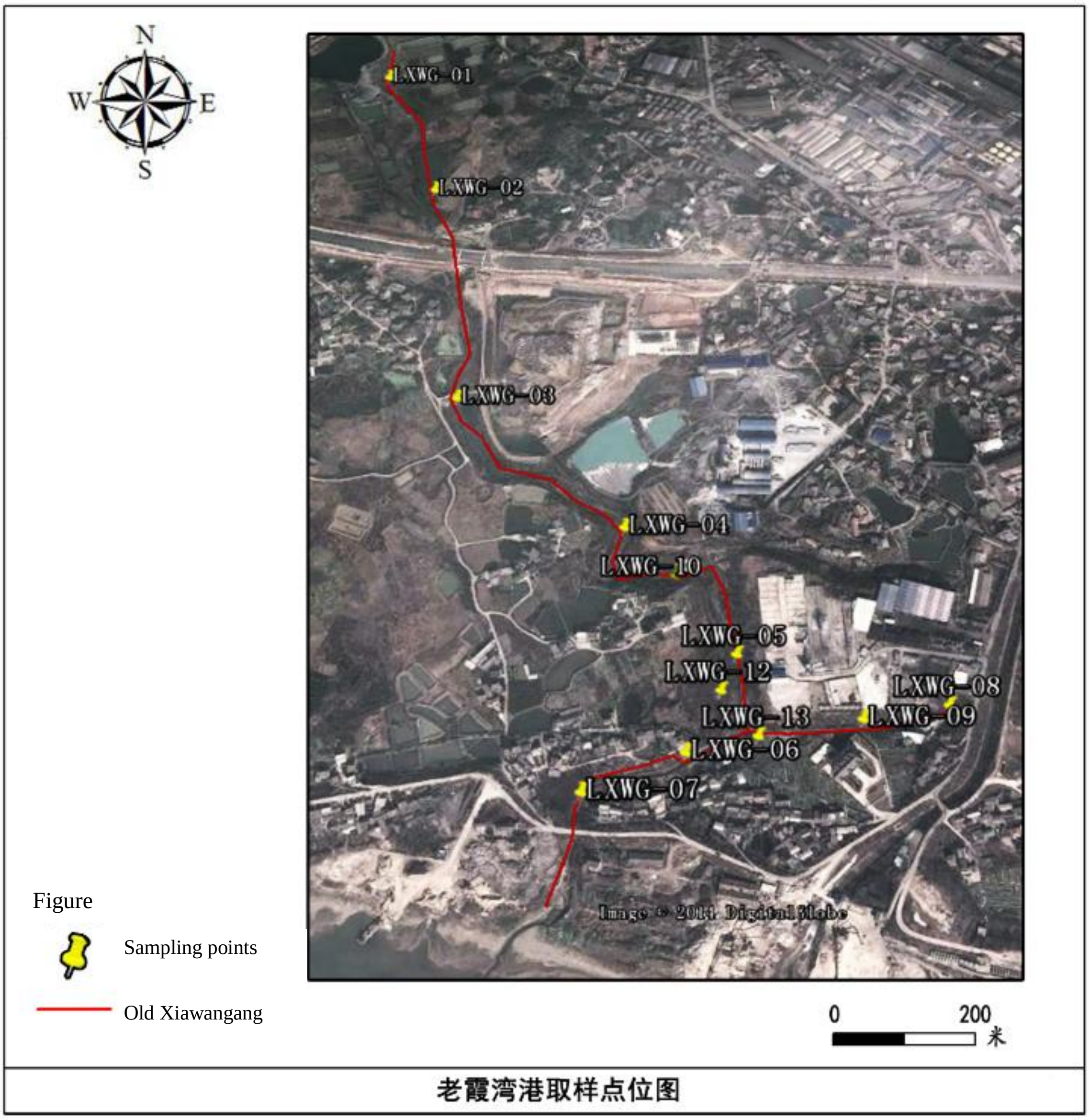


Figure3.3-9 Sampling points of Old Xiawangang

(2) Xinqiao Low Discharge Channel

Sampling survey has been carried out on the sediment and slope soil of Xinqiao Low Discharge Channel, including 18 sediment sampling points and 5 soil sampling points. The sampling points are shown in **Figure3.3-10**.

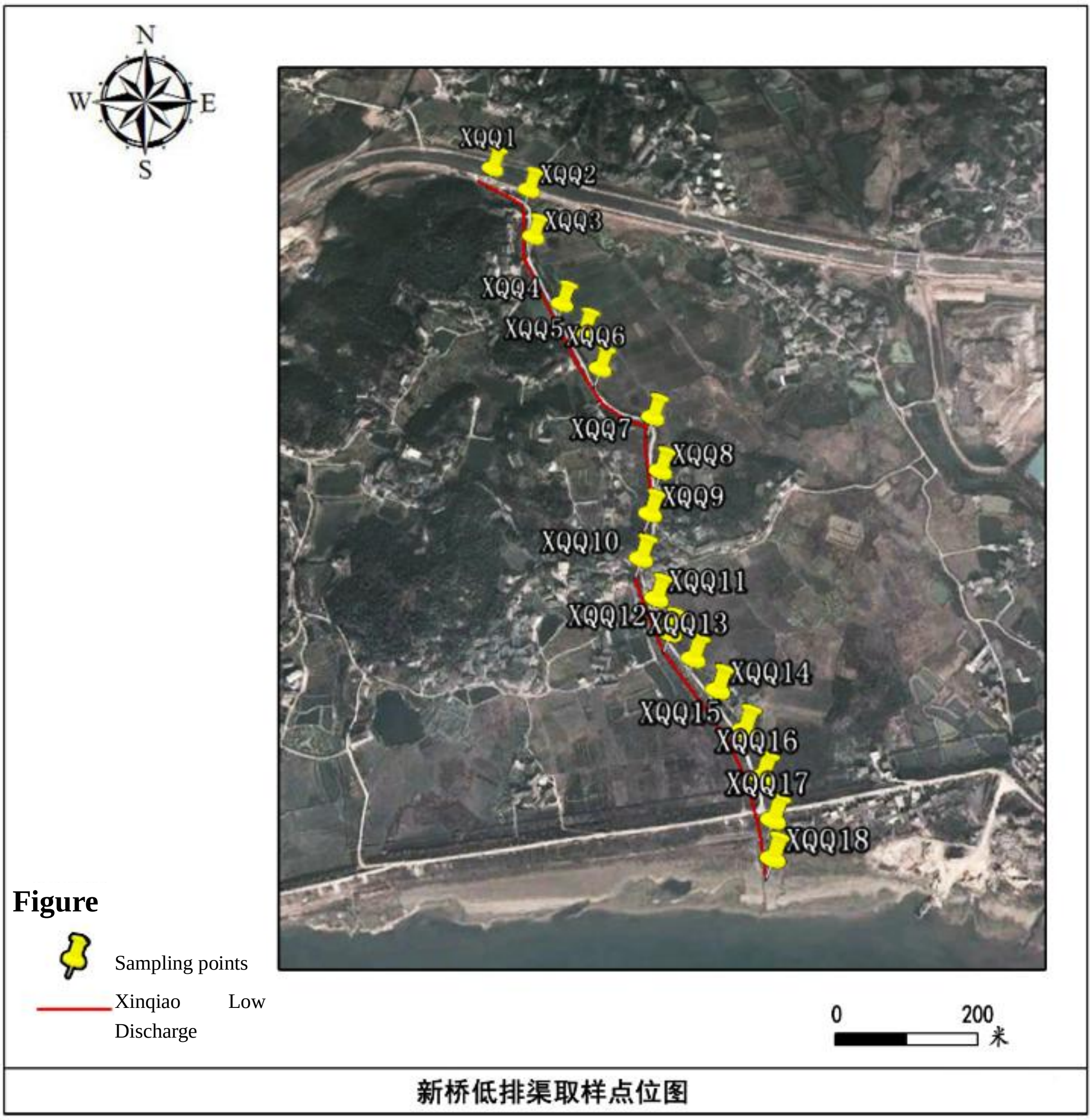


Figure3.3-10Sampling points of Xinqiao Low Discharge Channel

(3) Ponds

The pond sampling survey mainly covers water ponds in Tongtangwan sub-region, Tongxia sub-region and Qingshui sub-region. The sampling points of water ponds are shown in **Figure3.3-11**.

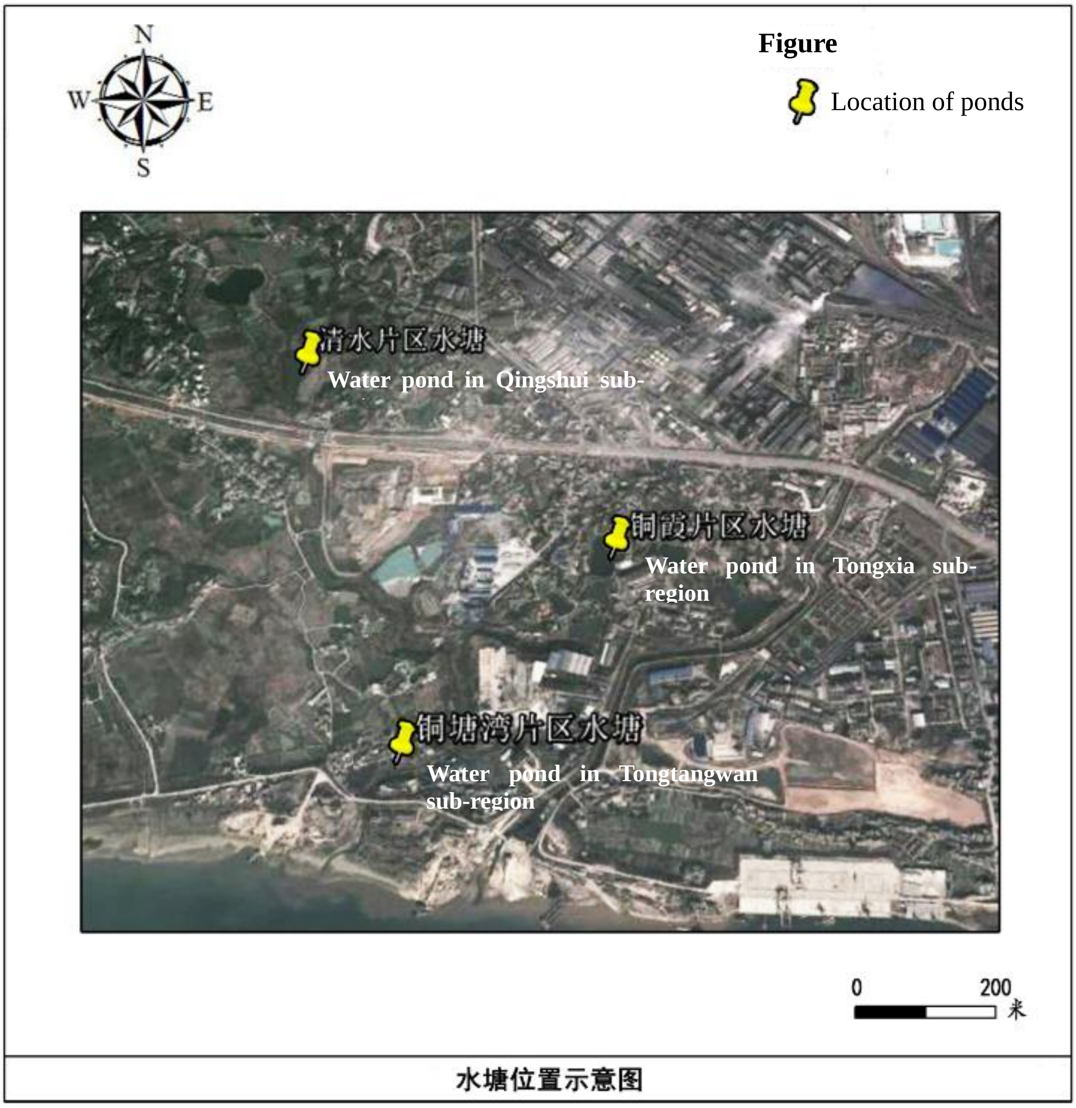


Figure3.3-11Sampling points of water ponds in three sub-areas

3.3.1.3 Waste piles survey

Previously, the Qingshuitang industrial zone had piled a lot of waste residue. In the past years, Xinqiao waste pile, Dahu waste pile and North waste pile have been centrally treated. At the early stage of closing down polluting enterprises, the EPA ordered the closed companies to utilize or safely dispose waste residue produced by these companies.

According to the waste distribution and contamination situation in the project area, a waste pile in Tongxia Sub-region needs cleanup. In addition, another waste pile is in the plant area of the close company, Zhuzhou Yongfa Metal Refining Co., Ltd.

The distribution of waste piles are shown in **Table 3.3-3**.

Table 3.3-3Basic information of waste piles

No.	Name	Area/m^2	Quantity/m^3	Location	Time	Source
1	Waste pile in Tongxia Sub-region	15661	81652	Tongxia Sub-region	1982-2010	Previously remained
2	Waste pile in the plant area	1154	3000	Plant area of Yongfa Refinery	2010-2012	
Total		16815	84652			

The waste pile in Tongxia Sub-region is about 550 m north of Tongxia Road. The waste pile has remained for years. The sampling survey has obtained a total of 10 residue samples. The specific location of the waste pile is shown in **Figure3.3-12**.

Figure3.3-12Location of the waste pile in Tongxia Sub-region

Waste pile in Tongxia Sub-region

Waste pile in Tongxia Sub-region

Waste pile in Yongfa Refinery

Waste pile in Yongfa Refinery

Figure3.3-13 Site photos of waste piles

3.3.1.4 Site survey on closed companies

This site survey covers a total of 6 closed companies, i.e. Zhuzhou Yongfa Metal Refining Co., Ltd. (Yongfa Refinery), Zhuzhou Brothers Industry Co., Ltd. (Brothers Industry), Zhuzhou Kangli Smelting Plant (Kangli Smelter), Zhuzhou Tiancheng Chemical Co., Ltd. (Tiancheng Chemicals), Zhuzhou Xinda Smelting Co., Ltd. (Xinda Smelter) and Zhuzhou Hehua Cement Plant (Hehua Cement). The locations of closed companies are shown in **Figure10.1-1**.

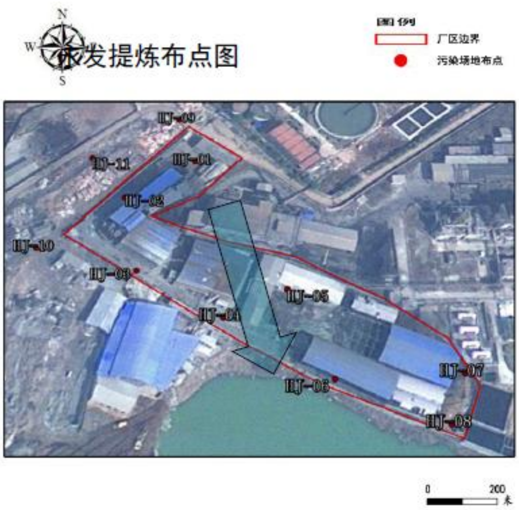
3.3.1.4.1 Zhuzhou Yongfa Metal Refining Co., Ltd.

Zhuzhou Yongfa Metal Refining Co., Ltd is located in the southern intersection of Tongxia Sub-region and Qingshi Sub-region. The company was established in March 2010, covering an area of 12,779.22 m^2. The north of the plant area is adjacent to Hunan Haili Zhuzhou Fine Chemicals Co., Ltd that is in production, south next to Dahu in Jianshe Village.

The company mainly produced secondary zinc oxide, zinc sulfate and metal indium, etc. Its geographical coordinates are 113°04′47.80″east longitude and 27°51′43.85″north latitude. In 2011, the company was included in the list of closed companies in the Implementation Plan for Closed, Eliminated and Relocated Enterprises in Comprehensive Remediation of Urban Environment in Zhuzhou 2011. The company was shut down in October 2012. The whole plant area is in a rectangular shape, higher in the west and lower in the east, without significant height difference. The ground is generally hardened. The north of the plant site is Qingshuitang industrial wastewater treatment plant, and 100 meters west of the plant site are a small amount of residential areas. The plant is about 550 meters away from the Xiang River River.

According to the Regulatory Planning for Core Zone of Qingshuitang Ecological Industrial Town of Zhuzhou City (2012), the site is planned as park green space and non-residential land.

The sampling points and site photos are shown in **Figure3.3-14**.



Sampling Points in Yongfa Refinery

Site photos of Yongfa Refinery

Site photos of Yongfa Refinery

Site photos of Yongfa Refinery

Figure3.3-14Sampling points and site photos of Yongfa Refinery

On May 9, 2014, site survey was carried out in the plant area of Yongfa Refinery and its surrounding areas. The site survey covered buildings in the plant area, production and storage workshops, sewage treatment pond, etc. It was found out that production-related buildings had been abandoned and seriously damaged. The wastern part of the plant area is a zinc oxide rotary kiln. The ground in the plant area is generally hardened. Under an abandoned factory shed in the mid-eastern part is piled with remaining waste residue with a volume of about 3,000m^3.

3.3.1.4.2 Zhuzhou Brothers Industry Co., Ltd.

Zhuzhou Brothers Industrial Co., Ltd. is located in the south of Tongxia Road in the QIZ. The company was founded in November 1997, mainly producing galvanized steel and other products, and covering an area of 22,929.91m^2. The plant area is surrounded by residential area and distributed with three large ponds. Its geographical coordinates are 113°04′38.11″east longitude and 27°51′54.54″ north latitude. The plant area of Brothers Industry was previously the branch plant of Zhuzhou Cotton Plant, which was leased to Brothers Industry around 1995. In 2011, the company was included in the list of closed companies in the Implementation Plan for Closed, Eliminated and Relocated Enterprises in Comprehensive Remediation of Urban Environment in Zhuzhou 2011. The company was shut down in October 2012. Most of the plant area is covered by buildings, and outdoor area is generally hardened.

The sampling points and site photos are shown in **Figure3.3-15**.

Sampling Points in Brothers Industry

Site photos of Brothers Industry

Site photos of Brothers Industry

Site photos of Brothers Industry

Figure3.3-15Sampling points and site photos of Brothers Industry

Zhuzhou Brothers Industrial Co., Ltd. mainly produced galvanized steel and other products, belonging to non-metallurgical chemical companies. Since the company has been shut down, it is difficult to contact former staff or seek more information. The available documents only reveal that this company was mainly involved in galvanizing.

On May 9, 2014, site survey was carried out in the plant area of this company and its surrounding areas. The site survey covered buildings in the plant area, production and storage workshops, sewage treatment pond, etc. It was found out that buildings in the plant area were in good condition. The ground in the plant area is generally hardened. No waste residue or wastewater remained in the plant area. A two-storey building is at the gate of the plant, once served as office area and now is still inhabited. The original production workshop was leased to others doing steel processing. The northwestern part of the plant area was originally the warehouse of Brother Industry, now is abandoned and surrounded by growing vegetables.

According to the original production and production processes, the potential contaminants of this plant are heavy metal elements Pb, Cd, As, and Zn.

3.3.1.4.3 Zhuzhou Kangli Smelting Plant

Zhuzhou Kangli Smelting Plant is located in Tongxia Road, Shifeng District, Zhuzhou. The company was founded in 1994, and mainly engaged in the processing and smelting of blister copper, with annual output of about 800 tons. Its geographical coordinates are 113°04′54.10″east longitude and 27°52′01.08″north latitude. The plant was shut down in 2008. A part of plant area has been built into roads, and now the remaining plant area is 4,593.33 m^2. Most of the production-related structures have been demolished in the plant. The whole site is now in the shape of inverted triangle. The eastern fence of the plant area is adjacent to Xiawangang, north adjacent to Tongxia Road, and west next to the residential area. The plant area is generally flat, slightly higher in the west. The pavement in the plant area had not been hardened. In 2011, the plant was included in the list of closed companies in the

Implementation Plan for Closed, Eliminated and Relocated Enterprises in Comprehensive Remediation of Urban Environment in Zhuzhou 2011.

The sampling points and site photos are shown in **Figure3.3-16**.

Sampling Points in Kangli Smelter

Site photos of Kangli Smelter

Site photos of Kangli Smelter

Site photos of Kangli Smelter

Figure3.3-16Sampling points and site photos of Kangli Smelter

Zhuzhou Kangli Smelting Plant was mainly engaged in the processing and smelting of blister copper. The raw materials in copper converting furance were mainly copper sludge, unrefined copper and copper raw materials from Zhuzhou Smelter, Shuikoushan in Hengyang, Daye in Hubei and nearby self-employed entrepreneurs. Previously, the plant had a blister copper production line, using matte residue and copper-cadmium residue pyrometallurgical method to refine blister copper. The raw material supply and the grade of copper in raw materials had a great impact on copper output. Matte residue was mainly from low-grade matte produced by large copper smelters and matte residue produced by blast furnace of crude lead smelting plants. Copper-cadmium residue was produced by purification process of zinc sulfate plants and indium smelting plants. The production capacity of the plant was 5000 t/a, and its actual output in 2007 was 4500 t.

On May 9, 2014, site survey was carried out in the plant area of Kangli Smelter and its surrounding areas. The site survey covered buildings in the plant area, production and storage workshops, sewage treatment pond, etc. It was found out that production-related buildings had been seriously damaged, and generally demolished. A sedimentation tank was in the western part of the plant area near Xiawangang. The ground in the plant area had generally not been hardened. Waste residue was piled in the central outdoor area. Temporary factory sheds were set up in the south and east side of the plant. A building at the gate of the plant is still inhabited.

According to the original production and production processes, the potential contaminants of this plant are heavy metal elements Pb, Cd, As, Zn and Cu produced during the process of blister copper smelting.

3.3.1.4.4 Zhuzhou Tiancheng Chemical Co., Ltd.

Zhuzhou Tiancheng Chemical Co., Ltd. is located in the south of Tongxia Road, Shifeng District, Zhuzhou, east of Zhuzhou Steel Plant and adjacent to Xiang River River in the south. The plant covers an area of 104,813.70 m^2. Its geographical coordinates are 27°51′34.25″north latitude and 113°05′38.66″east longitude. The site had been used as industrial land since 1958, and successively built as steel plant, phosphate fertilizer plant, tyre retreading plant (rubber plant) and Zhuzhou Chemical Additives Plant, with a complex land use history. Before used as industrial land, the site was a slope in hills, higher in the north and lower in the south. The height difference between its location on Tongxia Road and Xiang River River was approximately 10 meters. The site still has a railway line in normal use, passing through the site from northeastern corner to central area, and then to iron gate in the west. The north of Tiancheng Chemicals and both sides of Tongxia Roads are distributed with residential buildings and scattered vegetable fields. Outside the gate of the plant area is the comprehensive building of Zhuzhou Chemical Additives Plant. In 2003, the production workshops were gradually shut down and demolished, until the completion of demolition in 2010. Since then, the site has been abandoned.

The sampling points and site photos are shown in **Figure3.3-17**.

Sampling Points in Tiancheng Chemicals

Site photos of Tiancheng Chemicals

Site photos of Tiancheng Chemicals

Site photos of Tiancheng Chemicals

Figure3.3-17 Sampling points and site photos of Tiancheng Chemicals

Zhuzhou Chemical Additives Plant was once a leading manufacturer in China in manufacturing rubber vulcanization accelerator, and the main products and production capacity of the plant are shown in the following table.

Table 3.3-4Main products and annual output of Tiancheng Chemicals

Products	Output (t/a)
Accelerator M	1000
Accelerator DM	500
Accelerator NOBS	600
Accelerator CZ	500
Accelerator TMTD	1200
Highly active spherical nickel hydroxide	250

Pollution survey data of Tiancheng Chemicals mainly includes the sample data obtained by this survey and also refers to the survey data of this site collected by Nanjing Institute of Soil Science of the Chinese Academy of Sciences in 2012. The pollution situation of this site has been analyzed based on these two sources of data. According to the production history of this site, the potential contaminants of this plant are heavy metal elements Pb, Cd, As and Ni, and organic matters such as aniline and benzopyrene.

3.3.1.4.5 Zhuzhou Xinda Smelting Co., Ltd.

Zhuzhou Xinda Smelting Co., Ltd. is located in Qingshui Road, Shifeng District, Zhuzhou. The company was founded in 2002, covering an area of 9,259.41 m^2. Its geographical coordinates are 113°04′16.73″east longitude and 27°52′49.71″north latitude. The east side of the plant area is adjacent to Hehua Cement Plant, west side next to residential area and northeast side to the stone pit of Hehua Cement Plant. Xinda Smelter adopted rotary kiln-calcining process, uniformly mixed zinc-containing waste residue and raw coke powder according to a certain proportion, and then added the mixture to rotary kiln, finally obtained zinc oxide product by blast smelting. The production capacity of this plant was 3,000 tons/year. In 2011, the company was included in the list of closed companies in the Implementation Plan for Closed, Eliminated and Relocated Enterprises in Comprehensive Remediation of Urban Environment in Zhuzhou 2011. The company was shut down in October, 2012.

The sampling points and site photos are shown in **Figure3.3-18**.

Sampling Points in Xinda Smelter

Site photos of Xinda Smelter

Site photos of Xinda Smelter

Site photos of Xinda Smelter

Figure3.3-18 Sampling points and site photos of Xinda Smelter

On May 10, 2014, site survey was carried out in the plant area of Xinda Smelter and its surrounding areas. The site survey covered buildings in the plant area, production and storage workshops, sewage treatment pond, etc. It was found out that production-related buildings had been abandoned and seriously damaged. The ground in the plant area is generally hardened. Under an abandoned factory shed in the mid-eastern part is piled with a small amount of waste residue. A two-storey building is at the gate of the plant, once served as office area and now is still inhabited.

According to the original production and production processes, the potential contaminants of this plant are heavy metal elements Pb, Cd, As, Zn and Cu.

3.3.1.4.6 Zhuzhou Hehua Cement Plant

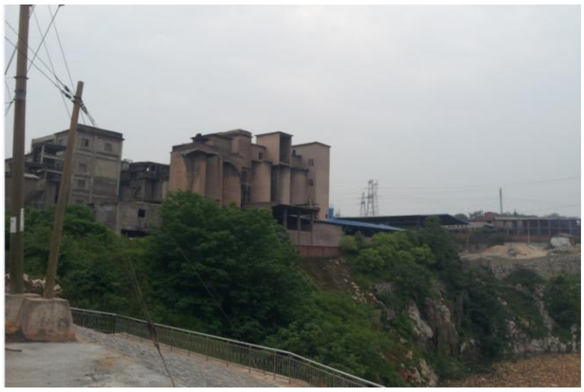
Zhuzhou Hehua Cement Plant covers an area of 66,443.73 m^2. The plant was founded in 1958, mainly producing lime cement. In 1976, it began to produce cement by soil. In 1985, the plant was transformed to produce cement by mechanical upright kiln, with an annual cement output of 22,000 tons. Since 1990s, the plant has gone through continuous technological innovation, and greatly improved its production capacity. In 2004, since the dust emission of its cement shaft kiln failed to meet emissions standards, the relevant departments of Zhuzhou City urged the plant to treat dust pollution and reach emission standards by the end of 2004. However, this plant still failed to meet emissions standards after treatment, Zhuzhou government office urged this plant to shut down. In 2005, this plant abolished the shaft kiln production line and changed into a grinding station. Thereafter, Hehua Cement Plant and Beijing Lanzi Sialite Concrete Technology Co., Ltd. jointly built a sialite concrete production line with annual production capacity of 500,000 tons. Sialite concrete is a new type of material jointly developed by Beijing Lanzi Sialite Concrete Technology Co., Ltd. and Tsinghua University. This material can replace cement and has better performance than cement. It is the first generation of high performance cementitious material made of such solid wastes as blast furnace slag, steel slag and coal ash. This plant was mainly engaged in cement manufacturing, and its raw material source was waste residue from Zhuzhou Smelter. Its cement products were at Grade PC32.5.

The sampling points and site photos are shown in **Figure3.3-19**.

Sampling Points in Hehua Cement Plant

Site photos of Hehua Cement Plant

Site photos of Hehua Cement Plant



Site photos of Hehua Cement Plant

Figure3.3-19Sampling points and site photos of Hehua Cement Plant

Zhuzhou Hehua Cement Plant mainly produced Grade PC32.5 cement. Cement production process was as follows: limestone, shale and iron powder were crushed and then grinded into raw material with appropriate components and uniform quality according to a certain mixed ratio; then raw material was calcinated in cement kiln to reach the state of partial melting and obtain silicate cement clinker mainly containing calcium silicate; then cement clinker was mixed with admixture and plaster, etc according to a certain proportion to prepare cement products. Zhuzhou Hehua Cement Plant adopted mechanized shaft kiln production technology, and its main production processes included crushing and pre-homogenization of raw materials, ingredients and powders, production homogenization and storage, kiln building and coal blending, shaft kiln burning, cement grinding, storage and packaging process, etc.

According to the original production and production processes, the potential contaminants of this plant are heavy metal elements Pb and Zn.

The number of sampling points in all closed companies are listed in **Table 3.3-5**. The sampling points and site photos of these companies are shown in **Figure3.3-14~ Figure3.3-19**.

Table 3.3-5List of sampling points and number of samples in closed companies

No.	Closed companies	Points/number	Number of samples/number
1	Yongfa Refinery	11	15
2	Brothers Industry	12	12
3	Kangli Smelter	13	18
4	Tiancheng Chemicals	20	22
5	Xinda Smelter	12	15
6	Hehua Cement	11	12
Total		79	104

3.3.1.5 Survey on residential area and surrounding uncovered soil

In this survey on residential area, the soil samples below impermeable pavements in large residential areas within the project area are collected using the scattered sampling method. A total of 22 sampling points have been selected. The sampling points of residential land are shown in **Figure3.3-20**.

The sampling of uncovered soil in residential area followed the sampling principle in Technical Guidelines for Site Environmental Survey (HJ 25.1-2014) and Technical Specifications for Soil Environmental Monitoring (HJ/T166-2004). A total of 51 sampling points have been arranged, among which 49 points are actual sampling points. The sampling points of uncovered soil in residential area are shown in **Figure3.3-21**.

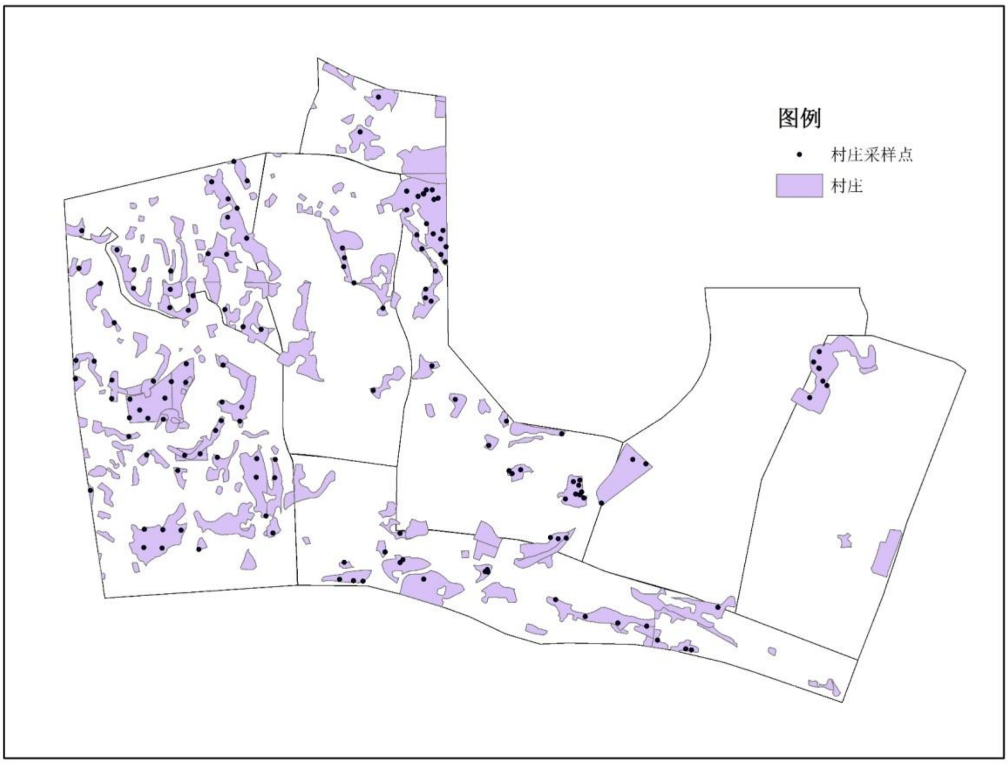


Figure3.3-20 Sampling points in residential land

Figure3.3-21 Sampling points on uncovered soil in residential area

3.3.1.6 Site survey on suface water quality

Changsha Environmental Protection College monitored the quality of surface water in Xinqiao Low Discharge Channel and Old Xiawangang within the project area from December 8, 2014 to December 10, 2014, and arranged 7 monitoring sections. The status of surface water quality is shown in Section 9.4.2.

The college also collected the monitoring data of water intake section at No. 3 Water Plant during the period of 2012-2014 and monitoring data of Xiawan (control section) at Zhuzhou section of Xiang River River during the period of 2010-2013 from Zhuzhou Environmental Monitoring Center Station.

3.3.1.7 Site survey on groundwater quality

From March 28 to April 2, 2012 (during the normal river flow period), Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection collected a total of 6 groundwater samples in Yingfeng, Qingshuihu Zone I and Zone II, and measured a total of 26 indicators in groundwater samples, including pH, hexavalent chromium, fluorides, chlorides, bromides, sulfates, nitrates, nitrites, phosphates and Ag, As, Be, Cd, Cr, Cu, Ni, Pb, Sb, Se, Tl, Zn, Mn, Hg, Na, K and Ca, etc.

From November 23 to December 2, 2011 (dry season), Nanjing Institute of Soil Science, Chinese Academy of Sciences arranged a total of 40 groundwater sampling points in Qingshi, Tongtangwan and Xiangshiling sub-regions, analyzed the metal component content of 44 shallow groundwater samples, concentrations of semi-volatile organic compounds (SVOCs) in 31 shallow groundwater samples, concentrations of volatile organic contaminants (VOCs) in 21 shallow groundwater samples and concentrations of major anions in 8 shallow groundwater samples.

In October 2014 (dry season), Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province conducted a survey on groundwater environment in the project area, and arranged 24 sampling points.

See details in Section 9.4.1 Groundwater Environmental Survey in Section

3.3.2 Conclusion of Site Investigation

3.3.2.1 Conclusion of soil pollution survey

The heavy metal pollutants detected in the project area mainly include Zn, Cu, Pb, Cd, As, Sr, Sb, Rb, Co, Ni, Cr, Sn, Hg and Tl, etc. Cd, Pb, Zn, Hg, Sb, As and Ag have shown significant surface accumulation phenomenon, and these heavy metal pollutants are the focus of this survey and abnormal elements of the surveyed area.

The analyzed organic pollutants are VOC, SVOC and organic chlorine, etc. The main organic pollutants of concerns in Qingshi and Xiangshiling sub-regions are benzo a-pyrene, aniline, diphenylamine & N-nitrosodiphenylamine, benzo b & k fluoranthene, acenaphthylene, acenaphthene, fluorene, phenanthrene and phenol, etc. These contaminants were dected in waste piles which have been removed. The project will deal with organic contamiants in Tiancheng Chemical Plant, which includes benzopyrene as main contaminant of concern. Except some hotspots in industrial sites, organic pollutants are not particular of concern for in the project area.

The survey results of each sub-region are shown as follows:

(1) The surface soil of Yingfeng Sub-region has obvious pollutant enrichment, with the maximum content of As reaching 48mg/kg, Cd reaching 37.5mg/kg, Zn reaching 1,430mg/kg, Hg reaching 2.41mg/kg, Se reaching 1.4 mg/kg and Ag 3.4mg/kg. The soil in this sub-region

has been affected by human factors, and its major pollutants are Cd, Pb, Zn, Sb, Hg, As and Ag. It is preliminarily estimated that the depth of contaminated soil is about 40cm, or even 60cm at some sampling points.

(2) The surface soil of Qingshuihu Sub-region has obvious pollutant enrichment, with the maximum content of Cd reaching 19.4 mg/kg, Pb reaching 576mg/kg, Zn reaching 907mg/kg, Sb reaching 10.9mg/kg, Ag 2mg/kg and As 58.3 mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Cd, Pb, Zn, Sb, Hg, As and Ag. It is preliminarily estimated that the depth of contaminated soil is about 60cm, or even exceeds 60cm at some sampling points.

(3) The soil of Qingshui Sub-region has been widely polluted by heavy metals, and its surface soil has the most serious pollutant enrichment, with the maximum content of Pb reaching 3,400mg/kg, As reaching 400mg/kg, Cd reaching 73.7mg/kg, Zn reaching 11,200mg/kg, Ni 150mg/kg, Cu 350mg/kg and Co 550mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Pb, As, Cd and Zn. It is preliminarily estimated that the depth of contaminated soil is about 20cm-40cm, or even exceeds 60cm at some sampling points.

(4) The soil of Tongxia Sub-region has been widely polluted by heavy metals, and its surface soil has the most serious pollutant enrichment, with the maximum content of Pb reaching 3,726mg/kg, As reaching 450mg/kg, Cd reaching 250mg/kg, Zn reaching 9,701mg/kg, Ni 150mg/kg, Cu 2,119mg/kg and Co 500mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Pb, Cd, As, Zn and Co. It is preliminarily estimated that the depth of contaminated soil has reached 50m, or even exceeded 60cm at some sampling points.

(5) The soil of Tongtangwan Sub-region has been widely polluted by heavy metals, and its surface soil has the most serious pollutant enrichment, with the maximum content of Pb reaching 1,240mg/kg, As reaching 671mg/kg, Cd reaching 353mg/kg, Zn reaching 2,620mg/kg and Cu 237mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Pb, Cd, As and Zn. It is preliminarily estimated that the depth of contaminated soil has reached 50m, or even exceeded 60cm at some sampling points.

(6) The soil of Qingshi Sub-region has been widely polluted by heavy metals, and its surface soil has serious pollutant enrichment, with the maximum content of Pb reaching 951mg/kg, As reaching 65.1mg/kg and Zn reaching 1,200mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Pb, As and Zn. It is

preliminarily estimated that the depth of contaminated soil has reached 50m, or even exceeded 60cm at some sampling points.

(7) The soil of Xiangshiling Sub-region has been widely polluted by heavy metals, and its surface soil has serious pollutant enrichment, with the maximum content of Pb reaching 661mg/kg, As reaching 122mg/kg and Zn reaching 444mg/kg. The soil in this sub-region has been affected by human factors, and its major pollutants are Pb, As and Zn. It is preliminarily estimated that the depth of contaminated soil has reached 50m, or even exceeded 60cm at some sampling points.

According to the conclusion of risk assessment in all sub-regions, the major heavy metal pollutants in the project area are Pb, As and Cd.

The contour maps of Cd, As and Pb are shown in **Figure3.3-22~Figure3.3-27**.

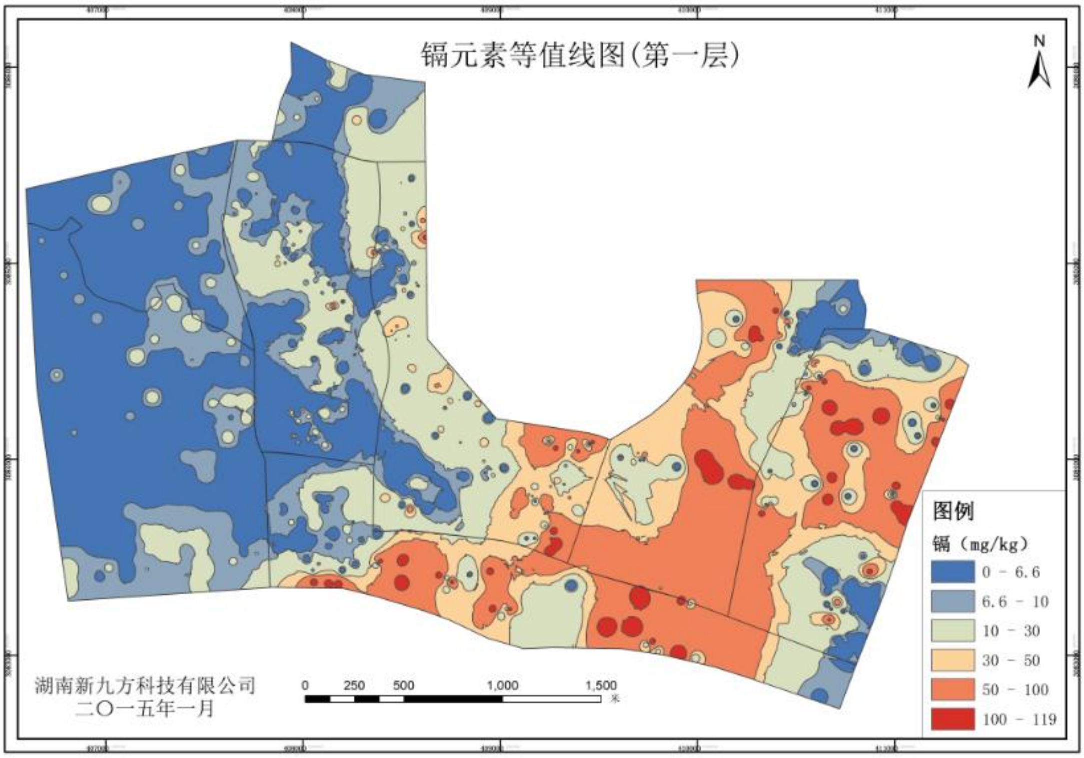


Figure3.3-22Contour map of Cd at the first soil layer

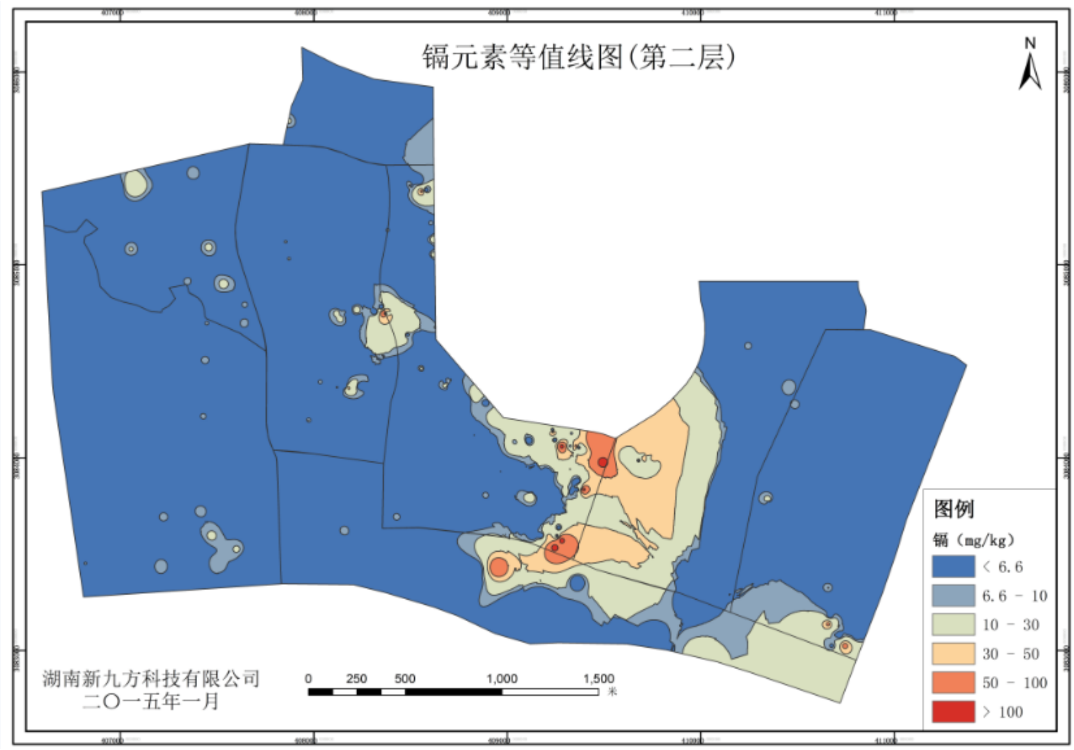


Figure3.3-23Contour map of Cd at the second soil layer

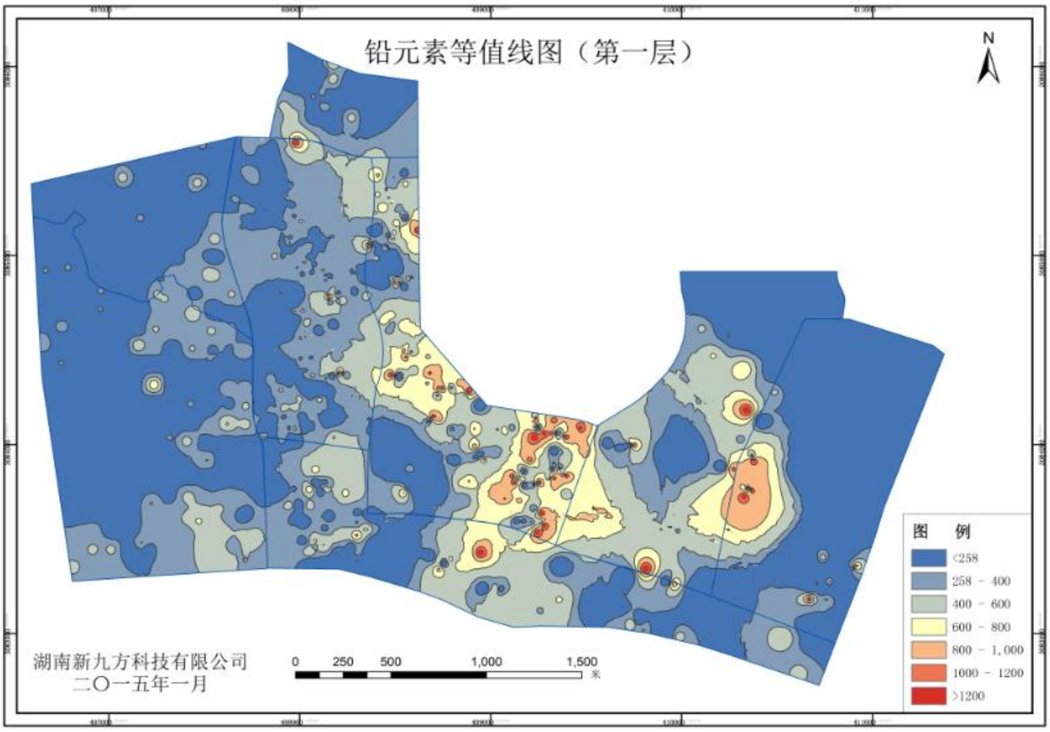


Figure3.3-24 Contour map of Pb at the first soil layer

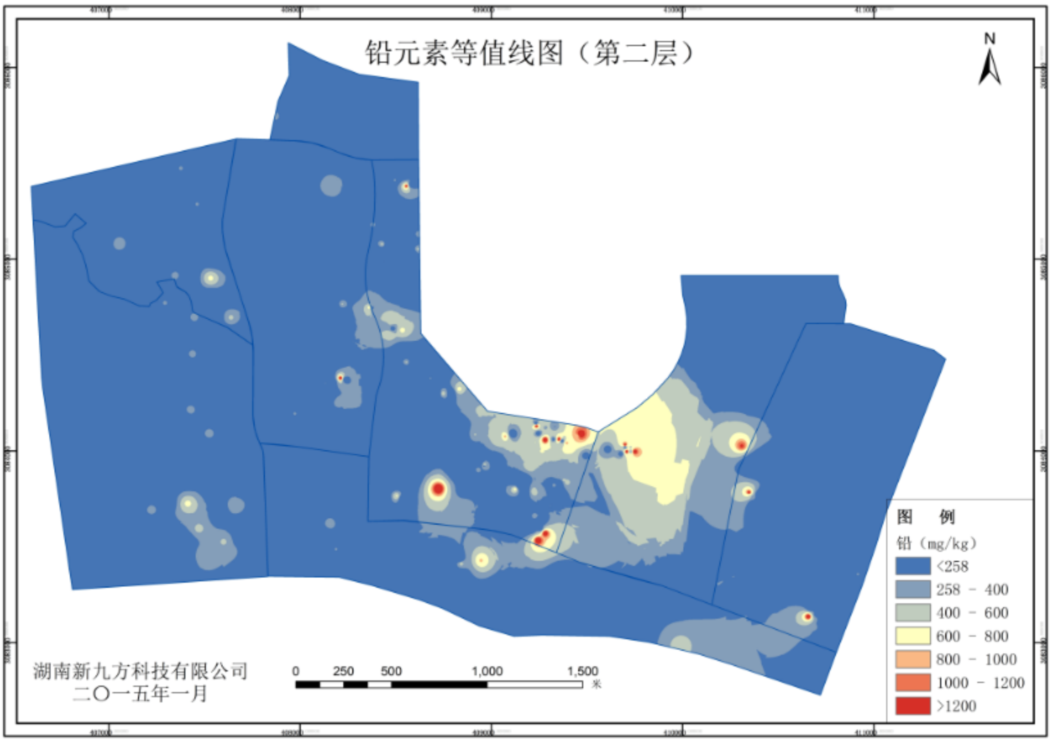


Figure3.3-25 Contour map of Pb at the second soil layer

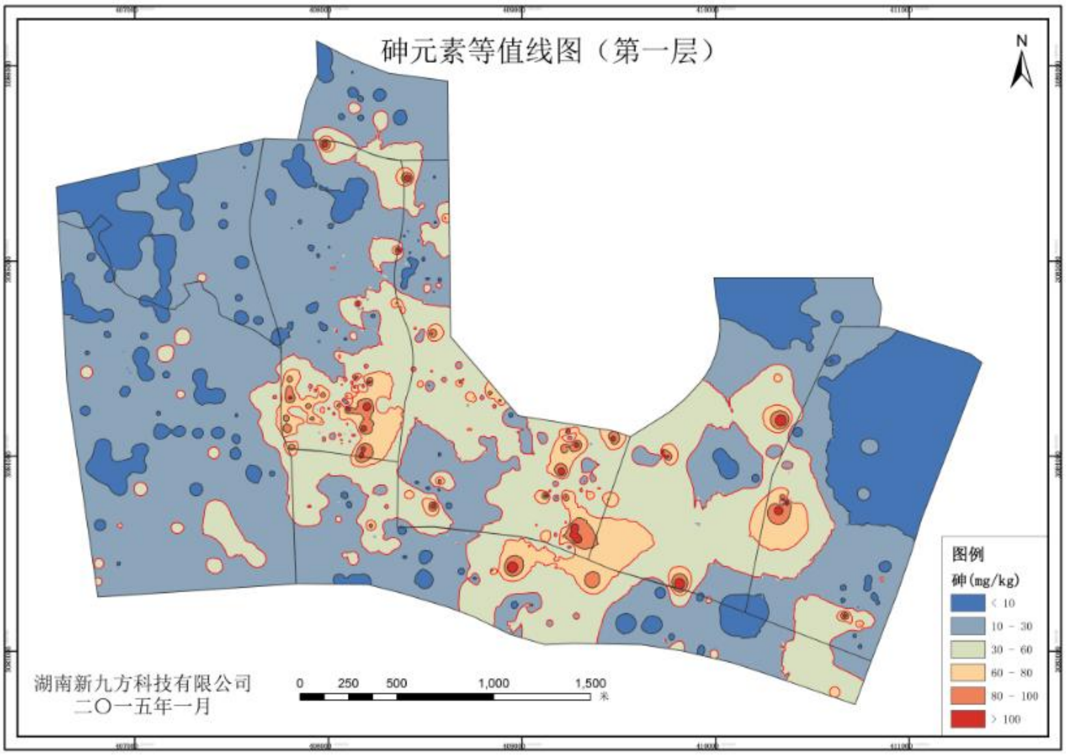


Figure3.3-26Contour map of As at the first soil layer

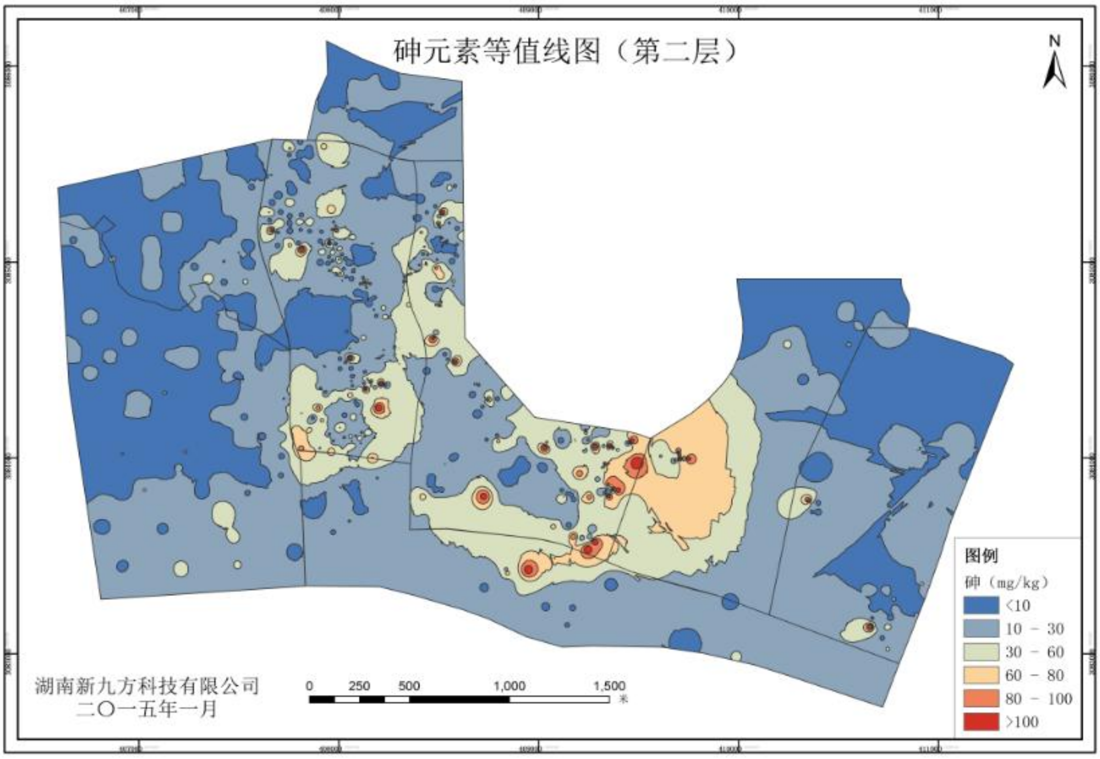


Figure3.3-27Contour map of As at the second soil layer

3.3.2.2 Conclusion of pond (channel) pollution survey

Hunan New World Science & Technology Co., Ltd. has conducted pond and channel pollution survey on the Old Xiawangang, Xinqiao Low Discharge Channel, water ponds in Tongtangwan sub-region, water ponds in Qingshui sub-region and water ponds in Tongxia sub-region, and drawn the following conclusions:

(1) The water of the Old Xiawangang can reach Class V standard of Environmental Quality Standard for Surface Water (GB3838-2002). According to the letter of confirmation of Zhuzhou Shifeng Environmental Protection Bureau, the Old Xiawangang and ponds in this region refer to Class V water quality standard that applies to water for agriculture or general landscape waters (the same below). The sediment of Old Xiawangang has high content of heavy metals, including the maximum content of Pb at 2,991.4mg/kg, Cd at 283.17mg/kg, As at 392.3mg/kg, Zn at 4,084.0mg/kg and Cu at 796.81mg/kg. According to the leaching concentration of heavy metals in sediments, it is estimated that the sediment belongs to general solid waste class II[1].

(2) The water of ponds in the project area can reach Class V standard of Environmental Quality Standard for Surface Water (GB3838-2002). The sediments of ponds contain high content of heavy metals, mainly including Pb, Cd, As and Zn. According to the leaching concentration of heavy metals in sediments, it is estimated that the sediment belongs to general solid waste class II.

3.3.2.3 Conclusion of Waste Residue Survey

Site survey has been conducted on two waste piles in the project area, i.e. waste pile in Tongxia Sub-region and waste pile in the plant area of Zhuzhou Yongfa Metal Refining Co., Ltd.

The waste pile in Tongxia Sub-region has high content of heavy metals, with the maximum content of Cd reaching 263.6mg/kg, Pb reaching 5,956.7mg/kg, Zn reaching 77,724mg/kg, As 220.3mg/kg and Cu 1,317.8 mg/kg.

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1 Class II general industrial solid waste: this generall industrial solid waste's leachate obtained by leaching tests carried out according to Solid Waste-Extraction Procedure for Leaching Toxicity GB5086, contains one or more pollutants of which the concentration exceeds the maximum allowable emission concentration specified by Integrated Wastewater Discharge Standard GB8978, or pH value is outside the range of 6~9.

The waste pile of Yongfa Refinery contains Cd of 27.63 mg/kg, Pb of 346.78 mg/kg, As of 44.61 mg/kg, Zn of 135.27 mg/kg and Cu of 15.80 mg/kg.

3.3.2.4 Conclusion of survey on closed companies

(1) The major heavy metal pollutants of Yongfa Refinery are Pb, Cd, As, Zn and Cu. Among them, the concentration range of Pb is 153.3～5,956.7mg/kg, Cd is 14.5~263.6mg/kg, As is 11.0~220.3mg/kg. The concentration of Pb in the plant most seriously exceeded the allowable standards, with exceeding rate reaching up to 46.7%.

(2) The major heavy metal pollutants of Brothers Industry are Pb, Cd, As and Zn. Among them, the maximum concentration of Pb is 1,505.5mg/kg, which is 2.5 times the allowable standard; the maximum concentration of Cd is 55.6mg/kg, which is 1.8 times the allowable standard; the maximum concentration of As is 160.6mg/kg, which is 2.7 times the allowable standard; the maximum concentration of Zn is 108kg/kg, which is 7.2 times the allowable standard. The exceeding rate of Pb is as high as 41.7%.

(3) The major heavy metal pollutants of Kangli Smelter are Pb, Cd, As, Cu and Zn. Among them, the concentration range of Pb is 100.1～12,689.0mg/kg, with an exceeding rate of 46.2%; the concentration range of Cd is 14.5～1,832.6mg/kg, with an exceeding rate of 38.5%; the concentration range of As is 15.0～832.6mg/kg, Zn is 368.3～38,989.0mg/kg, and Cu is 69.0～4,093.9mg/kg.

(4) Tiancheng Chemicals has combined pollution of heavy metals and organic compounds, and its major pollutants are Pb, Cd, As, Ni, benzopyrene and aniline. Among them, the maximum concentration of Pb is 970.0mg/kg, which is 2.43 times the allowable standard; the maximum concentration of Ni is 2,850.0mg/kg, which is 57 times the allowable standard. The concentration range of benzopyrene is 0.1～0.6mg/kg, with an exceeding rate of 75%; the concentration range of aniline is 0.1～45.2mg/kg, with an exceeding rate of 62.5%.

(5) The major heavy metal pollutants of Xinda Smelter are Pb, Cd, As, Zn and Cu. Among them, the concentration range of Pb is 153.3～17,729.0mg/kg, with an exceeding rate of 33.3%; the concentration range of Cd is 5.7～8,864.5mg/kg, with an exceeding rate of 26.7%; the concentration range of As is 11.0～883.9mg/kg, with an exceeding rate of 13.3%; the concentration range of Zn is 280.1～18,950.0mg/kg, with an exceeding rate of 40%; the

concentration range of Cu is 8.1～15,666mg/kg, with an exceeding rate of 13.3%.

(6) The major heavy metal pollutants of Hehua Cement Plant are Pb and Zn. Among them, the maximum concentration of Pb is 638.5mg/kg, with an exceeding rate of 8.3%; the maximum concentration of Zn is 100,500.0mg/kg, with an exceeding rate of 25%.

3.3.2.5 Conclusion of survey on residential area and surrounding uncovered soil

According to the survey, the heavy metal contents of 22 soil sampling points in large residential areas within the project area, including Pb, Cd, As, Zn and Cu, have not exceeded the standards. Most of the ground in the residential area has been hardened. The exposure pathways such as mouth, skin contact and inhalation are blocked. According to groundwater hydrogeological conditions of this region, the groundwater has weak flowability and poor mobility of pollutants. Therefore, the heavy metals in soil and groundwater of these residential areas have little effect on the health of the residents.

Site survey has been conducted on the uncovered soil around the residential areas in Xiangshiling, Qingshi and Tongtangwan sub-regions and residential areas near demolished plants. The survey results show that, a part of uncovered soil has been contaminated by Cd and Pb, and a soil area of 0.11km^2 needed to be replaced.

3.3.2.6 Conclusion of survey on surface water quality

According to this survey on the quality of water environment, combined with the historical monitoring data of water environmental quality in this region, the regional water environment mainly contains exceeded amount of ammonia nitrogen and total phosphorus, and heavy metal content of the regional waters did not exceed the corresponding standards.

3.3.2.7 Conclusion of survey on groundwater quality

Nanjing Institute of Environmental Sciences of Ministry of Environmental Protection, Nanjing Institute of Soil Science of Chinese Academy of Sciences and Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province have conducted groundwater quality survey in all sub-regions.

The site survey in all sub-regions were conducted in limited time periods. The surveyed regions are only local regions. Each survey adopted different evaluation criteria. Different assessment reports also failed to select complete evaluation factors and evaluation contents. This survey has adopted Class III standard of Groundwater Quality Standard as evaluation criteria, collectively analyzed and assessed the survey results of all evaluation units, and drawn the following conclusions:

From the perspective of different sub-regions, the major pollutants in the groundwater of Yingfeng Sub-region are nitrite, Cu and Mn; major pollutants in the groundwater of Qingshuihu Zone I are nitrate, nitrite, Mn and Hg; major pollutants in the groundwater of Qingshuihu Zone II are nitrate and Cu; major pollutant in the groundwater of Xiangshiling Sub-region is Zn; major pollutants in the groundwater of Tongtangwan Sub-region are Cd and Se; major pollutants in the groundwater of Qingshi Sub-region are Cd, Be, Ni, Se and Zn.

From the perspective of types of pollutants, nitrite and nitrate in the region have widely exceeded the standards; although the contents of heavy metal pollutants have exceeded standards in previous surveys, during this survey, the exceeded contents of heavy metal pollutants only appeared in a small number of sampling points in some sub-regions, expect that the exceeded contents of Be have appeared throughout the region according to the groundwater quality monitoring data collected by Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province. Other types of pollutants have not shown regional exceeding characteristics.

From the perspective of hydrogeological conditions, the groundwater in the investigated area can be divided into 5 categories, i.e. loose rock pore water, clastic rock pore-fissure water, clastic rock fissure water, shallow metamorphic rock fissure water and carbonate rock fissure karst water. The groudwater is affected by vadose zone permeability, fracture development degree and terrain. Except that the local carbonate rock fissure karst water layer contains a medium amount of groundwater, other water-bearing layers contain only a small amount of water, which generally exist in the form of hidden water and mainly supplied by precipitation. The supply, runoff and discharge processes of these water-bearing layers are not obvious. Since the groundwater flow has gentle slope and poor runoff conditions, the regional hydrogeological conditions are not conducive to the spread of contaminants. According to the current groundwater contamination situation, the regional groundwater primary subjects to agricultural pollution, along with some industrial pollution, but its risk to human health is controllable; according to the research result of the groundwater in the region, the current research work has many limitations. A comprehensive investigation of groundwater has not been carried out yet.

Since the groundwater system is a hidden and complex system, according to international experience, remediation of contaminated groundwater is a huge project that may take a long time and great investment. The remediation of groundwater system must be carried out on the basis of a comprehensive and systematic investigation of groundwater in the region.

3.3.2.8 Agricultural products

In accordance with Pollutants Threshholds in Food Products (GB-2762-2005) and relevant food products stanards for Zn, Cu, sampling results of vegetables collected in the project area indicate that the concentration of Cd, Pb and Zn is 0.103-4.32 mg/kg (with non-compliance rate of 46.7%), 0.072-4.32 mg/kg (with non-compliance rate of 46.7%) and 10.0-29.0 mg/kg (with non-compliance rate of 26.7%) respectively.

3.4Completed or ongoing pollution control projects in the project area

3.4.1 Completed remeidaiotn projects

ZREIDC has applied to the National Development and Reform Commission for special funds for the heavy metal pollution control projects in the Qingshuitang Industrial Zone. Projects that have been completed include construction of Tongxia Road, Xiawangang heavy metal pollution control project, Dahu heavy metal pollution control project, treatment project of waste residue containing heavy metals in the Qingshuitang Industrial Zone (including Xinqiao waste pile, north side waste pile and Dahu waste pile).

The locations of completed projects are shown in **Figure3.4-5**.

3.4.1.1 Xiawangang heavy metal pollution control project

Xiawangang originates from the dry pond in the northwestern part of Zhuzhou City, flows through the QIZ from north to south, mingles with the Xiang River River at 100m downstream of the gravel dock in Jianshe Village, Qingshui Town, Zhuzhou City. It is the first-grade tributary of the Xiang River River, with a basin area of 11.8 km^2. The contents of heavy metals such as Cd, Pb and As in the sediment of Xiawangang have seriously exceeded the allowable standards. At present, we have completed sediment dredging and harmless treatment of 4.06km heavily-polluted river section of Xiawangang, as well as ecological restoration of the river bank. A total of 50,080 m^3 heavy metal contaminated sediment and soil have been treated, including 38,360 m^3 of heavy metal contaminated sediment and 11,720 m^3 of heavy metal contaminated soil. The quantity of removed heavy metals, Cd, Pb, As, Cu and Zn in the sediment of Xiawangang is 0.47 t, 4.99 t, 0.26 t, 1.15 t and 22.16 t respectively.

The project investment is estimated at 202.83 million yuan, including 60 million yuan of national special funds and 9 million yuan of provincial funds. The project was commenced in December 2011 and accepted by the Environmental Protection Bureau of Hunan Province in September 2013.

The photos of Xiawangang before and after treatment are shown in **Figure3.4-1**.

Before treatment **After treatment**

Figure3.4-1Photos of Xiawangang before and after treatment

3.4.1.2 Qingshuitang heavy metal contaminated pond treatment project: Dahu heavy metal pollution control project

Dahu is located in Tongtangwan Sub-region, with a length of about 820m from east to west, width range of 63~200m from north to south and an area of 128,097 m^2. The site was originally the soil-taken field of Zhuzhou Xiawan Brickyard, and then formed a great pit after soil excavation, and finally formed a Dahu due to the low-lying terrain. Dahu has been used as a fish pond collectively owned by Jianshe Village. Since nearby residents dump domestic garbage into the Dahu, and some industrial enterprises in the QIZ dump industrial waste into the Dahu, the water of the Dahu has been polluted and gradually lost breeding capability. The east side of the Dahu is gravel pit, west adjacent to Xiawangang, north side is Yongfa

Refinery and Haili Zhuzhou Fine Chemicals, northeast side is Yingfeng neighborhood committee, and south side is residential area of Jianshe Village.

At present, the water of Dahu is mainly supplied by precipitation, as well as a small amount of domestic sewage and industrial wastewater. The water quantity is greatly affected by seasonal precipitation.

Dahu heavy metal pollution control project has treated the filtrated water, production wastewater and rainwater in the 427,000 m^3 of water body and sediment in Dahu contaminated by heavy metals, and carried out dehydration, stabilization, solidifition and backfilling of 98,000 m^3 heavy metal contaminated sediment. After the treatment, the Dahu can meet the requirements of land use planning for Tongtangwan Sub-region in Zhuzhou.

This project is a key part of heavy metal pollution control project in Qingshuitang Industrial Zone of Zhuzhou. The investment of this project is estimated at 102.6 million yuan. The project was commenced in December 2011 and completed and accepted in July 2013.

The photos of Dahu before and after treatment are shown in **Figure3.4-2**.

Before treatment **After treatment**

Figure3.4-2Photos of Dahu before and after treatment

3.4.1.3 Treatment project of waste residue containing heavy metals in the Qingshuitang Industrial Zone

The treatment project of waste residue containing heavy metals in the Qingshuitang Industrial Zone includes the treatment of Xinqiao waste pile, north side waste pile and Dahu waste pile, with a total quantity of waste residue of 1.966 million m^3. The project investment is estimated at 376.72 million yuan, including 113 million yuan of national special funds and 13 million yuan of provincial funds. The project was commenced in April 2012 and completed and accepted in December 2014.

The technical process of waste residue treatment project is shown in **Figure3.4-3**.

Xinqiao waste pile starts from Tongxia Road in the north, to Qingxia Road in the east, to the existing brickyard in the southeast and to the existing channel in the west. The waste pile is about 360m long from west to east, about 340m wide from north to south and covers a total area of 91,700m^2. The industrial residue in the waste pile includes carbide slag, salty mud, smelting slag and other mixed slag.

The north side waste pile is adjacent to Tongxia Road in the north and Xiawangang in the west. The waste pile is about 180m long from west to east, about 280m wide from north to south and covers a total area of 26,500m^2. The site includes a cement pipe processing plant and a waste material recycling company, piled with a large amount of black slag and other unknown residue. Most industrial wastes at the site are metallurgical slag and construction waste.

Dahu waste pile is located in Dahu Village Group of Jianshe Village. The east side of the waste pile is adjacent to the Dahu, west side is Xiawangang, south side is about 300m from Xiang River River, and northeast side is residential and plant area. The waste pile is about 330m long from west to east, 70m~150m wide from north to south and covers a total area of 45,470m^2. The industrial wastes at the site mainly include metallurgical slag, mineral processing tailings, construction waste and domestic garbage.

This project treated the Class II waste residue at the waste pile by stabilization/solidification process and in-situ anti-seepage landfilling.

Class II waste residue is treated by in-situ and ex-situ stabilization/solidification process. Bottom anti-seepage curtain and vertical grouting curtain are adopted in each waste pile, and the treated residue is safely filled in the backfilling zone of Xinqiao waste pile.

The photos of waste piles before and after treatment are shown in **Figure3.4-4**.

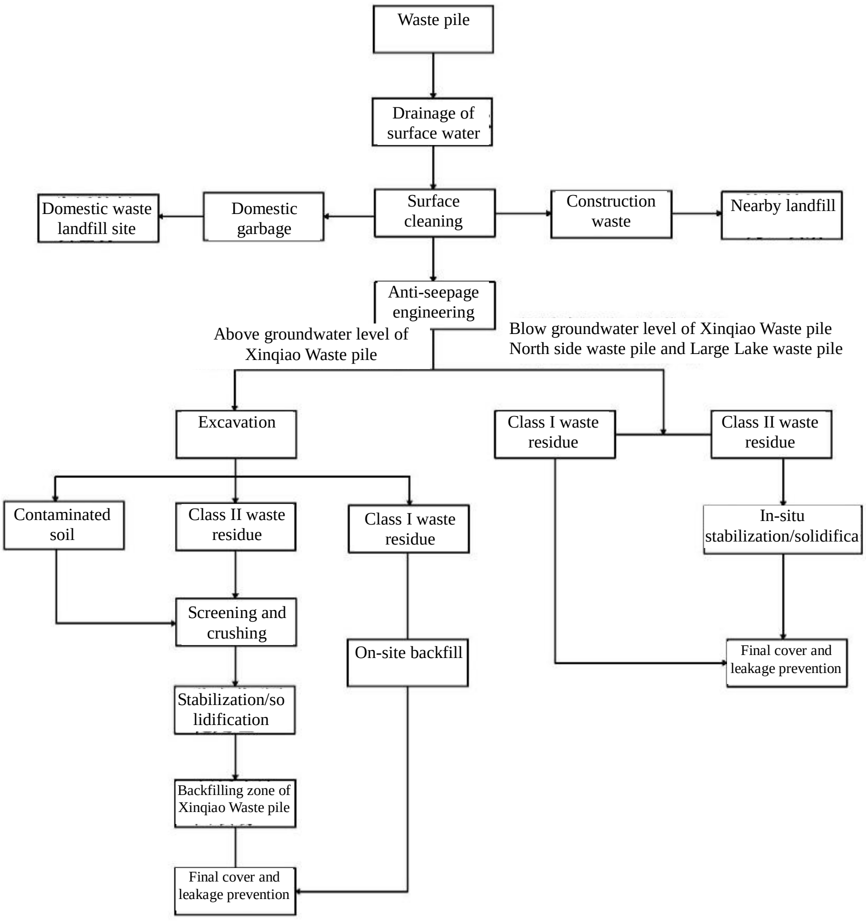


Figure3.4-3Technical process flow of waste residue treatment

Before treatment **After treatment**

Figure3.4-4 Photos of waste piles before and after treatment

3.4.2 Ongoing remediation porojects

3.4.2.1 Xinqiao Low Discharge Channel heavy metal remediaiton project

In the past, industrial wastewsater of Qingshuitang was discharged into Xiang River via the low dischage channel and other channels. After decades of accumulation, heavy metals such as Cd, Pb, Hg and As etc in the sediments significant exceeded relevant standards.

The project will carry out comprehensive treamtent of a 1.45 km channel section that is seriously contaminted with heavy metals, including sediment treatment and ecological rehabilitation.

Around 12113.4m3 sediments in the 1.45 km long channel will be treated through dewatering and solidification/stablization, and landfilling. Rehabilitation of dredged river bed and river bank will conducted as well.

The project is being carried out.

3.4.2.2 Old Xiawanggang Channel Heavy Metal Pollution Control Project Phase I

Before the Qingshuitang Wastewater Treatment Plan was built, industrail wastewater was dishcarged into Xiang River through Xiawanggang and Old Xiawangang. Before the Xiawanggang was built, the Old Xiawanggang had been the receiving water body for industrial wastewater for a long time. After decades of accumulation, heavy metals such as Cd, Pb, Hg and As etc in the sediments significant exceeded relevant standards.

The project will deal with 2.6km river section between Qingshui Road and Xiang River, and ponds in its downstream silted area. Activities include dredging, dewatering and treatment of sediments.

The project is under implementation. The World Bank Bank financed project will include ecological rehabilitation of river banks after the said remediaiton activities.

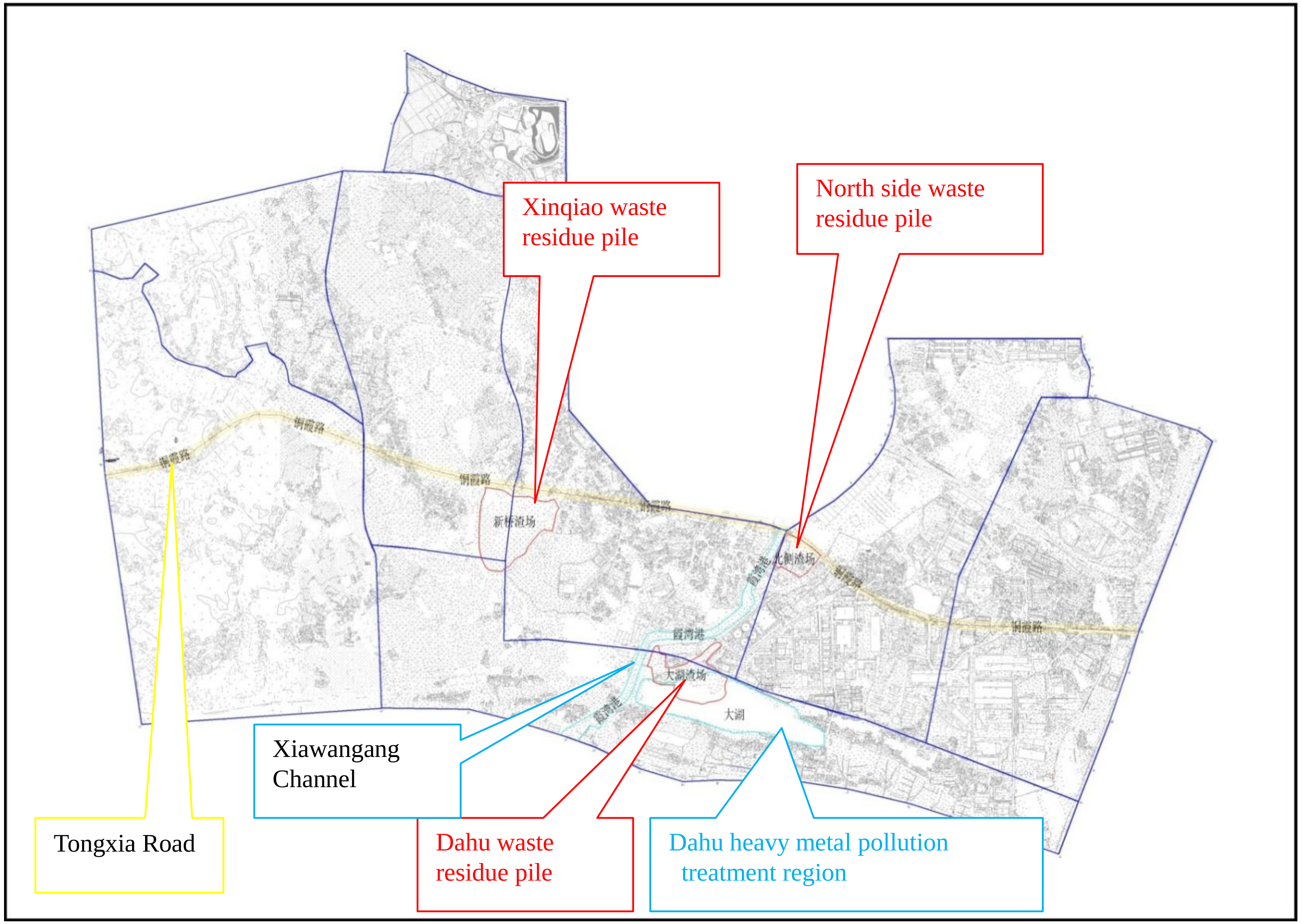


Figure3.4-5 Locations of completed projects in the region

4 Risk Assessment

4.1 Overview of risk assessment

4.1.1 Risk assessment work

During the period of 2011~2014, ZREIDC entrusted Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection and Nanjing Institute of Soil Science, Chinese Academy of Sciences to conduct risk assessment in 7 sub-regions of the project area. See details in the following table.

Table 4.1-1Risk assessment in 7 sub-regions of the project area

No.	Sub-region		Year	Evaluating organ	Risk assessment report
1	Qingshui		2011	Center for Survey, Assessment and Remediation of Contaminated Sites, Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection	Soil Pollution Risk Assessment Report of Qingshui Sub-region in Qingshuitang Industrial Zone of Zhuzhou City
2	Tongxia		2011		Soil Pollution Risk Assessment Report of Tongxia Sub-region in Qingshuitang Industrial Zone of Zhuzhou City
3	Yingfeng		2014		Soil Pollution Risk Assessment Report of Yingfeng Sub-region in Qingshuitang Industrial Zone of Zhuzhou City
4	Qingshuihu	Zone I	2014		Soil Pollution Risk Assessment Report of Qingshuihu Sub-region Zone I in Qingshuitang Industrial Zone of Zhuzhou City
		Zone II	2014		Soil Pollution Risk Assessment Report of Qingshuihu Sub-region Zone II in Qingshuitang Industrial Zone of Zhuzhou City
5	Qingshi		2014	Nanjing Institute of Soil Science, Chinese Academy of Sciences	Soil Pollution Risk Assessment Report of Qingshi Sub-region in Qingshuitang Industrial Zone of Zhuzhou City
6	Tongtangwan		2014		Soil Pollution Risk Assessment Report of Tongtangwan Sub-region in Qingshuitang Industrial Zone of Zhuzhou City
7	Xiangshiling		2014		Soil Pollution Risk Assessment Report of Xiangshiling Sub-region in Qingshuitang Industrial Zone of Zhuzhou City

The two research institutes identified pollution sources according to the results of the site survey data, determined the potential sensitive receptors and their exposure pathways to pollutants based on the future land use patterns of the QIZ in Zhuzhou, constructed the migration model of pollutants in environmental media and exposure model of sensitive receptors, and carried out risk assessment using risk assessment software, models and parameters of domestic and foreign authorities.

- Tongxia Sub-region and Qingshui Sub-region: human health risk assessment and ecological risk assessment were carried out;
- Yingfeng Sub-region and Qingshuihu Sub-region: human health risk assessment was carried out;
- Xiangshiling Sub-region, Qingshi Sub-region and Tongtangwan Sub-region: human health risk assessment and water environment risk assessment were carried out.

Human health risk assessment is a technical method to evaluate the harmness of one type or mutiple types of pollutants in a site of specific land use type to human health.

Ecological risk assessment of contaminated site is a technical method to evaluate the impact of pollutants in the site on plants, animals and eco-systems in specific areas.

Water environment risk assessment is a technical method to evaluate the risk and harmness of contaminated soil and underground water to the sensitive receptor, i.e. water environment.

4.1.2 Domestic and foreign references for risk assessment

Technical Guidelines for Risk Assessment of Contaminated Sites (HJ 25.3-2014) issued by the Ministry of Environmental Protection came into effect in July 2014. This guideline has refered to the widely-used risk assessment methods for contaminated sites in such countries as the United States, Canada, Britain, the Netherlands and Australia, taken into account the characteristics of domestic contaminated sites and population exposure scenarios, and provided an important technical support for assessment, remediation and environmental monitoring of contaminted sites in China.

Besides the Technical Guidelines for Risk Assessment of Contaminated Sites (HJ 25.3-2014), the risk assessment reports for Qingshi, Tongtangwan and Xiangshiling sub-regions prepared by Nanjing Institute of Soil Science, Chinese Academy of Sciences have also refered to the optimized calculation methods and model parameters of ASTM E2081 Guidelines.

Besides HJ 25.3-2014, the risk assessment reports for Yingfeng and Qingshuihu sub-regions prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental

Protection have also refered to the Integrated Risk Information System (IRIS) of USEPA, Risk Assessment Information System (RAIS), Risk Based Corrective Action (RBCA) software database, Concise International Chemical Assessment Documents (CICAD) of World Health Organization, risk assessment software, models and parameters of foreign authorities such as International Agency for Research on Cancer (IARC).

When Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection was preparing the risk assessment reports for Qingshui and Tongxia sub-regions in 2011, HJ 25.3-2014 had not been released yet. Besides the draft of Technical Guidelines for Risk Assessment of Contaminated Sites, the risk assessment reports for these two sub-regions have also refered to the Integrated Risk Information System (IRIS) of USEPA, Risk Assessment Information System (RAIS) of Oak Ridge National Laboratory of US Depatment Energy, risk assessment software, models and parameters such as US risk-based remedial action software database.

4.1.3 Priorities of risk assessment

Risk assessments in all sub-regions mainly include human health risk assessment, ecological risk assessment and water environment risk assessment.

According to the risk assessment reports for Qingshui and Tongxia sub-regions prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection, in consideration of background values of contaminated regions, the ecological risk control values of Cd, Pb, Zn and Cu are significantly lower than their human health risk control values, which is consistent with the basic concept of ecological risk and human health risk. Pollutants have an obvious impact on the ecosystem, ecosystem and species are quite vulnerable to pollutants and require higher levels of risk control.

Nanjing Institute of Environmental Sciences of Ministry of Environmental Protection, Nanjing Institute of Soil Science of Chinese Academy of Sciences and Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province have conducted groundwater quality survey in all sub-regions.

This survey has adopted Class III standard of Groundwater Quality Standard as evaluation criteria. From the perspective of different sub-regions, the major pollutants in the groundwater of Yingfeng Sub-region are nitrite, Cu and Mn; major pollutants in the groundwater of Qingshuihu Zone I are nitrate, nitrite, Mn and Hg; major pollutants in the groundwater of Qingshuihu Zone II are nitrate and Cu; major pollutant in the groundwater of Xiangshiling Sub-region is Zn; major pollutants in the groundwater of Tongtangwan Sub-region are Cd and Se; major pollutants in the groundwater of Qingshi Sub-region are Cd, Be, Ni, Se and Zn.

From the perspective of types of pollutants, nitrite and nitrate in the region have widely exceeded the standards; although the contents of heavy metal pollutants have exceeded standards in previous surveys, during this survey, the exceeded contents of heavy metal pollutants only appeared in a small number of sampling points in some sub-regions, expect that the exceeded contents of Be have appeared throughout the region according to the groundwater quality monitoring data collected by Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province. Other types of pollutants have not shown regional exceeding characteristics.

According to the risk assessment reports of Nanjing Institute of Soil Science of Chinese Academy of Sciences, if the maximum concentration limit (MCL) is used as evaluation criteria for water environment assessment, the major pollutants in the region are As, Cd, Ni, Zn, Be, Pb, Sb and Se; if the screening value of groundwater based on the protection of human health is used as evaluation criteria, then no pollutants exceed standardards or pose any potential risks.

From the perspective of hydrogeological conditions, the groundwater in the investigated area can be divided into 5 categories, i.e. loose rock pore water, clastic rock pore-fissure water, clastic rock fissure water, shallow metamorphic rock fissure water and carbonate rock fissure karst water. The groudwater is affected by vadose zone permeability, fracture development degree and terrain. Except that the local carbonate rock fissure karst water layer contains a medium amount of groundwater, other water-bearing layers contain only a small amount of water, which generally exist in the form of hidden water and mainly supplied by precipitation. The supply, runoff and discharge processes of these water-bearing layers are not obvious. Since the groundwater flow has gentle slope and poor runoff conditions, the regional hydrogeological conditions are not conducive to the spread of contaminants. According to the current groundwater contamination situation, the regional groundwater primary subjects to agricultural pollution, along with some industrial pollution, but its risk to human health is controllable; according to the research result of the groundwater in the region, the current research work has many limitations. A comprehensive investigation of groundwater has not been carried out yet.

Since the groundwater system is a hidden and complex system, according to international experience, remediation of contaminated groundwater is a huge project that may take a long time and great investment. The remediation of groundwater system must be carried out on the basis of a comprehensive and systematic investigation of groundwater in the region.

From the perspective of dynamic changes of regional groundwater level, the groundwater aquifer generally contains a small amount of water which is mainly supplied by atmospheric precipitation. The groundwater level mainly periodically changes with precipitation, with an annual variation range of only 0.5~1m. Thus, compared with dry season, the groundwater level slightly rises in rainy season. According to groundwater level revealed by existing boreholes provided by Geophysical Survey Team of Coalfield Geology Bureau of Hunan Province, the depth of groundwater level in the project area is 2.3~17.2m in dry season and 1.1~15.2m in rainy season. Since the minimum depths of groundwater level in the project area in both rainy and dry seasons are greater than the depth of remediated soil in the area, the fluctuations of groundwater level in the project area have little impact on the remediated soil at the depth of 60cm below the ground surface.

Taking into account that the region’s groundwater is not used as drinking water sources and based on the protection of human health, the groundwater pollutants in the region have not exceeded the groundwater risk control values. Since the priority of environment management in this area is the protection of human health, ecological risk and groundwater pollution risk will not be taken into account for the time being. After the implementation of the project, a systematic and long-term monitoring and research will be carried out on the soil, ecology and groundwater in the area. Meanwhile, appropriate management measures will be taken to strictly control groundwater contaminants in the region, prevent the spread of pollution, prohibit residents or enterprises from using groundwater as a source of drinking water, and carry out appropriate remediation work under complete conditions in the future.

Therefore, this risk assessment is primarily based on human health risk assessment in the completed risk assessment reports. The following section is a comprehensive summary of main contents and conclusions of human health risk assessment included in all risk assessment reports.

4.2Risk identification

According to soil survey in all sub-regions, the major risks in the project area include such pollutants as Pb, Cd and As. According to the land use type of this project area, the major risk produced by soil pollution is health risk. Therefore, the risk assessment focuses on human health risk, identifies and evaluates the potential environmental risk of heavy metals pollution in water ponds and sediments.

According to the Technical Guidelines for Risk Assessment of Contaminated Sites (HJ 25.3-2014), the future land use planning of the project area includes two typical land use patterns, i.e. sensitive land represented by residential land (referred to as “sensitive land”) and non-sensitive land represented by industrial land (referred to as “non-sensitive land”). “Residential land” and “non-residential land” mentioned in risk assessment reports of all sub-regions are corresponding to “sensitive land” and “non-sensitive land” in HJ 25.3-2014, respectively.

The future land use planning in the risk assessment reports prepared by Nanjing Institute of Environmental Sciences of the Ministry of Environmental Protection is based on the Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City (2010~ 2030). The future land use planning in the risk assessment reports prepared by Nanjing Institute of Soil Science of the Chinese Academy of Sciences is based on the Planning for Qingshuitang Ecological Industrial Town of Zhuzhou City. Sensitive and non-sensitive lands are divided according to these two plannings. These two plannings are described below:

(1) Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City (2010~ 2030)

According to the Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City, the future land use types of the project area mainly include park, Class II residential land, middle and primary schools, kindergartens, administrative office area, roadside greenbelt, green buffer, Class I industrial land, roads, gas stations, rainwater and wastewater treatment sites, excrement and garbage disposal sites, fire stations, hospitals, water area, recreational land and roads, etc.

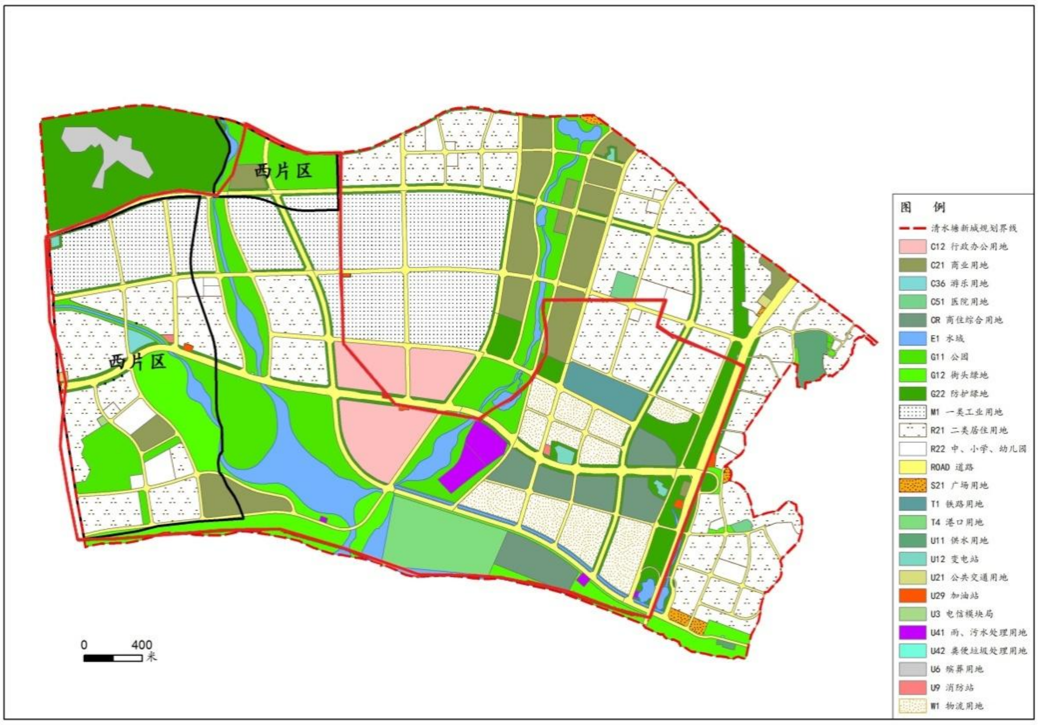


Figure4.2-1 Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City

(2) Planning for Qingshuitang Ecological Industrial Town of Zhuzhou City

Figure4.2-2Planning for Qingshuitang Ecological Industrial Town of Zhuzhou City

According to the Planning for Qingshuitang Ecological Industrial Town of Zhuzhou City, the future land use types of the project area mainly include residential land, administrative office area, commerical land, recreational land, sports land, land for medical and health care, land for education and scientific research, industrial land, warehouse land and special warehouse land for hazardous goods, etc.

During the feasibility study of this project, the conclusions of risk assessment in this region has been re-analyzed according to the Regulatory Planning for Core Zone of Qingshuitang Ecological Industrial Town of Zhuzhou City (2012). See details in Section 4.9.1.

4.3Relevant plannings, standards and guidelines

4.3.1 Relevant standards

(1) GB15618-1995 Environmental Quality Standard for Soils
(2) HJ350-2007 Standard of Soil Quality Assessment for Exhibition Sites (Trial)
(3) GB 5085 Identification Standards for Hazardous Wastes
(4) USEPA Region 9 Preliminary Remedial Goals (USEPA PRG IX)
(5) USEPA Soil Screening Levels (USEPA SSL)
(6) US Region 3, 6 and 9 Risk-based Screening Levels (RSL)

4.3.2 Relevant technical specifications

(1) HJ 25.2-2014 Technical Guidelines for Site Environmental Monitoring;
(2) HJ 25.1-2014 Technical Guidelines for Site Environmental Survey;
(3) HJ 25.3-2014 Technical Guidelines for Risk Assessment of Contaminated Sites;
(4) HJ/T 166-2004 Technical Specifications for Soil Environmental Monitoring;
(5) US ASTME2081 Guidelines;
(6) Guidelines for Site Environmental Assessment (JHF [2007]No. 8);
(7) Technical Guidelines for Site Environmental Monitoring (Exposure Draft)
(8) Technical Guidelines for Site Environmental Survey (Exposure Draft)
(9) Technical Guidelines for Risk Assessment of Contaminated Sites (Exposure Draft)

Note: Since the risk assessment in Qingxia and Qingshui sub-regions were completed in 2011, their risk assessment reports are based on the above guidelines and specifications (6) ~ (8), which are exposure drafts.

4.4 Contents of risk assessment

(1) On the basis of site surey, preliminary sampling and land use planning, risk assessment of contaminated sites have been carried out in 7 sub-regions covering an area of 8.48km^2, so as to gain a preliminary understanding of risk scope and distribution in contaminated sites.

(2) Health risk assessment is conducted to estimate the safety levels of major contaminants at an acceptable level, preliminarily determine risk control target, and provide scientific reference to further confirm remedial goals of contaminated soil and risk action values of pond sediment.

4.5 Risk assessment methods

4.5.1 Human health risk assessment

4.5.1.1 Hazard identification

Hazard identification is the first step in human health risk assessment process, mainly based on basic information of pollution and monitoring information of pollutants. The major pollutants of the polluted area are selected according to relevance principle. The activities of receptors are analyzed in different land use patterns. The channels for contaminants to contact or enter the human body are analyzed in different living and working situations (i.e. exposure scenarios). Conceptual model is established to reveal the exposure scenarios and exposure pathways of residents in polluted area in an intuitive way. The main work of this step is:

a). Select major pollutants;

b). Refer to the potential land use patterns, establish conceptual model and confirm potential exposure pathways;

c). Identify the toxic effects of major pollutants on human body.

4.5.1.2 Exposure assessment

Exposure assessment is the second step of human health risk assessment process, which determines or estimates the frequency, period, pathway and quantity of human exposure to contaminants. The carcinogenic and non-carcinogenic exposure dose in two land use patterns are evaluated according to Technical Guidelines for Risk Assessment of Contaminated Sites and Risk Assessment Information System (RAIS).

4.5.1.3 Toxicity assessment

Toxicity assessment is the third step of human health risk assessment process. The main task of this step is to obtain the carcinogenic and non-carcinogenic toxicity parameters of major pollutants to human body and calculate the ultimate risk.

Since the current study on toxicity data of pollutants to human body in China is still in the early stage, toxicity parameters has refered to the Appendix of Technical Guidelines for Risk Assessment of Contaminated Sites, and also collected from internationally recognized and authoritative database.

Nanjing Institute of Soil Science, Chinese Academy of Sciences has refered to the following toxicity parameters:

- Parameters recommended by Technical Guidelines for Risk Assessment of Contaminated Sites;
- Database constructed by Risk Reduction Plan of Texas, US (TXO8)

Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection has refered to the following toxicity parameters:

- Integrated Risk Information System (IRIS) of USEPA;
- US Risk Assessment Information System (RAIS);
- US Risk Based Corrective Action (RBCA) Software Database;
- Concise International Chemical Assessment Documents (CICAD) of World Health Organization;
- International Agency for Research on Cancer (IARC)

When the database only offers the Inhalation Unit Risk Factor (URF) and Inhalation Reference Concentration (RfC) of pollutants, these parameters need to be converted into carcinogenic slope factor (SF_i) and reference dose (RfD), to be used in risk calculations.

4.5.1.4 Risk characterization

Risk characterization is the last step of human health risk assessment process. The task of this step is to integrate all information based on the results of exposure assessment and toxicity assessment, and provide qualitative or quantitative description of the risks.

- Non-carcinogenic risk is described by hazard quotient, which is the ratio of daily intake dose of pollutants to reference dose, and used to characterize the harm level of human exposure to non-carcinogenic pollutants via a single pathway.

For non-carcinogenic risk, the acceptable level of both non-carcinogenic hazard quotient of a single pollutant and total non-carcinogenic hazard quotient is set at 1.

- With respect to the potential carcinogenic risk, the potential carcinogenic risk is estimated according to carcinogenic slope factor and carcinogenic exposure dose of pollutants. Carcinogenic risk is the probability of cancer or lesions induced by human exposure to carcinogens.

Acceptable carcinogenic risk: It is stipulated in Taiwan that the overall carcinogenic risk lower than 10^{-6} is the upper limit of acceptable carcinogenic risk. It is stipulated by USEPA that the acceptable carcinogenic risk of a single pollutant or a single exposure pathway cannot exceed 10^{-6}; both Missouri and New Mexico of US stipulate the acceptable carcinogenic risk as 10^{-5} when preparing risk-based soil standards; and the Netherlands stipulates the acceptable carcinogenic risk as 10^{-4} when preparing human health-based soil environment standards.

It is strictly stipulated in the Technical Guidelines for Risk Assessment of Contaminated Sites in China that the acceptable carcinogenic risk of a single pollutant is 10^{-6}.

In case of any sampling point where the carcinogenic risk of a single pollutant exceeds 10^{-6} or hazard quotient exceeds 1, its represented area should be designated as contaminated area with unacceptable risk.

4.5.2 Risk assessment of soil lead to human health

The risk assessment of lead differs from that of other contaminants. Reference dose (RfD) of non-carcinogenic contaminants is not used to evaluate the risk of Pb.

Due to matured studies on blood lead toxicity kinetics in human body (intake, distribution, metabolism, excretion, etc.), the USEPA and the Centers for Disease Control and Prevention determined to formulate relevant regulations and standards for Pb according to blood lead levels (PbB).

The risk assessment reports for Tongxia, Qingshui, Yingfeng and Qingshuihu sub-regions prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection have adopted the following models:

(1) It is stipulated by the EPA that the Integrated Exposure Uptake Biokinetic (IEUBK)

model is used to calculate the blood lead level in children aged 0~6 years as sensitive receptor exposed to sensitive lead polluted soil.

(2) The risk of lead contaminated soil to adult health is characterized by blood lead levels of pregnant women exposed to non-sensitive lead-contaminated soil. ALM model is used to calculate the blood lead level of pregnant women and derive the soil lead benchmark in non-sensitive land.

The risk assessment reports for Xiangshiling, Tongtangwan and Qingshi sub-regions prepared by Nanjing Institute of Soil Science, Chinese Academy of Sciences adopted the above IEUBK model to assess the risk of children exposure to Pb.

Since the ultimate remedial goals of all sub-regions refer to the assessment values of Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection, the Pb risk assessement adopts the conclusion of risk assessment reports prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection.

4.6Risk assessment of As and Cd in soil to human health

4.6.1 Conceptual model of human health risk assessment

The conceptual model is established for the purpose of clearly and vividly showing the medium and pathway for pollutants to reach or touch receptors in various exposure scenarios (living or working environment), so as to identify the exposure pathways of residents in the region and select the appropriate exposure calculation models and parameters to calculate exposure doses.

The exposure pathways under sensitive and non-sensitive land use patterns in this project are determined as: a). oral intake from soil; b). dermal exposure to soil; c). inhalation of soil particles.

4.6.2 Sensitive receptors under different land use patterns

For sensitive land, adults are chosen as sensitive receptors to assess carcinogenic risk, and childern as sensitive receptors to assess non-carcinogenic risk.

For non-sensitive land, adults are chosen as sensitive receptors to assess carcinogenic risk and non-carcinogenic risk.

4.6.3 Models and parameters for calculating exposure doses

Calculation models and parameters refer to Technical Guidelines for Risk Assessment of Contaminated Sites in China and US Risk Assessment Information System (RAIS) to assess carcinogenic and non-carcinogenic exposure doses under two kinds of land use patterns.

4.6.4 Toxic effects and toxicity parameters of pollutants

During quantitative calculation of risk level, the cumulative effect of different pollutants' toxicity has been taken into account. Under the conservative principle, 7 kinds of heavy metal pollutants that have been designated by environmental management departments and could easily cause harm to human health have all been taken into consideration, i.e. Zn, Cu, Cd, As, Ni, Cr and Hg. The risk of these 7 kinds of pollutants to human health have been assessed.

The toxic effects of major pollutants are shown in **Table 4.6-1**, and their toxicity parameters are shown in **Table 4.6-2**.

Table 4.6-1 Toxic Effects of Major Pollutants

Pollutants	Toxic effects		Target organ	Carcinogenic effect	Remark
	Acute toxicity	Chronic toxicity			
As	Acute gastroenteritis, cardiovascular damage, toxic hepatopathy, delayed neuropathy, skin and accessories lesions	Skin lesions, dermatitis, ulcers, skin cancer; brainrasia syndrome, gastrointestinal dysfunction, hepatomegaly	Liver, kidney, hematopoietic organs	Teratogenic, carcinogenic and mutagenic effect; classified as Class 1 human carcinogen by IARC	
Pb*	Nausea, diarrhea, abdominal distension; paroxysmal abdominal cramps; organ damage; jaundice	Neurasthenia; children are particularly sensitive to Pb, resulting in minimal brain dysfunction syndrome (MBD); toxic peripheral neuropathy; colic, digestive disorders, liver damage	All body systems and organs, mainly affecting these organs: nerve system, hematopoietic organs, digestive system, cardiovascular system, kidney	Teratogenic, carcinogenic and mutagenic effect; classified as Class 2B suspected human carcinogen by IARC	The lead content in human blood can not exceed 10μg /dL.
Cd	Gastrointestinal irritation, shock, acute renal failure	Renal tubular dysfunction, osteoporosis, osteomalacia (Itai-itai disease)	Mainly accumulating in liver and kidney; oral intake mainly cause toxicity in liver and kidney; inhalation may cause lung damage; both can cause high blood pressure and anemia	Reproductive toxicity, mutagenic and carcinogenic effects; Class I carcinogens, namely human carcinogen (IARC)	FAO/WHO confirmed that the maximum tolerable Cd intake per person per week is 0.4-0.5mg; the normal human body aging 40-60 years old has cadmium content of about 30mg, 10mg of which is present in the kidney, and 4.1mg is stored in the liver.
Cr	Stomach corrosion, cramps, convulsions, epilepsy, liver dysfunction, acute chemical respiratory tract inflammation, conjunctivitis, asthma	Chronic conjunctivitis, asthma, skin rashes, contact dermatitis, jaundice, abnormal liver function	Lung and skin	Animal experiments proved that it has teratogenic, mutagenic and carcinogenic effects; IARC classified trivalent chromium as Class 3 carcinogen, which is not carcinogenic to humans, hexavalent chromium as Class 1	

				carcinogen, which is carcinogenic to humans.	
Ni	Acute chemical bronchitis, pneumonia	Skin lesions, respiratory tract damage, respiratory tract cancer	Lung, liver, kidney, blood vessels	Reproductive toxicity, carcinogenic, teratogenic and mutagenic effects; Class I carcinogens, namely human carcinogen (IARC)	The daily intake of nickel for normal human body is about 0.3-0.5mg, and its total content in body is about 10mg, mainly stored in the skin.
Zn	Acute gastroenteritis, zinc fume fever, conjunctivitis, keratitis, skin local hyperemia	Chest tightness, shortness of breath, cough; lung membrane thickening, mild impairment of pulmonary ventilation function	Whole body	No evidence proved that it is carcinogenic	It is an essential micro element, about 2g in adults.
Cu	Acute chemical gastroenteritis, nausea, vomiting, stomach burning, jaundice, hepatomegaly, abnormal liver function, hemolytic anemia, local skin necrosis	Contact dermatitis (pimples, eczema-like change), eye and nose irritation, pulmonary interstitial fibrosis	Whole body	No evidence proved that it is carcinogenic	The daily dietary intake is about 2.5 ~ 5mg, and its content in the body of adults is about 50-120mg. It is distributed in the whole body, mainly in the liver, brain, heart and kidney.
Hg	Headache, dizziness, nausea; cough, chest pain; bronchitis, pulmonary edema; abnormal liver function, hepatomegaly	Hypomania, oral gingivitis, neuropsychiatric disorders, stomatitis, kidney damage	Kidney, heart, lung, brain	IARC (1987) did not give a conclusive answer whether mercury and its compounds are carcinogenic; USEPA (1989) concluded that mercury is not a human carcinogen.	

Note: “*”The toxicity of Pb is assessed according to blood lead level based on human dynamics model.

Table 4.6-2 Carcinogenic and non-carcinogenic toxicity parameters of major pollutants

Pollutants	RfD-oral (mg/kg/day)	RfD-dermal (mg/kg/day)	RfD-inhala (mg/kg/day)	SF-oral (1/(mg/kg/day))	SF-dermal (1/(mg/kg/day))	SF-inhala1 (1/(mg/kg/day))	Carcinogenic risk level *
Zn	0.3	0.3	-			-	D
Cu	0.04	0.04	-			-	D
Cd	0.001	0.001	-			7.2	B1
As	0.0003	0.0003	-	1.5	1.5	17.2	A
Ni	0.02	0.02	2.254E-05			1.92	A
Cr	1.5	1.5	0.005			-	NA
Hg	0.0003	0.0003	0.0003				D

*: The carcinogenic risk level is divided according to US IRIS: A (identified as a human carcinogen, with sufficient animal carcinogenicity toxicity test data and complete human carcinogenic toxicity data), B1 (sufficient animal carcinogenicity toxicity test data, but insufficient human carcinogenic toxicity data), B2 (likely to be human carcinogen deduced from sufficient animal carcinogenicity toxicity data), C (suspected human carcinogens without sufficient animal carcinogenicity toxicity data), D (cannot be classified), E (proven as non-human carcinogen), NA (carcinogenic pollutants defined by RBCA software database but still needs to be further confirmed).

4.6.5 Carcinogenic and non-carcinogenic risk of As and Cd in soil

According to the human health risk assessment, the risk levels of different sampling points are classified into low risk, medium risk and high risk, as shown in **Table 4.6-3**.

Table 4.6-3Classification of risk level

Risk type	Low risk	Medium risk	High risk
Carcinogenic risk	≤1.0E-05	1.0E-05~1.0E-04	≥1.0E-04
Non-carcinogenic hazard quotient	≤1	1~2	≥2

According to risk classification in the above table, the carcinogenic risk and non-carcinogenic risk are superposed according to the spatial distribution under the same land use pattern. The risk level at a single sampling point is classified under the principle of “approaching higher risk”. So the different risk levels are obtained in sensitive and non-sensitive land use patterns in the project area.

4.6.6 Risk control values of As and Cd in soil

4.6.6.1 Calculation of risk control values

Risk control value is the permissible content of pollutants in soil deduced from the acceptable risk level. The calculation of risk control value is the inverse process of risk calculation. This value has no uniform definition at home and abroad. It is defined as “soil risk control value” in Technical Guidelines for Risk Assessment of Contaminated Sites in China, while defined as the soil screening level (SSL) by USEPA, risk-based screening level by US Region 3, 6 and 9, and intervention value by the Netherlands.

(1) Calculation of risk control value of pollutants in soil with non-carcinogenic risk

a). Non-carcinogenic risk control value of soil pollutants taken orally

$$RCV_{oral} = \frac{TR \times RfD_{oral}}{CDI_{oral}}$$

b). Non-carcinogenic risk control value of soil pollutants taken through dermal exposure

$$RCV_{dermal} = \frac{TR \times RfD_{dermal}}{CDI_{dermal}}$$

c). Non-carcinogenic risk control value of soil pollutants taken through inhalation of soil particles

$$RCV_{inhalation} = \frac{TR \times RfD_{inhalation}}{CDI_{inhalation}}$$

d). Non-carcinogenic risk control value of soil pollutants taken through all exposure pathways

$$RCV_{total} = \frac{TR}{\frac{CDI_{oral}}{RfD_{oral}} + \frac{CDI_{dermal}}{RfD_{dermal}} + \frac{CDI_{inhalation}}{RfD_{inhalation}}}$$

Where, RCV is risk control value, unit: mg/kg; TR is target risk value, i.e. acceptable risk level; other parameters are the same as those in the sections of exposure assessment and toxicity assessment.

(2) Calculation of risk control value of pollutants in soil with carcinogenic risk

a). Carcinogenic risk control value of soil pollutants taken orally

$$RCV_{oral} = \frac{TR}{CDI_{oral} \times SF_{oral}}$$

b). Carcinogenic risk control value of soil pollutants taken through dermal exposure

$$RCV_{dermal} = \frac{TR}{CDI_{dermal} \times SF_{dermal}}$$

c). Carcinogenic risk control value of soil pollutants taken through inhalation of soil particles

$$RCV_{inhalation} = \frac{TR}{CDI_{inhalation} \times SF_{inhalation}}$$

d). Carcinogenic risk control value of soil pollutants taken through all exposure pathways

$$RCV_{total} = \frac{TR}{CDI_{oral} \times SF_{oral} + CDI_{dermal} \times SF_{dermal} + CDI_{inhalation} \times SF_{inhalation}}$$

Where, RCV is risk control value, unit: mg/kg; TR is target risk value, i.e. acceptable risk level; other parameters are the same as those in the sections of exposure assessment and toxicity assessment.

4.6.6.2 Risk control values of Cd and As

The risk control values of Cd in sensitive land are 6.62mg/kg, 23.1mg/kg and 23.1mg/kg corresponding to the carcinogenic risk control levels of 1.0E-06,1.0E-05 and 1.0E-04; the risk control values of Cd in non-sensitive land are 23.3mg/kg, 122.6mg/kg and 122.6mg/kg corresponding to the above three carcinogenic risk control levels.

The risk control values of As in sensitive land are 0.14mg/kg, 1.4mg/kg and 6.9mg/kg corresponding to the carcinogenic risk control levels of 1.0E-06,1.0E-05 and 1.0E-04; the risk control values of As in non-sensitive land are 0.28mg/kg, 2.8mg/kg and 28mg/kg corresponding to the above three carcinogenic risk control levels.

4.7Risk assessment of Pb in soil to human health

4.7.1 Risk control value of Pb in soil based on blood lead level in sensitive land

The Integrated Exposure Uptake Biokinetic (IEUBK) model is used to calculate the blood lead level in children. The IEUBK model is mainly used to predict blood lead levels of children aged 0~6 years exposed to lead in environment. The model consists of 4 sub-modules, i.e. exposure module, uptake module, biokinetic module and probability distribution module. The model is combined with statistics to correlate children's blood lead levels with lead exposure of difference pathways and sources.

Based on the assumption that the distribution of children's blood lead levels is approximately a normal distribution, the geometric mean value of children's blood lead levels is estimated according to the collected information about children's exposure to environmental lead, so as to estimate the probability of children's blood lead level exceeding the critical value of 10μg/dL.

The sources of lead in IEUBK model include soil, indoor/outdoor dust, drinking water, air and food. The model has defined the bio-availability of Pb intake from different environmental mediums, i.e. absorption proportion. The conceptual model of receptor exposed to environmental lead (**Figure4.7-1**) is established according to the modules included in IEUBK model.

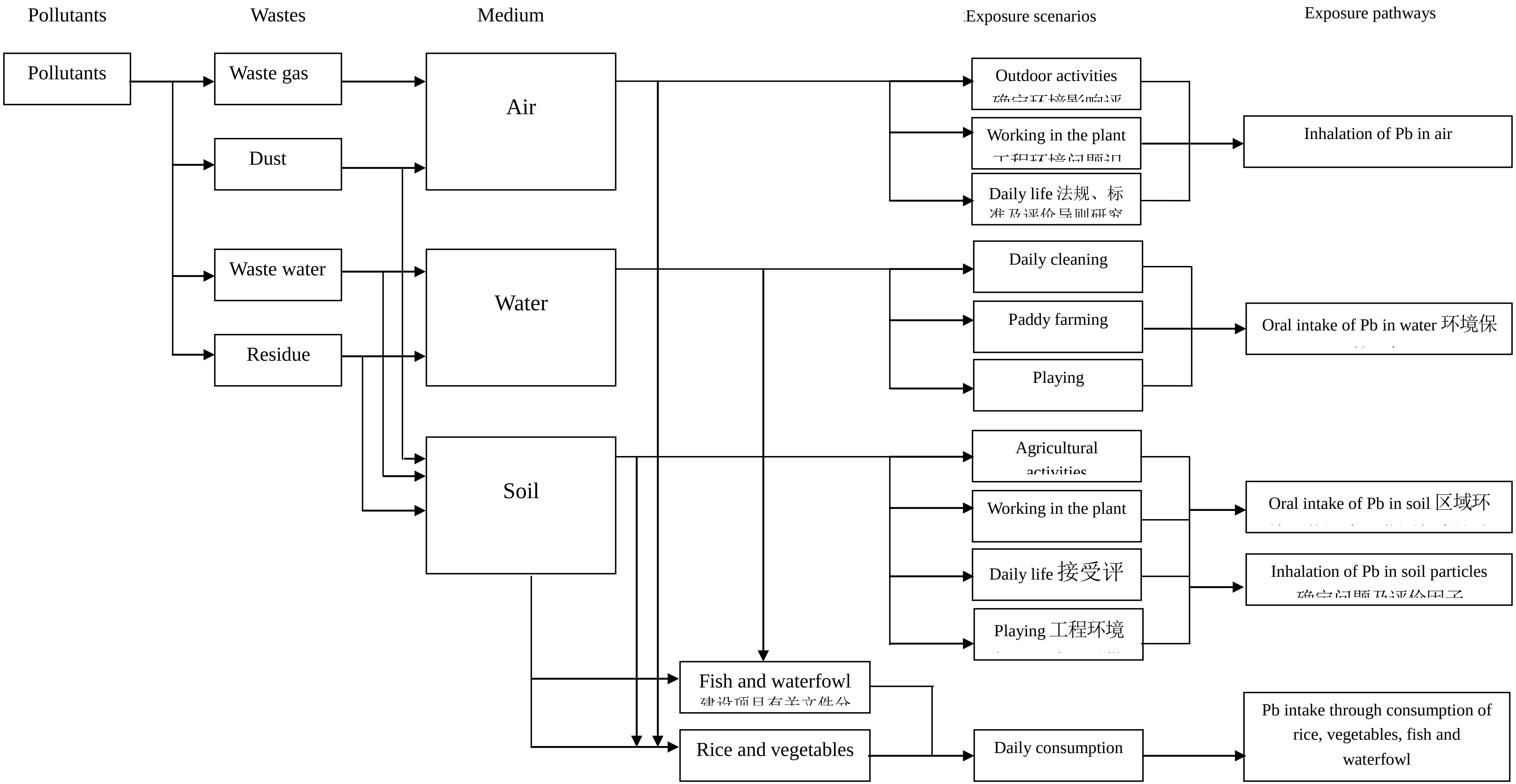


Figure4.7-1 Conceptual model for lead exposure

4.7.1.1 Exposure module

IEUBK model uses intake rate (IN) to describe children's lead intake from environmental media.

Since this survey focuses on soil, other sources of Pb in IEUBK model have not been investigated. Therefore, when calculating the risk control value of Pb in soil of residential land using IEUBK model, Pb content of other sources are collected in the following two ways: a). all parameters refer to default parameters of IEUBK model; b). Pb contents in the air, drinking water and food are acquired by querying the data. The permissible content of Pb in soil are calculated under the above two conditions respectively.

4.7.1.2 Uptake model

Different ways of lead intake have different bioavailability. It is defined by IEUBK model that the bioavailability of Pb intake from soil & dust, diet, drinking water and air is 30%, 40~50%, 60% and 25~45 % respectively. Accordingly, the ultimate Pb content UP_{poten} uptaken by children via the above environmental mediums can be expressed as:

$$UP_{poten} = (ABS_{diet} \times IN_{diet}) + (ABS_{dust} \times IN_{dust}) + (ABS_{soil} \times IN_{soil}) + (ABS_{air} \times IN_{air})$$

Biokinetic module of IEUBK model adopts mechanism model to describe the physiological-biochemical process of lead transport in the human body, and correlate the lead absorption efficiency with lead content in various organs of the human body, especially blood lead levels. Due to the differences in childern's own behaviors, living habits and individual types, children's blood lead levels have shown great variability under the condition of same environmental lead concentrations. This variability is described by IEUBK model using geometric standard deviation (GSD).

This survey has only measured the Pb content in soil of the project area. Therefore, when calculating the risk control value of Pb in soil of residential land using IEUBK model, Pb contents of other sources except for soil refer to standard lead levels in corresponding criteria.

4.7.1.3 Determination of permissible blood lead level

It is stipulated by EPA and CDC that the blood lead level exceeding 10μg/dL (serum, the same below) is harmful to chilren. The EPA determined the risk reduction target for blood lead uptaken from contaminated sites as follows: the possibility of children's blood lead level exceeding 10μg/dL should be lower than 5% or less after site remediation.

4.7.1.4 Parameter selection of IEUBK model and calculation of permissible Pb content in the soil of residential land

Based on the above assumption of lead contents from other sources and permissible blood lead levels, IEUBK model is used to calculate the critical value of soil lead content when the geometric standard deviation of blood lead level in childern aging 0~6 years old is 1.6% and the probability of blood lead level exceeding 10μg/dL is 5%.

Suppose the Pb in drinking water can reach the drinking water standard of 10μg/L after treatment, Pb in air can reach the ambient air quality standard of 1.0μg /m^3, and Pb in vegetables can reach corresponding standard of 0.3mg/kg, then Pb in soil shall meet the standard of 258mg/kg.

4.7.2 Risk control value of Pb in soil based on blood lead level in non-sensitive land

The risk of lead contaminated soil to adult health is characterized by blood lead levels of pregnant women exposed to lead-contaminated soil of non-sensitive land. ALM model is used to calculate the blood lead level of pregnant women and derive the risk control value of Pb in the soil of non-sensitive land.

This method only takes into account the direct uptake of Pb from soil and indoor dust, adopts the biokinetic slope factor (BKSF) to characterize the linear relationship between environmental lead exposure and blood lead levels of pregnant women, and uses geometric standard deviation to describe the difference in blood lead levels among individuals in similar lead exposure scenarios.

The risk control value of Pb in the soil of non-sensitive land is calculated as 627mg/kg.

4.7.3 Comparison of risk control values of Pb in soil calculated according to blood lead levels

The risk control values of Pb in the soil of sensitive land and non-sensitive land, as well as relevant standards and screening levels are listed in **Table 4.7-1**. Pb in vegetables can greatly constrain the Pb content in soil. When determining the risk control value of Pb in soil, the permissible Pb content in other 3 environmental mediums should be taken into account, so as to ensure that the probability of children's blood lead level exceeding 10μg/dL is lower than 5%.

Table 4.7-1Reference value for calculating the risk control value of Pb in soil based on blood lead levels

Sensitive land (IEUBK model)				
Parameters	**Pb in drinking water (μg/L)**	**Pb in vegetables (mg/kg)***	**Pb in air ($\mu g/m^3$)**	**Pb in soil (mg/kg)****
IEUBK Default parameters	4	0	0.1	390
Standard***	10	0.3	1.0	258
Non-sensitive land (ALM model)				627

*: Lead contaminated vegetables account for 25% of the total vegetable consumption.
**: Pb intake from soil includes direct Pb intake from soil and inhalation from soil particles.
***: Permissible content of Pb in soil based on the assemption that Pb content in drinking water, vegetables and air can reach corresponding standards after the remediation.

4.8Risk control values and remedial goals

According to the Approval of Risk Assessment Report of Soil Contamination in Qingshui Sub-region of Qingshuitang Industrial Zone in Zhuzhou (XHH[2012] No. 105) issued by Zhuzhou Environmental Protection Bureau, it is approved that the soil remediation of core area of $16km^2$ in the Qingshuitang Industrial Zone refers to the risk control values determined by the risk assessment reports of soil contamination in Qingshui and Tongxia sub-regions.

Risk control values in the risk assessment reports prepared by Nanjing Institute of Soil Science, Chinese Academy of Sciences are slightly different from those in the risk assessment reports prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection. However, the risk assessment reports prepared by Nanjing Institute of Soil Science, Chinese Academy of Sciences clearly refer to the achievements made by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection to determine the risk control values of Xiangshiling, Tongtangwan and Qingshi sub-regions.

Therefore, the following section will describe the determination process of risk control values by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection.

Risk control value is the permissible content of pollutants in soil deduced from the acceptable risk level. The calculation of risk control value is the inverse process of risk calculation. This value has no uniform definition at home and abroad. It is defined as "remedial goal" in Technical Guidelines for Risk Assessment of Contaminated Sites in China, while defined as the soil screening level (SSL) by USEPA, risk-based screening level by US Region 3, 6 and 9, and intervention value by the Netherlands.

According to the parameters recommended by Technical Guidelines for Risk Assessment of Contaminated Sites, we calculated the risk control values of Cd and As based on different acceptable carcinogenic risk levels (1.0E-06, 1.0E-05, 1.0E-04) via a single exposure pathway and all exposure pathways in the sensitive and non-sensitive land use patterns, and also calculated the risk control values of Cd and As based on the acceptable non-carcinogenic hazard quotient via a single exposure pathway and all exposure pathways. The minimum value is selected as the risk control value of a pollutant at a certain risk control level and in a specific land use pattern.

The risk control values of Pb are obtained using IEUBK model and ALM model.

Table 4.8-1Risk control values of As, Cd and Pb in soil and remedial goals

Unit: mg/kg

Pollutants	Carcinogenic risk control levels	Risk control values		Soil remedial goals	
		Sensitive land	Non-sensitive land	Sensitive land	Non-sensitive land
As	1.0E-06	0.14	0.28	31	53
	1.0E-05	1.4	2.8		
	1.0E-04	6.91	28		
Cd	1.0E-06	6.62	23.3	6.6	23.3
	1.0E-05	23.1	122.6		
	1.0E-04	23.1	122.6		
Pb	-	258	627	258	627

The above remedial goals of all pollutants are compared with soil screening levels and standards of corresponding pollutants specified by other countries or regions, so as to analyze the rationality of remedial goals for priority pollutants in this project, as shown in Table 4.8-2.

Table 4.8-2Comparision between remedial goals of As, Cd, Pb and other screening levels

Unit: mg/kg

Pollutants	Remedial goals		RSL*		SSL**	Exhibition standards	
	Sensitive land	Non-sensitive land	Residential	Industrial	Residential	Grade A	Grade B
Cd	6.62	23.3	70.00	800	78.00	1.00	22.00
As	31	53	0.39	1.6	0.45	20.00	80.00
Pb	258	627	400	800	400	140	600

*: RSL is Risk based screening level, defined by US Region 3, 6 and 9;

**: SSL is Soil screening level defined by USEPA.

According to the comparison, the same pollutant has different remedial goals in different countries or documents, which reveals different parameters selected for calculation and different control demands. Taking into account the acceptable level, economic cost, technical feasibility and control demands of the project area, and in order to facilitate the remediation project in the area, the remedial goals of Cd, As and Pb in the contaminated soil of the project area are determined as follows: the remedial goals of As, Cd and Pb in residential land are recommended as 30mg/kg, 10mg/kg and 400mg/kg respectively; the remedial goals of As, Cd and Pb in non-residential land are recommended as 60mg/kg, 30mg/kg and 600mg/kg respectively, as shown in **Table 4.8-3**.

Table 4.8-3 Recommended soil remedial goals for this project

Unit: mg/kg

Soil pollutants	Soil remedial goals	
	Sensitive land	Non-sensitive land
Cd	10	30
As	30	60
Pb	400	600

4.9 Re-analysis and conclusion of risk assessment

4.9.1 Re-analysis

With respect to the determination of remedial region, the risk assessment reports prepared by Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection refers to Planning for Qingshuitang Circular Economy Industrial Zone in Zhuzhou City (2010~2030), while the risk assessment reports prepared by Nanjing Institute of Soil Science, Chinese Academy of Sciences refers to the Planning for Qingshuitang Ecological Industrial Town of Zhuzhou City. Both plannings are early plannings for this region, and now the planning has been updated as the Regulatory Planning for Core Zone of Qingshuitang Ecological Industrial Town of Zhuzhou City (2012). Therefore, the feasibility study unit has re-analyzed the risk assessment reports on the basis of the conclusions of risk assessment and remedial goals of pollutants determined by risk assessment, taking into account the progress of implemented projects and production of operating plants in the project area. The project area is divided into risk controllable area, risk acceptable area and remediation area. The re-analysis process is shown in **Figure4.9-2**. The spatial distribution of different risk areas in the project is shown in **Figure4.9-1**.

These three risk areas are defined as follows:

- Risk acceptable area: the risk acceptable area is 2.02 km^2 determined by risk assessment reports;
- Risk controllable area: the risk controllable area includes the following areas in unrisk acceptable area determined in the risk assessmenet reports, i.e. hardened residential area, site of plants in production, pollution control project that have been completed or are being implemented (Xiawangang heavy metal pollution control project, Dahu heavy metal pollution control project, treatment project of waste residue in Xinqiao waste pile, north side waste pile and Dahu waste pile), covering an area of 3.73 km^2;
- Remediation area: the remediation area is the rest area expect for the risk controllable area in the unrisk acceptable area determined in the risk assessmenet reports, covering an area of 2.73km^2.

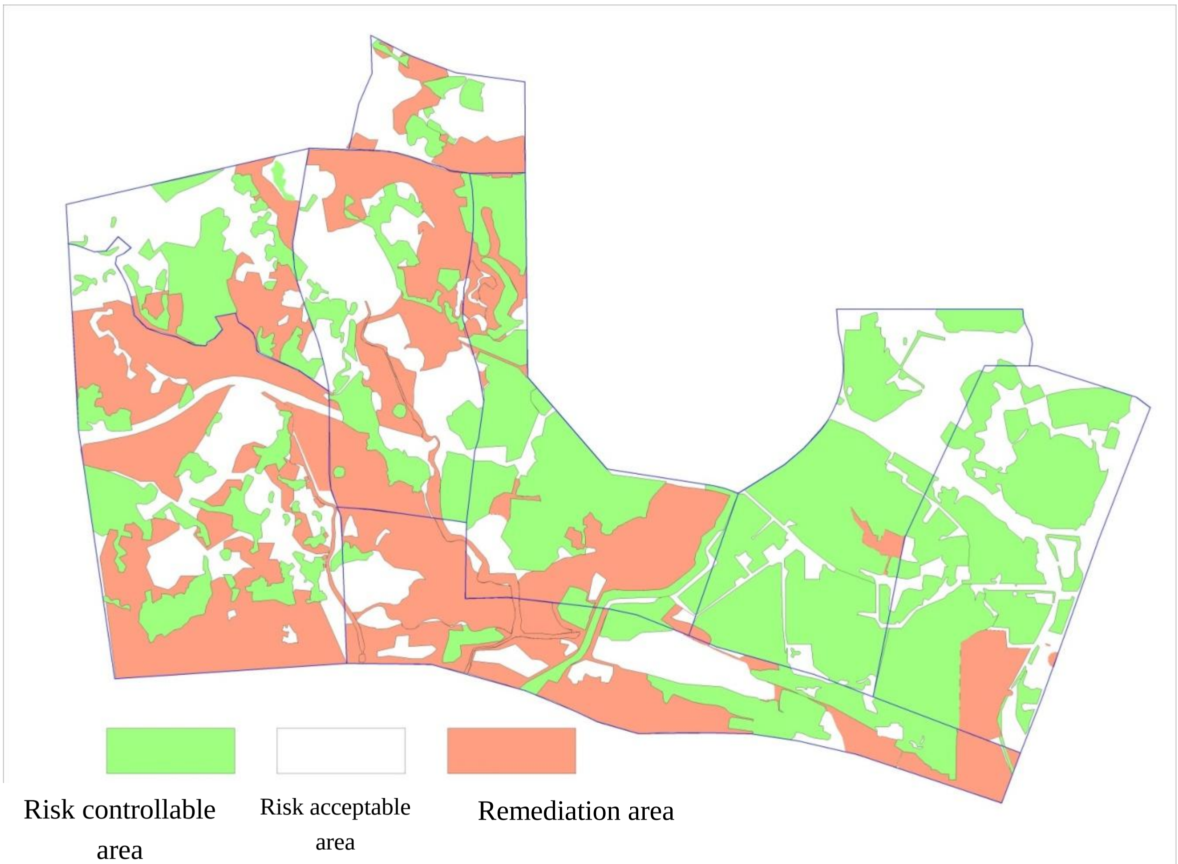


Figure4.9-1 Spatial distribution of different risk areas in the project area

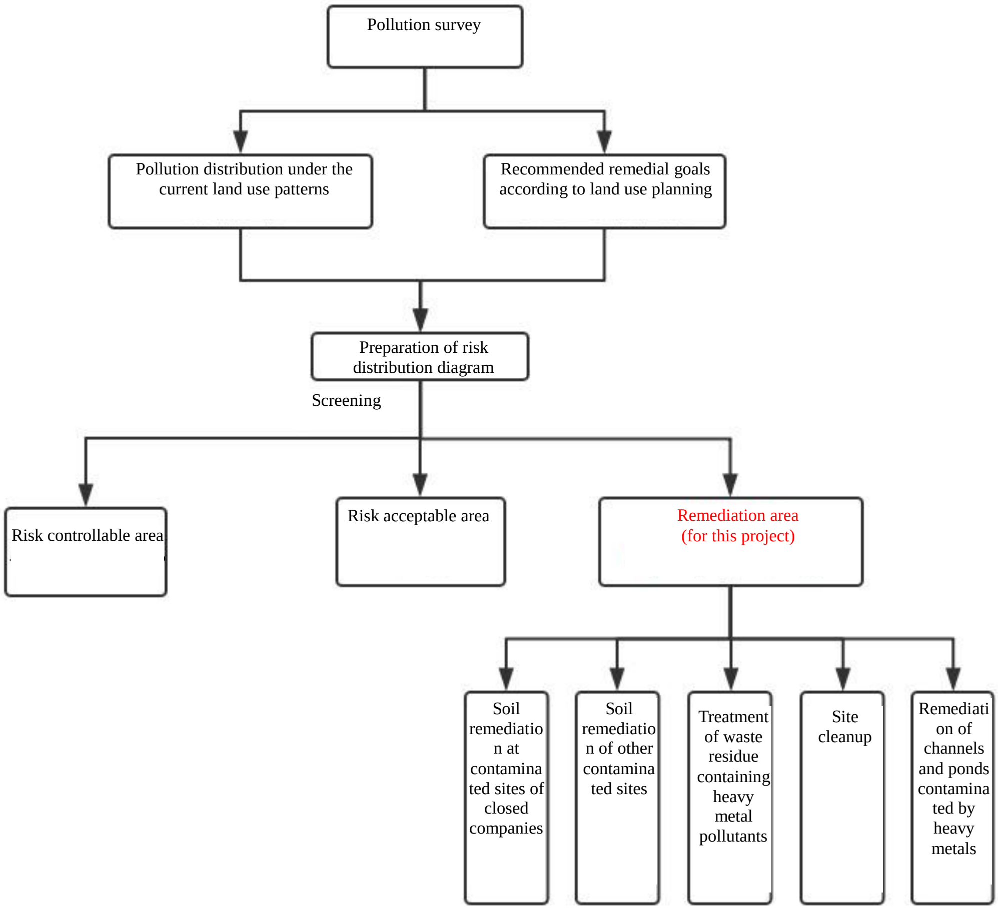


Figure4.9-2 Determination of project content and scale based on the conclusion of risk asssessment

4.9.2 Remediation area

According to the results of risk assessment, the remediation area of this project is 2,727,116m^2. The distribution of remediation area is shown in **Figure4.9-3**. The comparison between remediation area determined by risk assessment and remediation area determined by feasibility study is shown in **Table 4.9-1**.

Table 4.9-1Comparison between remediation area determined by risk assessment and that determined by feasibility study

Unit: m^2

Sub-region	Remediation area determined by risk assessment	Remediation area determined by feasibility study	Difference	Remark
Xiangshiling	47943	100571	52628	Risk assessment has taken into account the current land use situation. The original site of Tiancheng Chemicals has been adjusted from administrative office area (non-sensitive land) to residential land (sensitive land), resulting in the increase of remediation area.
Tongtangwan	127597	618381	490784	The Qingshuihu ecological wetland has been added to the remediation area, resulting in the increase of sensitive land; meanwhile the contaminated residential areas have been added.
Qingshi	40360	88887	48527	The feasibility study classified the site of plants in production as risk controllable area, and proposed measures for pollution prevention and control of these plants.
Qingshui	483575	444377	-39198	The main reason for the adjustment is that the risk assessment did not take into account the current land use situation. The uncontaminated residential area, site of plants in production and pollution control projects implemented in recent years are classified as risk controllable area. In addition, the planning adjustments in small areas are taken into account in the feasibility study.
Tongxia	842375	351590	-490785	
Qingshuihu	1467450	861584	-605866	
Yingfeng	362400	261276	-100674	
Total	3371700	2727116	-644584	

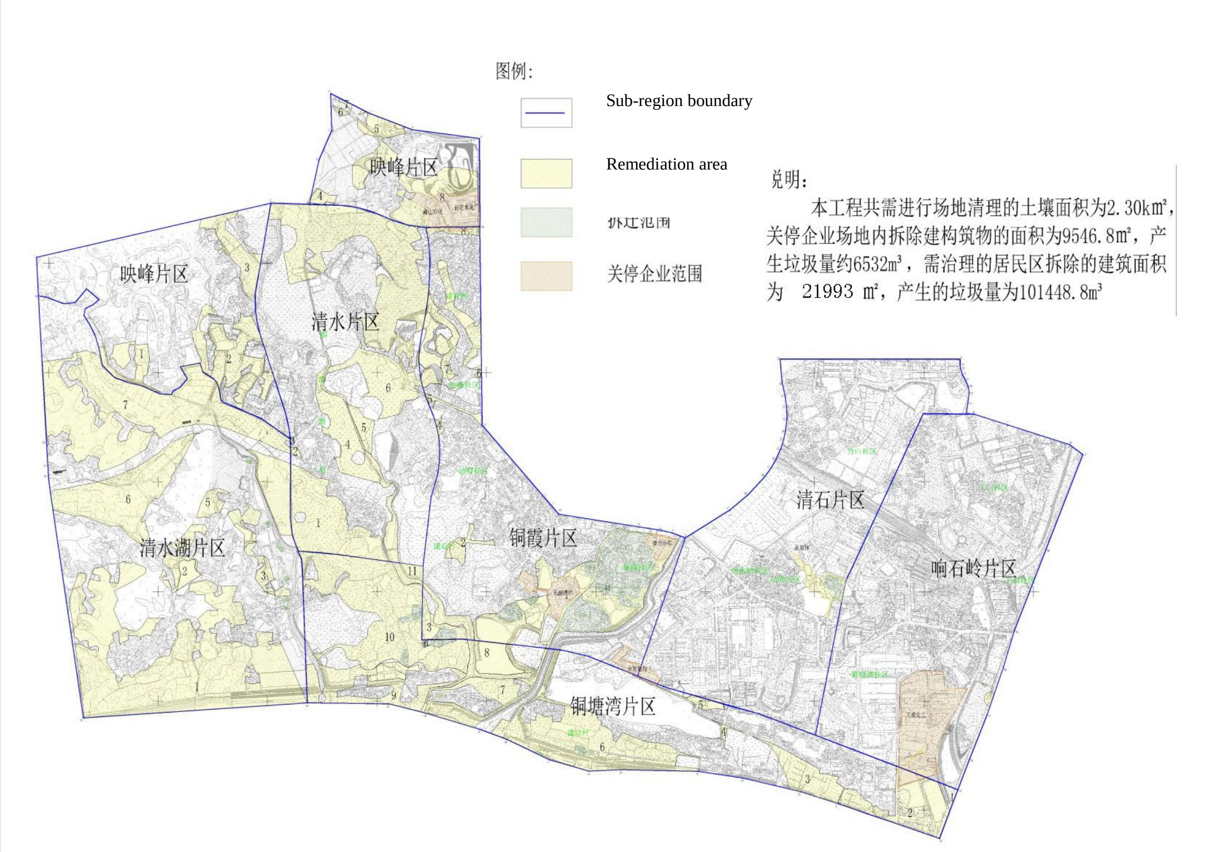


Figure4.9-3 Distribution of remediation area

4.9.3 Statistics of risk acceptable area and risk controllable area

Risk acceptable area and risk controllable area are not the remediation area of this project. These two types of areas have a total area of 5.75 km^2, as shown in **Figure4.9-4**.

4.9.3.1 Risk controllable area

After determining the recommended remedial goals, statistics have been made on the uncontaminated area and those areas where pollution control has been completed or still in progress within the project scope:

1) According to site survey and pollution analysis, all 7 sub-regions in the project area have large residential areas, of which the soil have been hardened before the construction of surrounding companies, so these residential areas will not polluted by dust. Meanwhile, sampling analysis has been conducted on the soil below the hardened ground in the residential areas, and the results show the soil below the hardened ground has not been polluted by heavy metals. So these residential areas are confirmed as uncontaminated areas. However, those residential areas close to Zhuzhou Smelter and other heavily polluted areas have excessive amounts of heavy metals in soil. Accordingly, these contaminated residential areas are within the scope of this remediation project.

Meanwhile, site survey has also been conducted on uncovered soil surrounding residential areas, and results show that a small quantity of uncovered soil has excessive amounts of heavy metals, covering an area of 0.11km^2. For this part of uncovered soil, this project will propose suggestions for remediation of uncovered soil in the non-remediation area.

2) With respect to those plants in production, on the one hand, the products, production processes and productivity of these plants are in line with the relevant industrial policies; on the other hand, the environmental protection bureau has rigorously monitored the wastewater, waste gas and waste residue of these plants.

According to the environmental monitoring data 2012~2014 provided by Zhuzhou Environmental Protection Bureau, the waste discharge of some enterprises have met environmental emission standards. However, other enterprises such as Liuhua Guicheng and Zhongcheng still have excessive emissions of dust and sulfur dioxide, Haili Fine Chemicals, Haohua and Pinhe Zinc have excessive emissions of COD and ammonia nitrogen in waste water. The Environmental Protection Bureau has issued notices to urge these companies to complete technology upgrades by 2016, so as to ensure that all types of pollutants can reach emission standards. Those companies that fail to reach the emission standards in due time will be closed during the year of 2015~2017. Therefore, these companies in production will not be included in the remediation scope of this project.

According to the Implementation Plan for Overall Relocation and Transformation of Qingshuitang Old Industrial Zone in Zhuzhou (2013-2022), most enterprises in the industrial zone will be successively closed, relocated, transformed or newly built.

Therefore, these companies in production will not be included in the remediation scope of this project.

In the future, if the sites of those closed companies need to be re-used, the re-use of these remaining sites should comply with the provisions of Notice on Enhancing Pollution Control during Shut-down, Relocation and Original Site Redevelopment of Industrial Enterprises, and Environmental and Social Management Framework. Environmental survey shall be carried out on these sites. For those contaminated sites that are confirmed by site survey and risk assessment, the owner of the site shall be urged to fulfill the responsibility for the remediation of closed and relocated enterprises, prepare the remediation plan, and incorporate the costs of site survey, risk assessment and remediation works into relocation costs.

3) The construction of Tongxia Road has been completed in the project area. Tongxia Road passes the project area from west to east. Prior to its construction, the heavy metal contaminated soil in this region has been remediated. Therefore, Tongxia Road is also not included in the remediation scope of this project.

4) The heavy metal pollution control projects have been implemented in the project area since 2011. Projects that have been completed include Xiawangang heavy metal pollution control project, Dahu heavy metal pollution control project, treatment project of waste residue containing heavy metals in the Qingshuitang Industrial Zone (including Xinqiao waste pile, north side waste pile and Dahu waste pile).

The sites of completed projects in the project area will also not be included in the remediation scope of this project.

Based on the above four points, we summarized the areas beyond the remediation scope of this project. The statistical results showed that this project area includes a risk controllable area of 3.73 km^2 . The detailed statistics results are shown in the following table.

Table 4.9-2Statistics of risk controllable area in the project area (Unit: m^2)

No.	Sub-region	Risk controllable area					Subtotal
		Enterprises in production	Unconta mi-nated residentia l area	Newly-built road (Tongxia Road)	Completed remediation projects	Remediation projects in progress	
1	Tongtangwan	97593	222621		160132	5270	485616
2	Tongxia	111795	354837	39011	86131		591774
3	Qingshui	7122	181630	27406	36377		252535
4	Qingshi	638027	163351	36590	18821		856789
5	Xiangshiling	467759	347598	35183			850540
6	Yingfeng	26330	273360				299690
7	Qingshuihu		319741	55113		21046	395900
	Total	1348625	1863138	193303	301461	26316	3732843

4.9.3.2 Risk acceptable area

Risk acceptable area is defined as the area whose risk level confirmed by risk assessment and sample analysis is within the acceptable range for human body. The risk acceptable area of this project is 2.02km^2.

Table 4.9-3 Statistics of risk acceptable area in the project area (Unit: m^2)

No.	Sub-region	Risk acceptable area
1	Tongtangwan	114853
2	Tongxia	109121
3	Qingshui	402740
4	Qingshi	276025
5	Xiangshiling	308054
6	Yingfeng	410275
7	Qingshuihu	400616
	Total	2021682

4.9.4 Conclusion of risk assessment

(1) Remediation area

The remediation area of this project is 2,727， 116m^2.

(2) Remedial goals

According to the Approval of Risk Assessment Report of Soil Contamination in Qingshui Sub-region of Qingshuitang Industrial Zone in Zhuzhou (XHH[2012] No. 105) issued by Zhuzhou Environmental Protection Bureau, it is approved that the soil remediation of core area of 16km^2 in the Qingshuitang Industrial Zone refers to the risk control values determined by the risk assessment reports of soil contamination in Qingshui and Tongxia sub-regions.

The remedial goals of As, Cd and Pb in residential land are recommended as 30mg/kg, 10mg/kg and 400mg/kg respectively; the remedial goals of As, Cd and Pb in non-residential land are recommended as 60mg/kg, 30mg/kg and 600mg/kg respectively.

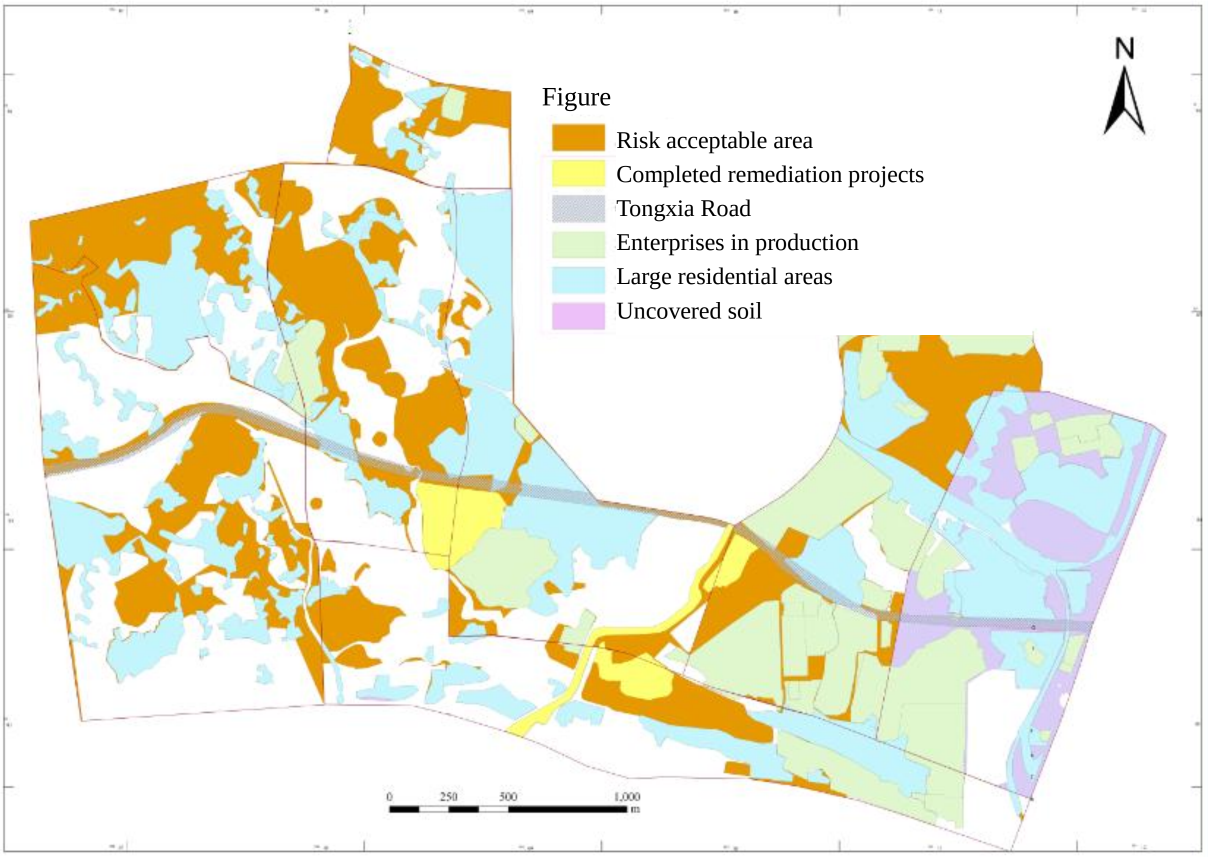


Figure4.9-4 Risk controllable area and risk acceptable area

5 Project Profile

5.1 Project overview

Project name: The World Bank-China Proposed Zhuzhou Brownfield Remediation Project;

Project site: Qingshuitang Industrial Zone in Zhuzhou;

Construction unit: ZREIDC

Project investment: RMB 1508 million;

Project type: Environmental remediation project

5.2 Construction content and scale

The project covers a total area of 8.48 km^2. The east side of the project area is adjacent to Xiangtian Road, west side close to Beijing-Guangzhou high-speed rail, north side next to Zhuzhou Smelter, and south side adjacent to Xiang River River. Acoording to the overall planning and administrative division of the QIZ, the project area is divided into seven sub-regions, including Xiangshiling, Qingshi, Tongtangwan, Tongxia, Qingshui, Yingfeng, and Qingshuihu. The sub-region division is shown in **Figure5.2-1**.

During the feasibility study of this project, the conclusions of soil pollution risk assessment has been re-analyzed to avoid repeated remediation under the precondition of pollution risk control. The whole project area is divided into risk acceptable area, risk controllable area and remediation area. The spatial distribution of different risk areas in the project is shown in **Figure4.9-1**.

The risk acceptable area is 2.02 km^2, and risk controllable area is 3.73 km^2, totalling 5.75km^2. The scope of risk acceptable area and risk controllable area is shown in **Figure4.9-4**. The risk acceptable area and risk controllable area are not included in the remediation scope of this project. However, these areas are a part of the project area. Any remediation activities in these areas in the future shall conform to the same environmental standards as this project.

The remediation area is 2.73km^2, within the scope of this remediation project. The remediation area is shown in **Figure4.9-3**. Most of the project activities will take place within the project area, except that 1) excavated soils from Tianchen Chemical Plant will be moved to a cement plant outside QIZ for treatment because the soils contain organic pollutants, and 2) backfilling clean soils will come from other places in Zhuzhou. These off-site impacts and measures have been included in the project EA.

The remediation works in this area are shown in **Table 5.2-1**.

Table 5.2-1Main contents of the remediation project

I. Soil surface cleaning and remediation

1. Area and volume of soil surface cleaning: soil area of 2.30km^2; demolished building waste of 45843m^3.
   （1） Cleaning of 6 closed companies: including Zhuzhou Yongfa Metal Refining Co., Ltd., Zhuzhou Brothers Industry Co., Ltd., Zhuzhou Kangli Smelting Plant, Zhuzhou Tiancheng Chemical Co., Ltd., Zhuzhou Xinda Smelting Co., Ltd. and Zhuzhou Hehua Cement Plant, with a demolished area of 9546.8 m^2, building waste of 6532.0 m^3 and cleaning area of 21993 m^2;
   （2） Cleaning of residential area: 94 households need to be relocated, involving 372 affected residents and concentrating in Xiawan New Village, Yingfeng Community, Qingxia Community and Jianshe Village, with a demolished area of 126811.1m^2 and building waste of 39310m^3.
2. Replacement of uncovered soil: the uncovered soil around the residential areas in Xiangshiling, Qingshi and Tongtangwan sub-regions and residential areas near demolished plants will be replaced. About 110855m^2 of uncovered soil in non-remediation area needs to be replaced, the depth of replaced soil is 0.5m, and 55427.5m^3 of clean soil are needed.
3. Soil remediation in contaminated sites:
   (1) Remediation technology and scale of heavy metal contaminated soil: refer to domestic standards and USEPA Super Fund Plan to determine the remediation method of this project.

Remediation technique	In-situ stabilization and blockage	In-situ stabilization and ecological restoration	Ex-situ stabilization and solidification	Transport to industrial planning area	Ecological restoration	Ecological interception
Area: m^2	738968	128054	474202	622937	229266	98030
Volume: m^3	443381	76832	284521	373762	137560	58818

(2) 6 closed enterprises: 0.13km^2. Contaminated soils excavated and moved to S/S facility. Amount: 74313m^3; organic contaminated soil is located in the plant area of Zhuzhou Tiancheng Chemical Co., Ltd., with an area of 8274m^2, contaminated soil quantity of 16548 m^3. The organic contaminated soil is transported to Sinoma Zhuzhou Cement Co., Ltd for incineration disposal.

4、Waste piles treatment: the remaining waste piles in the project area include waste pile in Tongxia Sub-region, waste pile in the plant area of Hongxin Industry and sporadic residue along the Low Discharge Channel. The waste residue is excavated and directly transported to stablization or solidification treatment site, with a total volume of 84,700 m^3. After treatment, the waste residue is delivered to the landfill site .
II. Water and sediment remediation of ponds
1、Remediation work involves 26 ponds, with a total area of 0.17km^2, water accumulating volume of 259,500m^3 and contaminated sediment volume of 173,000m^3. 2、Post –clean up ecological remediation of the Old Xiawangang Channel. Area: 54279m^2
III. Infrastructure/treatment/diposal works for site remediation
1、 Renting stablization or solidification treatment site of Xinqiao waste pile: covering an area of 4000m^3, with the maximum daily treament capacity of 400m^3/d; 2、 Renting the dehydration site of Xiawangang: covering an area of 5500m^2, including dehydration area of 4000m^2 and temporary sediment storage site of 1500m^2; 3、 Building a new dehydration site: covering an area of about 4200m^2, including dehydration area of 4000 m^2 and temporary sediment storage site of 200 m^2; 4、 Building a new temporary storage site: building a temporary storage site besides the stablization or solidification treatment site, covering an area of 10000m^2, with industrial waste of about 150,000m^3. 5、 Landfill site: the abandoned limestone mine of Zhuzhou Heha Cement Plant will be built into a landfill site, covering an area of 38265m^2, with available total capacity of 2million m^3. 6、 Building new temporary roads: The main roads of this project include Tongxia Road, Qingxia Road, Old Tongxia Road and Huanbao Avenue under construction, supplemented by other village roads. The existing roads are taken full advantage of, village roads are appropriately improved, and some temporary roads are built to facilitate earthwork transport. Village Road of 13832m is reconstructed and temporary roads of 1802m are newly built.
Ⅳ. Environmental Information and Demonstration Center
To maximize the demonstration impact of the project, an environmental demonstration center will be established, which will not only serve as an environmental education platform for the public to review the pollution history, display remediation achievements and anticipate the

future development of environmental protection; but also a monitoring data center to provide support for environmental management and green development. The center will also provide information on area's redevelopment plans and serve as a center for the affected to file their complaints. Specific activities include a management building with a construction area of 820m2; an environmental protection exhibition center with construction area of 7,150m2, and an experiment/demonstration base with an area of 40,000m^2.
Ⅴ. Studies
（1）Study on Qingshuitang Brownfield Remediation and Strategic Planning：(i) recommendations for filling the potential gaps between the remediation results and future land use/urban development strategic planning, through defining remedial remediation targets or refining the strategic planning; (ii) a strategic environmental and social impact assessment for the remediation and redevelopment of Qingshuitang core zone; (iii) application of green remediation in the future remediation practices in Qingshuitang； (iv) policy recommendations for addressing policy, regulation, financing and market issues in the remediation and redevelopment. （2）Study on the compliance framework for Qingshuitang environmental quality and industrial pollution control： (i) regional groundwater monitoring and modelling; (ii) monitoring of industrial emissions, secondary pollution analysis and data analysis for environmental management.

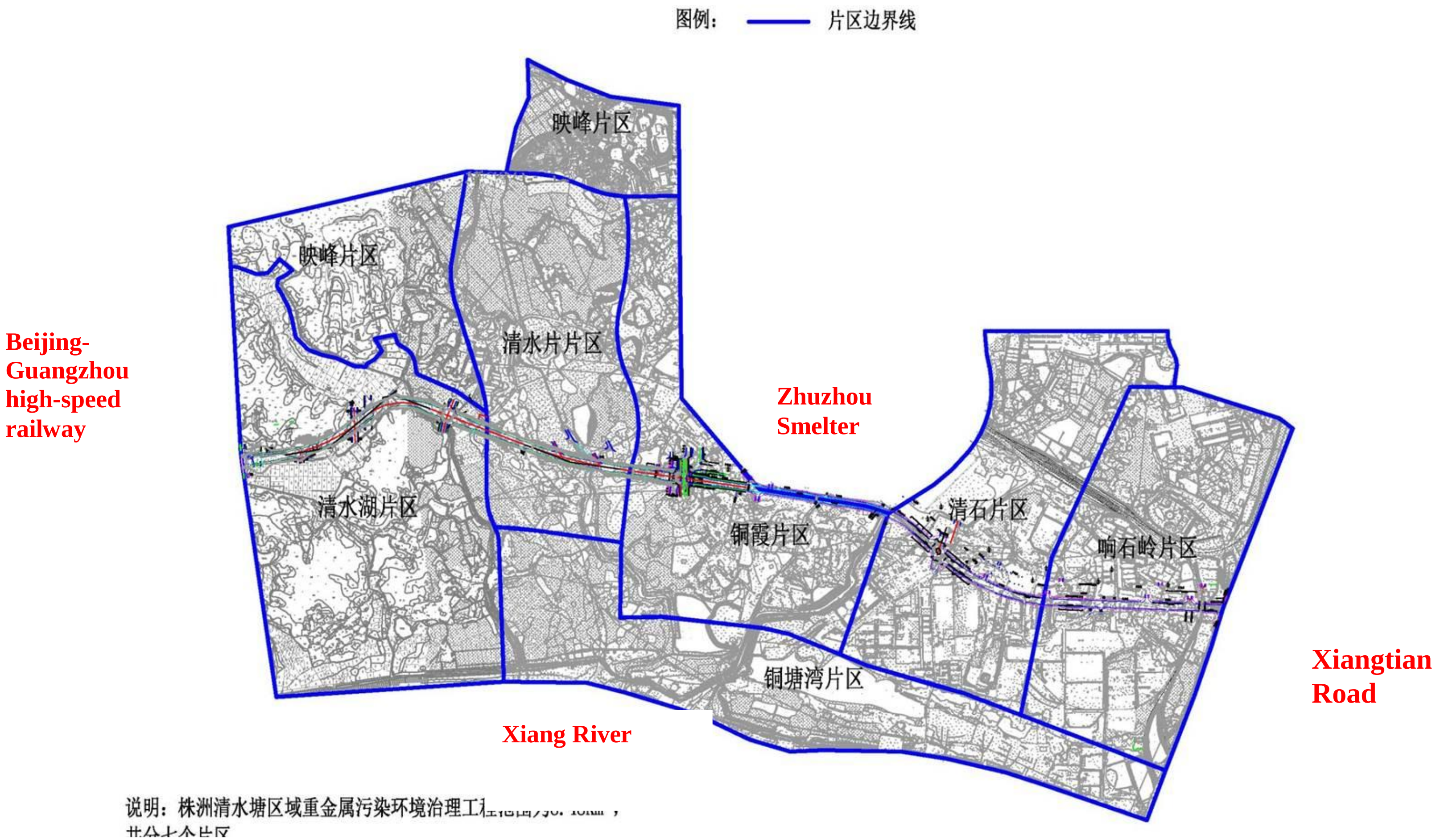


Figure5.2-1 Project scope and partition map

Note: Zhuzhou Brownfield Remediation Project covers an area of 8.48km^2.

2.73km^2 of remediation area is divided according to the contaminated targets, as shown in **Table 5.2-2**.

Table 5.2-2 Remediation area Unit: m^2

Contaminated sites	Area (m^2)	Pollutants to be treated
Closed companies	191579	Cd, As and Pb, Ni and benzopyrene (Tiancheng Chemicals)
Other contaminated soils	2291457	Cd, As and Pb
Old Xiawan Channel	54279	
Pond	172986	
Waste pile	16815	
Total quantity	2727116	

Note: Uncovered soil area to be replaced in the non-remediation area is 0.11km^2, which is included in the remediation area.

The remediation scale in remediation area is shown in **Table 5.2-3**.

Table 5.2-3 Remediation scale in remediation area Unit: m^3

Item	Remediation	Area (m^2)	Quantity (m^3)	Total (m^3)
Site cleanup	Construction waste cleanup of closed companies	9547	6532	45842
	Construction waste cleanup of residential area	126811	39310	
	Soil surface cleanup	2291457		
Remediation of closed companies	Site remediation of closed companies	191579	90861	90861
Soil remediation of other contaminated sites	Yingfeng sub-region	183376	110026	1374874
	Qingshuihu sub-region	895948	537569	
	Qingshui sub-region	411982	247189	
	Tongxia sub-region	231317	138790	
	Qingshi sub-region	28150	16890	
	Tongtangwan sub-region	538789	323273	
	Xiangshiling sub-region	1895	1137	
Residue treatment	Waste piles	16815	81652	84652
	Waste residue in closed companies		3000	
pond sediment remediation	Old Xiawangang Channel	54279	-	-
	Pond sediment	172986	172986	172986
Uncovered soil remediation in non-remeidation area	Replacemnet of uncovered soil	110855	55428	55428

The remediation quantities of heavy metal contaminated soil using different remediation techniques are shown in **Table 5.2-4**.

Table 5.2-4Remediation quantities of heavy metal contaminated soil using different remediation techniques

Remediation techniques	Area (m^2)	Volume (m^3)
In-situ stabilization and blockage	738968	443381
In-situ stabilization and ecological restoration	128054	76832
Ex-situ stabilization and solidification	474202	284521
Transport to industrial planning area	622937	373762
Ecological restoration	229266	137560
Ecological interception	98030	58818
Total	2291457	1374874

6 Remediation Program

6.1 Soil surface cleanup

Firstly, remediation site cleanup will be carried out, then remediation of waste residues left over from history and bottom mud of channels and ponds, and finally, treament of soil in the contaminated site. See **Figure6.1-1** for cleanup route.

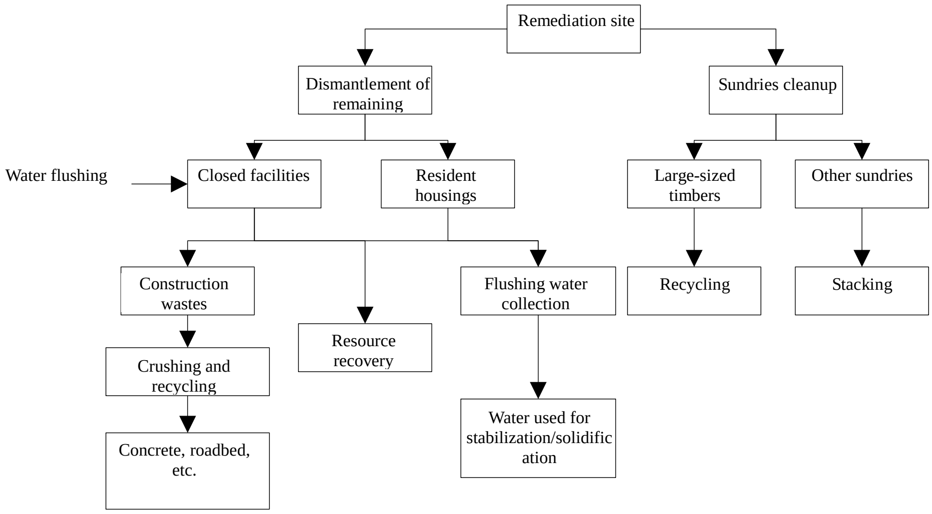


Figure6.1-1Cleanup route for the remediation site

6.1.1 Cleanup scale

Prior to the remediation of contaminated soil in the remediation site, site cleanup shall be carried out. The cleanup involves dismantlement of buildings of six closed facilities and resident houses and removal of sundries including trees, stumps, tree roots, bushes and garbages in the treatmet site. See **Figure6.1-2** for the location of six closed facilities.

Apart from closed facilities, channels, ponds and water residue sites, the total area of soil involved in the project is 2.30 square kilometers, so the area of site cleanup is 2.30 square kilometers in total. The large-sized timbers produced during surface cleanup will be recycled, and other sundries will be transported for secure landfill.

The buildings in the closed facilities and resident housings in the contaminated area will be dismantled and removed. See **Figure6.1-3** ~ **Figure6.1-8** for classification of buildings to be dismantled and to be washed as well as those not to be dismantled in the closed facilities. According to the estimation, the quantity of construction wastes is 45843 cubic meters, among which, the area of buildings to be dismantled is 9546.8 square meters, producing wastes of 6532 cubic meters, and the area of resident housings to be dismantled is 21993 square meters, producing wastes of 39310 cubic meters. The construction wastes in the residential area will be crushed directly and used as aggregates of concrete and roadbed or backfilled in the area. Because the remaining buildings of the closed facilities are covered with dust produced during production, in order to prevent environmental contamination caused during transfer of construction wastes, the construction wastes shall be washed prior to being crushed, and then be crushed and used as aggregates of concrete and roadbed or backfilled in the area.

Table 6.1-1Estimation of site cleanup quantity

I. Cleanup of surface sundries in the site		
No.	**Sub-Region**	**Area (m^2)**
1	Yingxia Sub-Region	183376
2	Qingshuihu Sub-Region	895948
3	Qingshui Sub-Region	411982
4	Tongxia Sub-Region	231317
5	Qingshi Sub-Region	28150
6	Tongtangwan Sub-Region	538789
7	Xiangshiling Sub-Region	1895
	Total	2291457

II. Cleanup of buildings and structures in the closed facilities							
No.	**Enterprise**	**Floor area/m^2**	**Area of buildings to be dismantled /m^2**	**Quantity of construction wastes /m^3**	**Area of buildings to be washed /m^2**	**Equipment to be dismantled**	**Quantity of flushing water /m^3**
1	Xinda Smelter	12270.6	4753.6	3252.5	97.8	None	1410.9
2	Brothers Industry	22929.9	0.0	0.0	0.0	None	0.0
3	Yongfa Refinery	12779.2	3677	2515.8	180.0	Production equipment	1150.9
4	Kangli Smelter	9906	1116.2	763.7	116.5	None	384.6
5	Tiancheng Chemicals	104813.7	0.0	0.0	0.0	None	0.0
6	Hehua Cement	28879.4	0.0	0.0	7316.5	Ball mill	4170.4
	Total	191579	9546.8	6532.0	7710.8		7116.8

III. Cleanup of construction wastes in the residential area			
No.	**Region**	**Area of buildings to be dismantled /m^2**	**Quantity of construction wastes/m^3**
1	Xiangshiling Sub-area	0.0	0.0
2	Qingshuihu Sub-area	2464.3	763.93
3	Qingshui Sub-area	0.0	0.0
4	Yingfeng Sub-area	0.0	0.0
5	Qingshi Sub-area	145.7	45.17
6	Tongxia Sub-area	6291	4167.9
7	Tongtangwan Sub-area	13091.1	4167.94
	Total	21993	39310

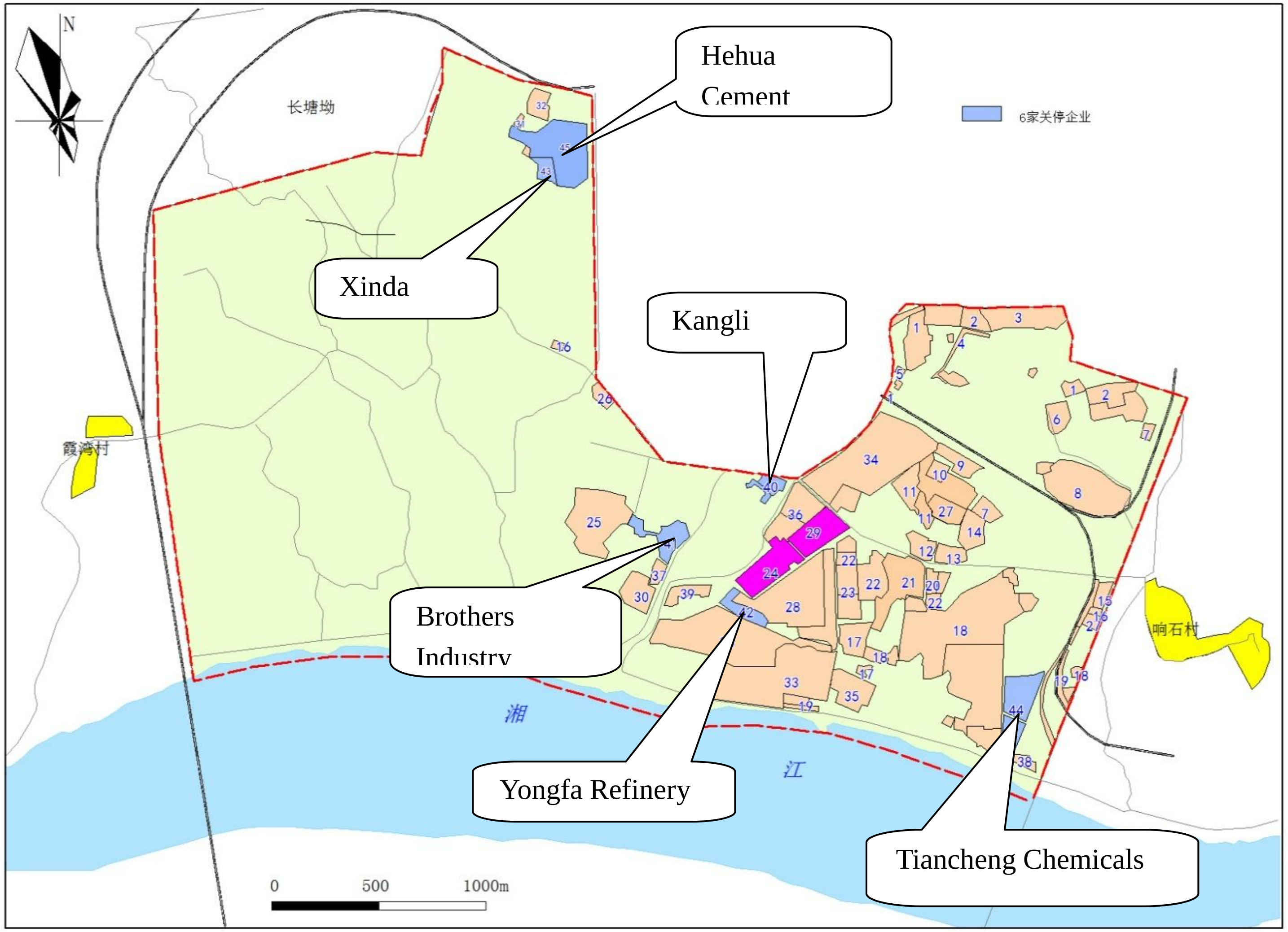


Figure6.1-2Location map for closed facilities in the project scope

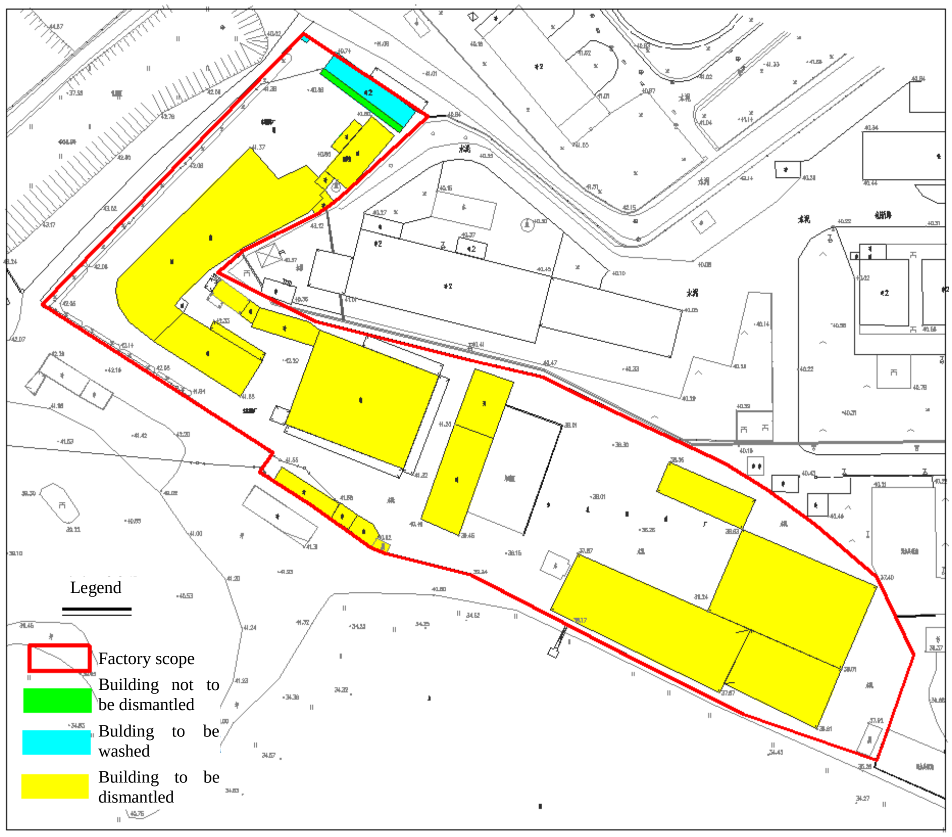


Figure6.1-3 Classification of buildings to be dismantled and to be washed in Yongfa Refinery

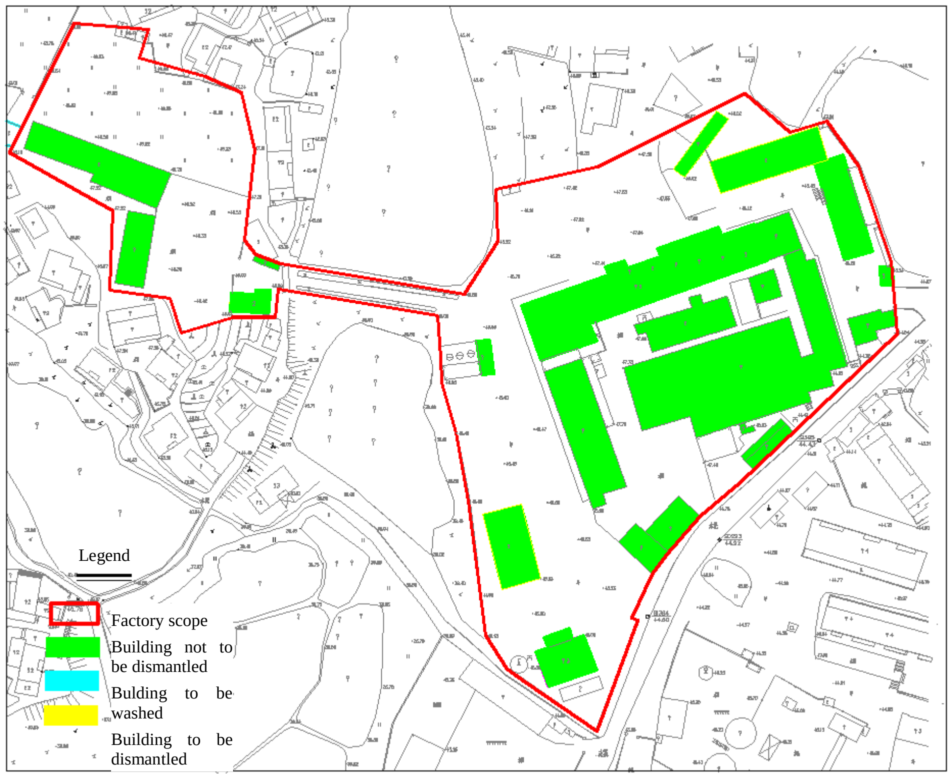


Figure6.1-4 Classification of buildings to be dismantled and to be washed in Brothers Industry

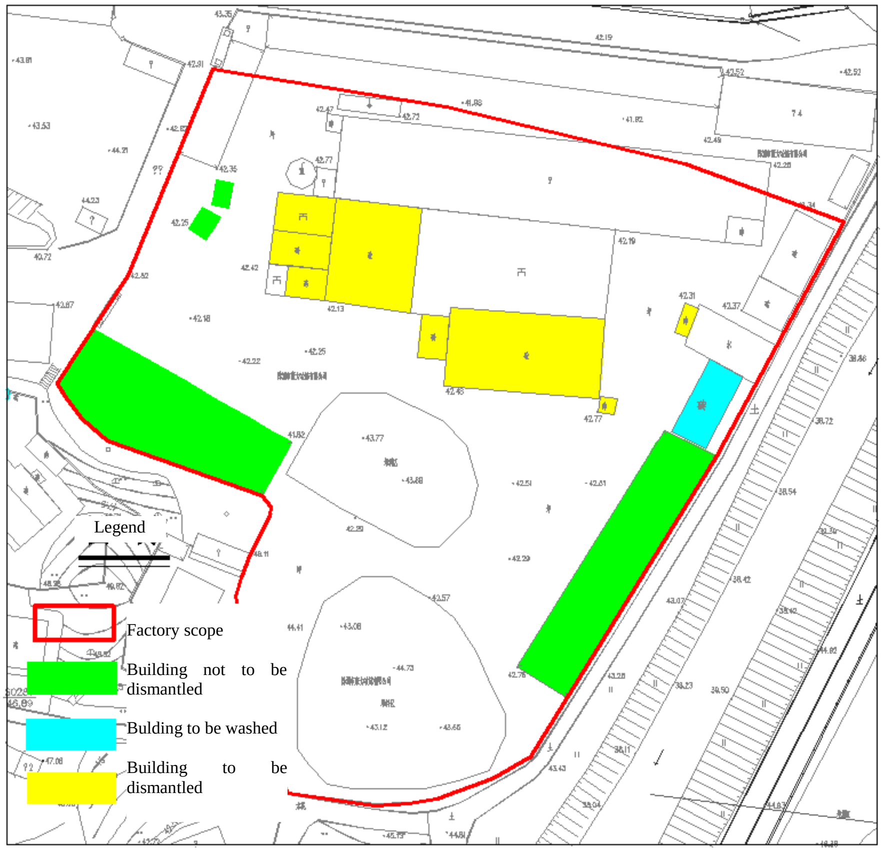


Figure6.1-5Classification of buildings to be dismantled and to be washed in Kangli Smelter

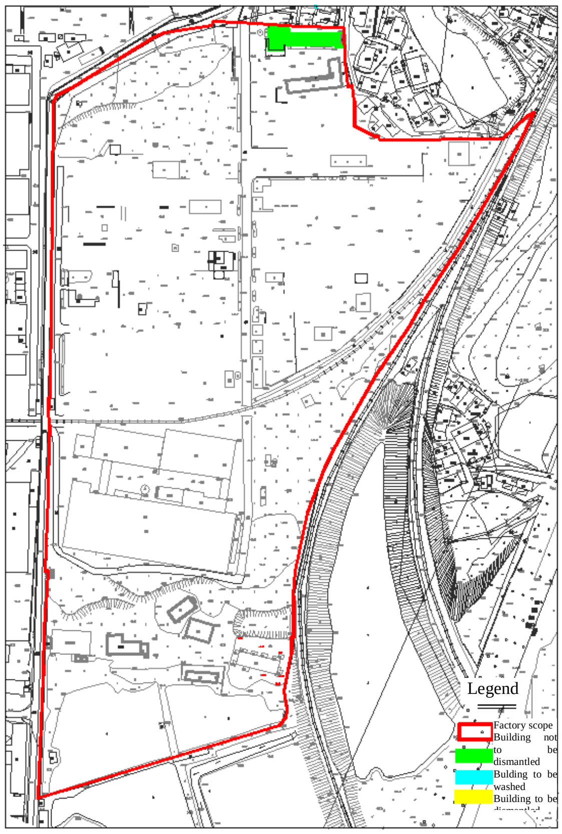


Figure6.1-6 Classification of buildings to be dismantled and to be washed in Tiancheng Chemicals

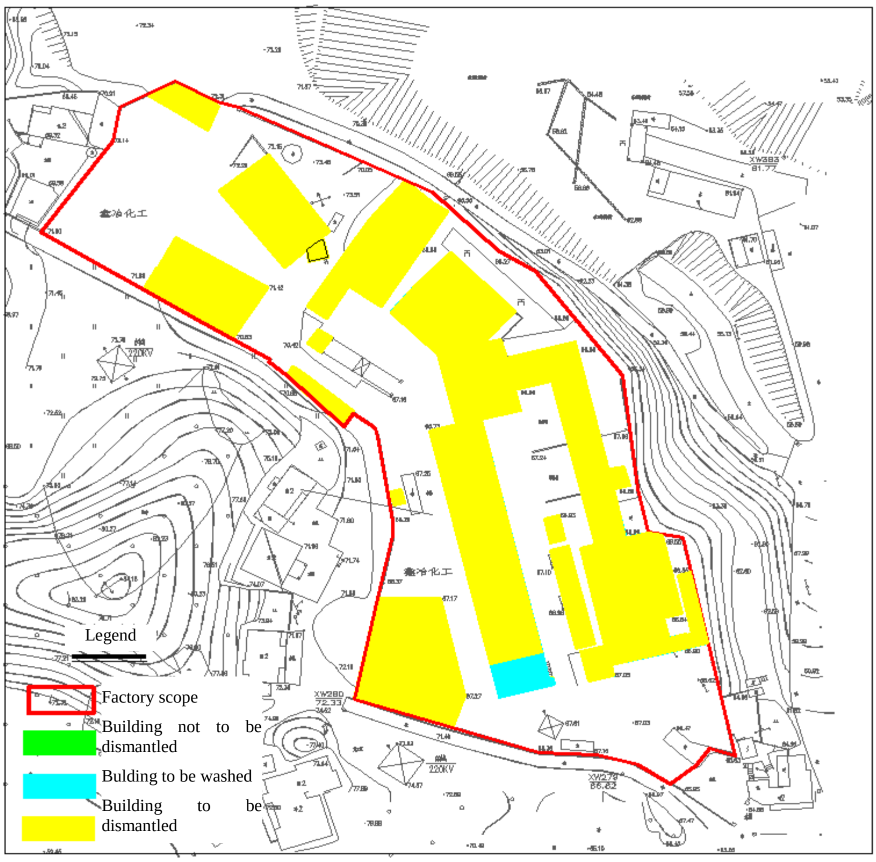


Figure6.1-7 Classification of buildings to be dismantled and to be washed in Xinda Smelter

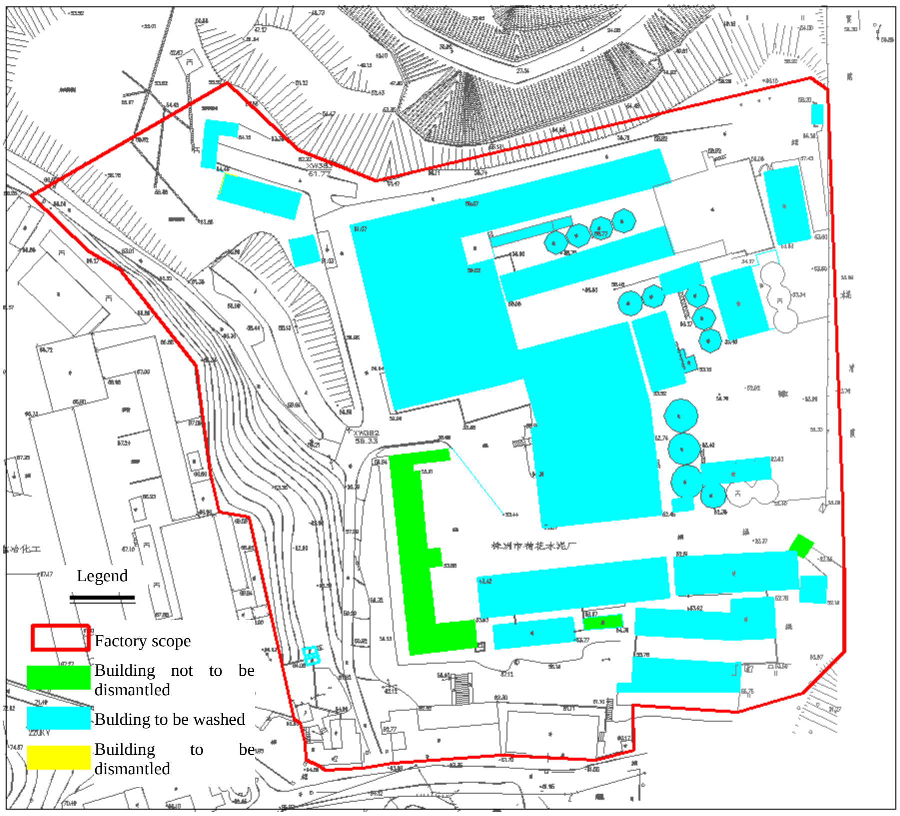


Figure6.1-8 Classification of buildings to be dismantled and to be washed in Hehua Cement

6.1.2 Treatment program for surface sundries

Except for vegetation and matters to be reserved, all trees, stumps, bushes and garbages in the remediation area shall be cleared, among which, the trees with DBH ＞15cm shall be sawed to certain length and then transported and used.

As for surface soil and turf, the depth and range of cleanup shall be determined according to the site situation, and the cleanup wastes shall be transported to the solid waste landfill or stock site for stacking by category, in order to save land. Grubbing shall be carried out according to the situation of site cleanup. Wastes shall be stacked without interfering construction as well as agricultural production and environmental protection.

All stumps, tree roots, bamboo roots and other organic matters in the remediation area shall be eradicated thoroughly, and in principle the depth of grubbing shall be more than 30cm.

Dismantlement of original roads, bridges, culverts, pavements, sidewalks and rimstones shall be carried out after suitable arrangement.

6.1.3 Treatment program for construction wastes

6.1.3.1 Overview

According to *Zhuzhou Administrative Methods for Urban Construction Wastes*, when carrying out building dismantlement, site grading, clearing of construction garbage and waste soil and other construction operations, watering shall be carried out at the same time in order to prevent flowing dust pollution. Vehicle flushing platform shall be set in the construction site, and vehicles shall be flushed before running out of the site. The construction site garbage shall be transported with enclosed vehicles and no garbage shall be obsolete or fled along the road. The treatment of construction wastes shall follow the principle of quantity reduction, re-utilization and harmlessness, and the comprehensive utilization of construction wastes shall be supported and encouraged.

All underground structures, wall bases and foundations of other obstacles in the remediation scope shall be eradicated to certain depth. In case that blasting is required, the surrounding structures and facilities to be reserved shall be protected effectively, and related construction approval shall be obtained.

The construction wastes produced after dismantling the structures in the closed facilities shall be crushed and washed in situ, and then be sorted manually and recycled.

The construction wastes in the residential area may be crushed in situ, and then be sorted manually and recycled, and no washing is required.

6.1.3.2 Resource recycling methods

After being crushed and sorted to coarse and fine aggregates, the construction wastes will be used for making concrete, road base materials and building bricks instead of natural aggregates.

Steel doors and windows, waste rebars, iron nails, cast-iron pipes and black and white plates shall be sorted and then transported to non-ferrous metals smelters or steelworks for smelting.

Waste bricks and tiles may be reused after being cleared up. Waste ceramic tiles and sanitary wares may be crushed and sorted and then be used for making porous or sintering bricks.

Waste glass may be sorted and be transported to glass ceramic plants or glass-works for making glass or glass ceramics as raw materials.

Wooden roof trusses and doors and windows may be re-utilized or be recycled after being processed, or be used for making medium-density fiber boards.

6.1.3.3 Treatment of construction wastes

(1) Site buildings in the closed facilities

The buildings in the closed facilities are divided into two categories, i.e. structures to be dismantled and washed and structures not to be dismantled but to be washed. According to the investigation results of site contamination, the area of buildings to be dismantled in the closed facilities is 9546.8 square meters, producing construction wastes of 6532.0 cubic meters, which are mainly from structures directly related to production, stacking of raw and auxiliary materials and waste treatment and disposal. The area of buildings not to be dismantled but to be washed is 7710.8 square meters, mainly structures in office quarters and living quarters obviously contaminated during production. The quantity of water used for washing the exterior walls of structures is 7116.8 cubic meters, and the wastewater will be collected through grooves and into pre-sedimentation tanks, and then treated by mobile water treatment equipment for recycling.

As for the construction wastes produced during dismantlement, the matters which may be directly recycled, such as metallic materials, wooden materials and plastic materials, will be sorted manually and directly supplied to corresponding companies. Matters such as large-sized waste concrete, bricks and marbles will be crushed by mobile crushers and then transported to Zhuzhou Building Materials Plant for comprehensive utilization. After being sorted and crushed, the construction wastes shall be washed in situ, and the waste water shall be collected in pre-sedimentation tanks and treated by mobile water treatment equipment, and then be reused for washing.

(2) Buildings in residential area

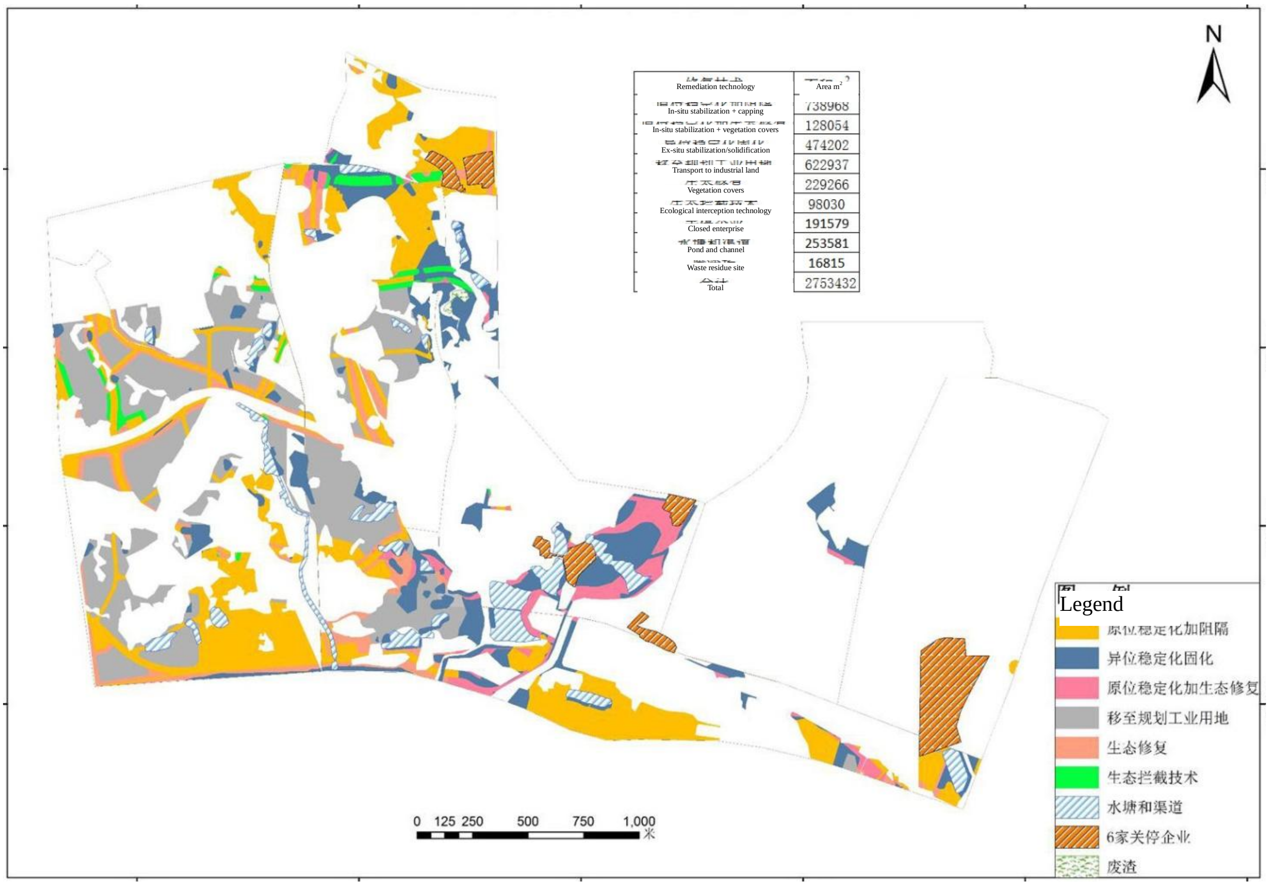
The construction wastes produced during relocation in residential area shall be sorted and crushed and then be recycled.

6.2 Treatment program for soil in contaminated site

6.2.1 Plot contaminated soils remediation

6.2.1.1 Remediation scale

According to the conclusions of risk assessment and reanalysis, the area of contaminated soil to be treated in the project is 2.30 square kilometers, and the quantity of soil is 1378.1 thousand cubic meters. According to the technical route, different remediation technologies will be applied for different land planning and different contamination extents of soil. See **Figure6.2-1** for remediation technologies for contaminated soil, and see **Table 6.2-1** for quantity of soil remediation in each region.



Remediation technology	Area m^2
In-situ stabilization + capping	738968
In-situ stabilization + vegetation covers	128054
Ex-situ stabilization/solidification	474202
Transport to industrial land	622937
Vegetation covers	229266
Ecological interception technology	98030
Closed enterprise	191579
Pond and channel	253581
Waste residue site	16815
Total	2753432

Figure6.2-1 Distribution map for remediation technologies for contaminated land

Table 6.2-1Estimation of quantities of soil remediation in different regions

Region	Xiangshiling Sub-area		Qingshuihu Sub-area		Qingshui Sub-area		Yingfeng Sub-area		Qingshi Sub-area		Tongxia Sub-area		Tongtangwan Sub-area		Total	
	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)	Area (m^2)	Volume (m^3)
In-situ stabilization + capping	1895	1137	300529	180317	127461	76477	97278	58367	0	0	6510	3906	205295	123177	738968	443381
In-situ stabilization + vegetation covers	0	0	0	0	7820	4692	1057	634	0	0	79190	47514	39987	23992	128054	76832
Ex-situ stabilization + solidification	0	0	50185	30111	79365	47619	18227	10936	28150	16890	133765	80259	164510	98706	474202	284521
Transport to non-sensitive land	0	0	368085	220851	128079	76847	46557	27934	0	0	3978	2387	76238	45743	622937	373762
Vegetation covers	0	0	124452	74671	39880	23928	9575	5745	0	0	2600	1560	52759	31655	229266	137560
Ecological interception technology	0	0	52697	31618	29377	17626	10682	6409	0	0	5274	3164	0	0	98030	58818
Total	1895	1137	895948	537569	411982	247189	183376	110026	28150	16890	231317	138790	538789	323273	2291457	1374874

6.2.1.2 Technical route

The project introduces the concept of single contamination index (P_i), which is used for evaluating the degree of soil contamination or the quality levels of soil environments.

P_i is a kind of relative dimensionless index, and is also called sub-index. The mathematical expression is the ratio of the measured value of single contamination factor of soil (C_i) to the target value of cleaning (S_i): $P_i=C_i \div S_i$. Single contamination index (Pi) directly reflects times of ultra standard and contamination extent, and is the significant basis for determining soil environmental management. The higher the P value, the more severe the contamination.

According to the target value determined by risk assessment and the measured value of soil contamination, P_i values of different extents of soil contamination are explained as below:

Table 6.2-2Classification and explanation of single contamination index

P_i	Ratio	Explanation
P_0	Ratio of measured value of soil contamination (C_i) to target value of soil cleanup in sensitive area (S_1) $C_i/S_1 \leq 1$	Indicate that the extent of soil contamination doesn't exceed the target value of soil cleanup in sensitive area, and there is no contamination
P_1	Ratio of measured value of soil contamination (C_i) to target value of soil cleanup in sensitive area (S_1) $1<C_i/S_1 \leq 1.5$	Indicate that the extent of soil contamination exceeds the target value of soil cleanup in sensitive area, but doesn't exceed the target value of soil cleanup in non-sensitive area
P_2	Ratio of measured value of soil contamination (C_i) to target value of soil cleanup in sensitive area (S_1) $C_i/S_1>1.5$	Indicate that the extent of soil contamination exceeds the target value of soil cleanup in non-sensitive area
P_3	And Ratio of measured value of soil contamination (C_i) to target value of soil cleanup in non-sensitive area (S_2) $C_i/S_2 \leq 2$;	Indicate that the extent of soil contamination exceeds the target value of soil cleanup in non-sensitive area
P_4	And Ratio of measured value of soil contamination (C_i) to target value of soil cleanup in non-sensitive area (S_2) $C_i/S_2>2$	Indicate that the extent of soil contamination exceeds the target value of soil cleanup in non-sensitive area

As for the contaminated soil for which the total concentration of heavy metals in the remediation area after cleanup exceeds the target value of cleanup, the unified remediation and disposal will be carried out according to particular pollutants in soil, contamination extents and land usage specified in *Regulatory Detailed Planning for the Core Zone of Qingshuihu Eco-city in Zhuzhou City*.

1) Areas planed as sensitive land:

a) Area planned as residential land and educational land. Ex-situ remediation method will be used, and then different remediation technologies will be applied according to contamination extents.

When $1<P\leq 1.5$, the soil in this area will be transported to non-sensitive land or industrial solid waste landfill;

When $P\geq 1.5$, the technology of ex-situ stabilization / solidification will be applied for the soil in this area.

b) Area planed as greenbelt, square land and sports land. In-situ remediation method will be used, and then different remediation technologies will be applied according to contamination extents,

When $1<P\leq 1.5$, the contaminated soil will be treated with the technology of vegetation covers;

When $P\geq 1.5$, the contaminated soil will be treated with the technology of in-situ stabilization, and then vegetation covers.

c) Area planed as water area. Ex-situ remediation method will be used, and then different remediation technologies will be applied according to contamination extents.

When $1<P\leq 1.5$, the soil in this area will be transported to non-sensitive land or industrial solid waste landfill;

When $P\geq 1.5$, the technology of ex-situ stabilization / solidification will be applied for the soil in this area.

2) Areas planed as non-sensitive land:

As for areas planed as non-sensitive land, such as industrial land, commercial land, roads and public facilities land, different remediation technologies will be applied according to contamination extents.

When $P\leq 2$, the technology of in-situ stabilization + capping will be applied for the soil in this area;

When $P\geq 2$, the technology of ex-situ stabilization / solidification will be applied for the soil in this area.

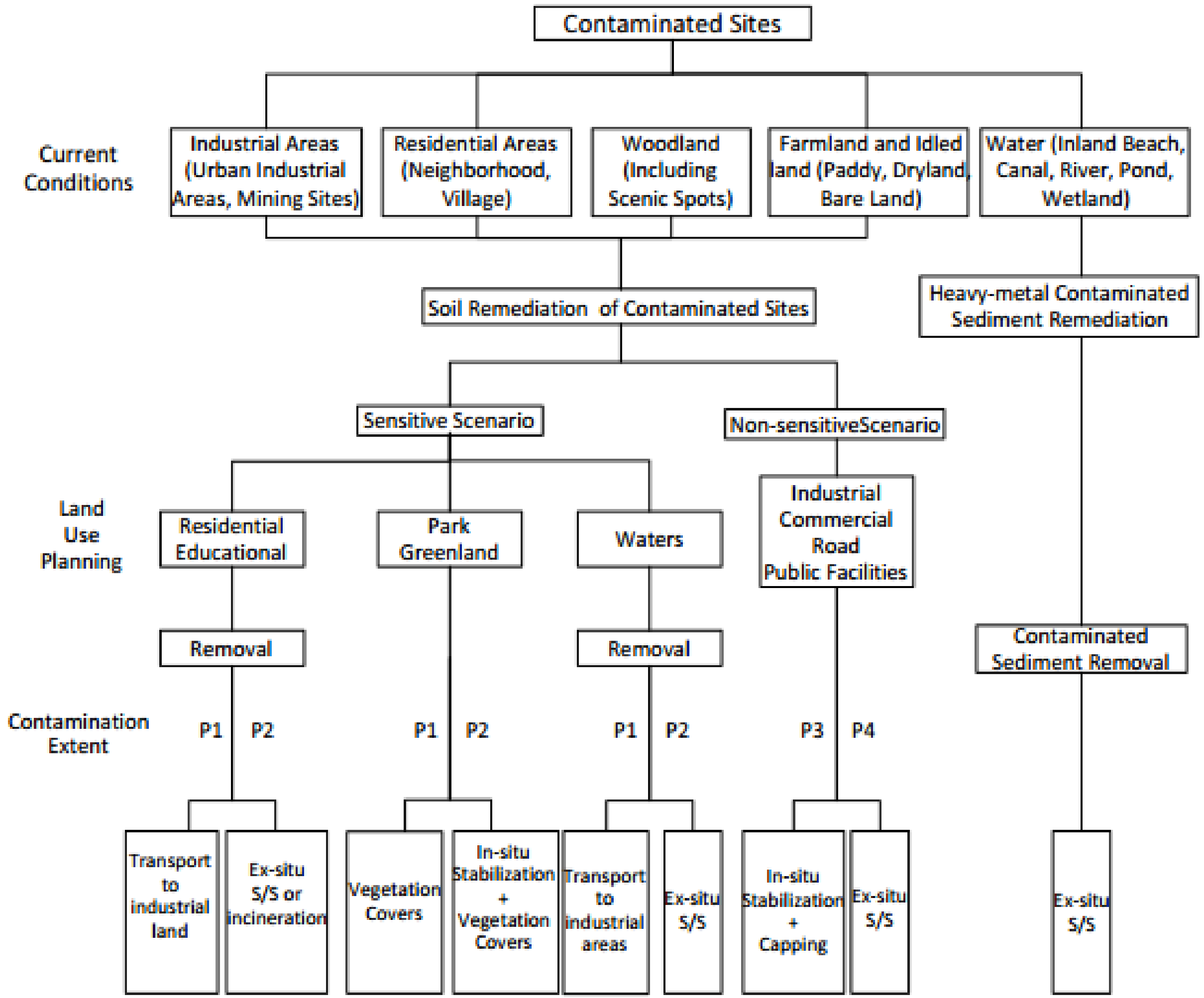


Figure6.2-2 Technical routes for remediation of heavy-metal contaminated soil

6.2.1.3 Ex-situ remediation

Ex-situ remediation area includes sensitive land and non-sensitive land. As for the soil in residential land and educational land as well as water area planed as sensitive land, when P≤1.5, the soil will be transported to non-sensitive land or to industrial solid waste landfill; when P≥1.5, the soil will be treated with the technology of ex-situ stabilization/solidification. As for the soil in industrial land, commercial land, road land and public facilities land which are planned as non-sensitive land, when P≥2, the soil will be treatment with the technology of ex-situ stabilization/solidification.

The quantity of heavy-metal contaminated soil requiring ex-situ remediation is 658.3 thousand cubic meters, among which, the quantity of soil to be transported to non-sensitive land is 373.8 thousand cubic meters, and the quantity of soil requiring ex-situ stabilization/solidifcation is 284.5 thousand cubic meters.

Table 6.2-3 Quantities of ex-situ remediation of contaminated soil

Region	Ex-situ stabilization/solidification		Transported to industrial land	
	Area /m^2	Volume /m^3	Area /m^2	Volume /m^3
Xiangshiling sub-area	0	0	0	0
Qingshuihu Sub-area	50185	30111	368085	220851
Qingshui Sub-area	79365	47619	128079	76487
Yingfeng Sub-area	18227	10936	46557	27934
Qingshi Sub-area	28150	16890	0	0
Tongxia Sub-area	133765	80259	3978	2387
Tongtangwan Sub-area	164510	98706	76238	45743
Total	474202	284521	622937	373762

Note: for soil to be transported to planned non-sensitive land, the soil which cannot be absorbed in non-sensitive land shall be transported to industrial solid waste landfill for landfilling, and if the quantity of soil is less than the quantity of soil in non-sensitive land, external clean soil shall be transported for backfilling.

(3) Soil excavation, cleanup and transportation

According to transportation distance of soil and project progress, the project requires the following digging and transportation equipment:

a) Excavator: 8 excavators with bucket capacity of 1.5~2.0 m^3.

b). Soil transporter: 24 enclosed transporters with loading capacity of 10.0 m^3 **.**

(4) Stabilization/solidification

According to the technical route, the quantity of soil requiring ex-situ stabilization/solidification in the project is 284.5 thousand cubic meters.

The project will use the existing treatment site for treating contaminated soil, and reply on Xinqiao treatment site which has been built for treatment, where treatment equipment is complete and can run normally.

Dosage of agent: prior to engineering construction, it is suggested to entrust qualified laboratory to carry out pilot tests to evaluate the effect of stabilizatio/solidification agents on lead, arsenic and cadmium in contaminated soil and determine the uptiml ratio of agents as well as the agent dosage and process parameters for different contaminated soil.

Table 6.2-4Dosage of stabilizing agent/curing agent

Dosage of powder /t	Dosage of aqueous solution /t	Dosage of curing agent/t
7156.15	143122.30	17890.40

Curing of stabilized/solidified soil: The stabilized/solidified soil shal be transferred to stabilizing site for curing after being stirred evenly, and the curing time may not be less than two days, in order to ensure the complete stabilization.

Disposal of stabilized/solidified soil: The quantity of soil requiring ex-situ stabilization/solidification is 284.5 thousand cubic meters, and the capacity-increasing ratio takes 10%. After stabilization/solidification, the quantity of soil is 313 thousand cubic meters, and the soil will be transported to the newly-built industrial solid waste landfill for landfilling.

6.2.1.4 In-situ remediation

For the areas of greenland, square land and sports land planned as sensitive land, in-situ remediation method will be used and different remediation technologies will be applied according to contamination extents.

a). When P≤1.5, the contaminated soil will be treated with the technology of vegetation covers;

2.When P≥1.5, the contaminated soil will be treated with the technology of in-situ stabilization, and then vegetation covers;

Areas planned as non-sensitive land: when P≤2, the contaminated soil will be treated with the technology of in-situ stabilization plus capping.

(1) Remediation scale of contaminated soil

The quantity of soil requiing in-situ remediation is 693.4 thousand cubic meters, among which, the quantity of soil to be treated with in-situ stabilization plus capping is 460.1 thousand cubic meters, the quantity of soil to be treated with in-situ stabilization plus vegetation covers is 78.7 thousand cubic meters, the quantity of soil to be treated with vegetation covers is 117.5 thousand cubic meters, and the quantity of soil to be treated with ecological interception is 37.1 thousand cubic meters.

Table 6.2-5 Quantities of in-situ remediation of contaminated soil

Region	In-situ stabilization + capping		In-situ stabilization + vegetation covers		Vegetation covers		Ecological interception	
	Area /m^2	Volume /m^3	Area /m^2	Volume /m^3	Area /m^2	Volume /m^3	Area /m^2	Volume /m^3
Xiangshiling Sub-area	1895	1137	0	0	0	0	0	0
Qingshuihu Sub-area	300529	180317	0	0	124452	74671	52679	31618
Qinngshui Sub-area	127416	76477	7820	4692	39880	23928	29377	17626
Yingfeng Sub-area	97278	58367	1057	634	9575	5745	10682	6409
Qingshi Sub-area	0	0	0	0	0	0	0	0
Tongxia Sub-area	6510	3906	79190	47514	2600	1560	5274	3164
Tongtangwan Sub-area	205295	123177	39987	23992	52759	31656	0	0
Total	738968	443381	128054	76832	229266	137560	98030	58818

(2) Vegetation covers and ecology

For the areas of greenland, square land and sports land planned as sensitive land, the technology of vegetation covers will be used, and the area of covers is 0.23 square kilometers, anti-heavy-metal plants such as oleanders, crape myrtles, camphor trees, red after-wood, monthly roses and radix ophiopogonis will be selected.

As for the areas with good vegetation covers in current mountainous land, ecological interception belt will be built surrounding the contaminated mountainous land, to collect and treat the surface water in the area of vegetation covers, and the area of land controlled by ecological interception belt is 0.10 square kilometers.

The treatment cycle of vegetation covers is about 3-5 years, which can meet the requirements of rehabilitation standard.

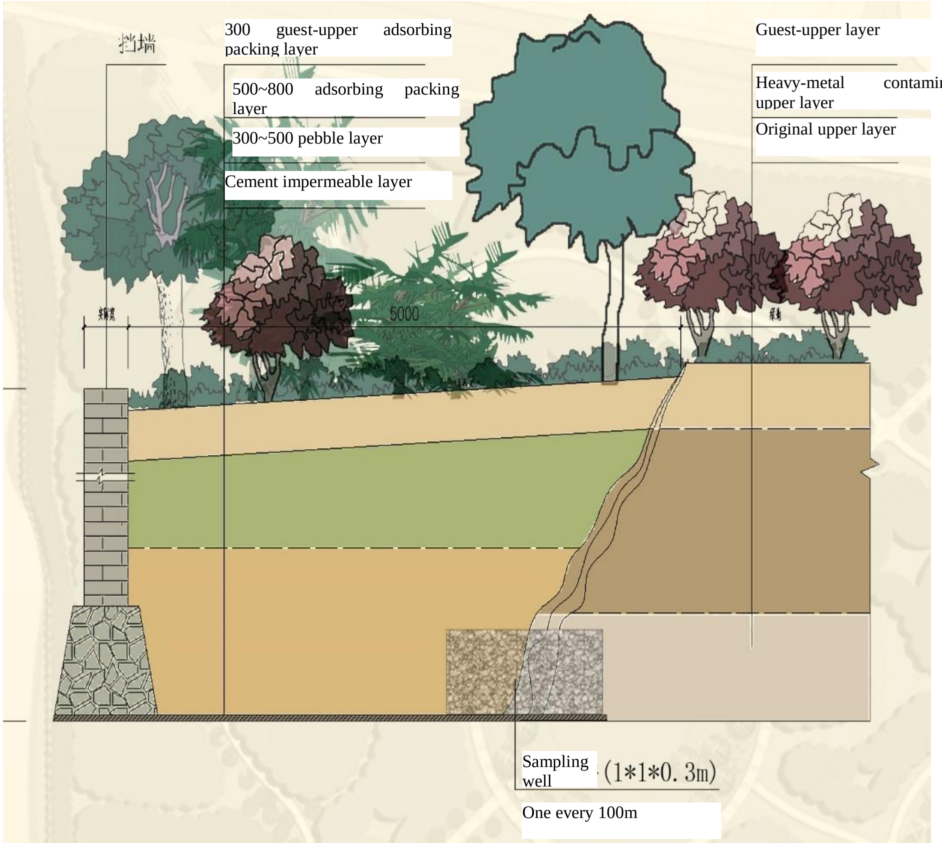


Figure6.2-3 Diagram for treatment of ecological interception belt

(3) In-situ stabilization

According to the difference of the following remediation processes after in-situ stabilization, the technologies can be divided as below:

In-situ stabilization + capping, area of soil: 0.74km^2, and quantity of remediation: 443.4 thousand m^3.

In-situ stabilization + vegetation covers, area of soil: 0.13km^2, and quantity of remediation: 76.8 thousand m^3.

The optimal operating condition of in-situ stabilization is that the dosage of powder is 5%. Prior to engineering construction, it is suggested to entrust qualified laboratory to carry out pilot tests to evaluate the effect of stabilization agents on lead, arsenic and cadmium in contaminated soil and determine the optimal ratio of agents as well as the agent dosage and process parameters for different contaminated soil.

Table 6.2-6Addition ratio and dosage of stabilizing agent

Quantity of remediation	Addition ratio of agent %	Dosage of agent /t
52.02	5	42.92

d). In-situ stabilization + capping

The technology of soil capping is laying a capping layer on the contaminated soil or the treated soil to block the transfer and diffusion routes of contaminants in soil and isolate the contaminated soil from the surrounding environment, in order to prevent contaminants from contacting human bodies and transfer along with rainfall or groundwater and further avoid harming human bodies and surrounding environment.

The in-situ soil capping system is mainly comprised of soil capping system, soil covering system and detecting system. The soil capping system is mainly composed of impermeable materials such as HDPE film and mud wall, and capping layer is built surrounding the contaminated area to restrict the contamination in a certain area; the soil covering system usually is composed of clay layer, artificial synthetic material lining layer, sand layer and covering layer or multilayer combination; the detecting system is mainly composed of monitoring wells at upstream and downstream of the capping area.

As for the areas planned as non-land, when $P \leq 2$, the contaminated soil will be treated with the technology of in-situ stabilization, and hardening coverings will be carried out according to land usage, and the area is 0.74 square kilometers.

e) In-situ stabilization + vegetation covers

As for the areas of greenland, square land and sports land planned as sensitive land according to technical routes, when $P \geq 1.5$, the contaminated soil will be treated with the technology of in-situ stabilization plus vegetation covers, and the area of vegetation covers is 0.13 square kilometers. Plants like camphor trees, photinia serrulata, sweet-scented osmanthus, Chinese ilex and cynodon dactylon will be planted.

6.2.2 Soils remeidiation in closed enterprises

6.2.2.1 Remediation scale

The project will remediate contaminated sites in 6 closed enterpirses that cover an area of 0.13km2 in total.

Table 6.2-7Remediation and Volume of Soils in Closed Enterprises

No	Name	Total area （m^2）	Remediation area（m^2）	Volume （m^3）	Remark
1	Xinda	12271	6692	6594	
2	Brothers	22930	1146	1146	
3	Yongfa	12779	5774	5594	
4	Kangli	9906	5195	5079	
5	Tiancheng	104814	34058	68116	Organic contaminated soils: 16548m^3
6	Hehua	28879	11648	4332	
	Total	191579	64514	90861	

Note: remediation depth subject to suevey depth。

6.2.2.2 Remediation of heavy metal contaminated soils

Heavy metal contamianted soils in the closed enterprises will be excavated and moved to S/S facility for treatment. Total volume is 74313m3.

Agent addition will make reference to plot soils that will undertake ex-situ S/S treatment. It is recommended that before implementation, pilot will be carried out by certified lab to evluate effects of the agent on Pb, As, Cd in the contaminated soils, and find most suitable agent dosing ratio and parameters.

6.2.2.3 Remediation program for organic contaminated soil

According to the investigation report on earlier-stage site and soil and the risk assessment report on soil contamination, the organic contaminated area requiring remediation is distributed in the factory site of original Zhuzhou Tiancheng Chemicals Factory. The area of soil is 8724 square meters, and the quantity of contaminated soil is 16548 cubic meters.

Organic contaminated soil will be excavated mechanically, and the excavation will be carried out at the same time with truck loading. When excavating soil the foundation pit shall be covered temporarily in order to prevent flowing dust and contaminants from transferring. Some construction soil residues and remaining project entities (foundation piles) existing in the site increase the quantity of construction wastes and the difficulty of excavation. During excavation, the remaining project entities shall be crushed and removed, and the construction wastes shall be stacked in uncontaminated area. In this project, enclosed vehicle shall be used for transporting contaminated soil to Sinoma Zhuzhou Cement Co., Ltd. for incineration disposal.

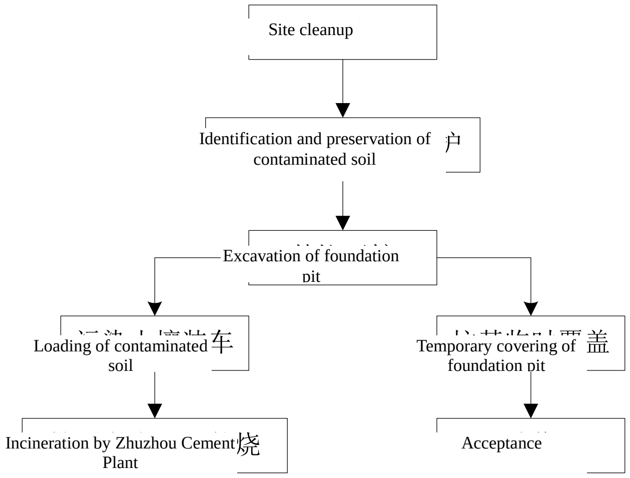


Figure6.2-4 Process flow chart for excavation of contaminated soil

Raw and auxiliary materials required by production of Sinoma Zhuzhou Cement Co., Ltd. mainly are outsourced rotary kiln clinkers, slags and clay from Zhuzhou Smelter Group. The quantity of organic contaminated soil to be remedied in the project is 16548 cubic meters.

6.3 Treatment program for waste residue

6.3.1 Remediation scale

The remaining waste residue storage site in the project scope include residue heap in Tongxia Region, remaining waste residue in Yonngfa Refinery and scattered waste residue along the low-discharge channel. The waste residue heap in Tongxia Region is about 550m on the north of Tongxia Road. The total quantity of waste residue in the project is 84.7 thousand cubic meters. See **Table 6.3-1** for distribution of waste residue heaps. See **Figure3.3-12**、**Figure10.1-1**

Table 6.3-1Statistics of remediation scale of waste residues

No.	Name of residue heap	Area (m^2)	Quantity (10 thousand m^3)	Remark
1	Waste residue heap in Tongxia Region	16815	8.17	
2	Waste residue in Yongfa Refinery		0.3	In Yonngfa Refinery
Total			8.47	

Note: according to site investigation, there is a small quantity of waste residues in Kangli Smelter and Xinda Smelter, which will be transported to Zhuzhou Smelter Group for incineration and recycling, so it is not involved in the remediation scope of this project.

6.3.2 Stabilization/solidification treatment of waste residues

After being excavated, the waste residues will be directly transported to stabilization/solidification operation site for treatment.

The dosage of agent will mainly refer to the scientific research conclusions of *Key Technical Research and Comprehensive Demonstration Topic for Heavy Metal Contamination Remediation of Xiang River Water Environment- Xiawangang Bottom Mud Remediation Project* (Hunan University National Water Pollution Control and Treatment Science and Technology Major Project) and the productive experimental results of other remediation projects which have been implemented in Qingshuitang District.

Prior to engineering construction, it is suggested to entrust qualified laboratory to carry out pilot tests to evaluate the effect of stabilization agents on lead, arsenic and cadmium in contaminated soil and determine the optimal ratio of agents as well as the agent dosage and process parameters for different contaminated soil.

See **Table 6.3-2** and **Table 6.3-3** for addition ratio and dosage of stabilizing and solidifying agents.

Table 6.3-2 Addition ratio of stabilizing agent/solidifying agent

Addition ratio of powder/%	Addition ratio of aqueous solution /%	Addition ratio of solidifying agent /%
2	4	5

Table 6.3-3 Dosage of stabilizing agent/solidifying agent

Dosage of powder /kg	Dosage of aqueous solution /kg	Dosage of solidifying agent /kg
2796	5592	6990

After treatment, the waste residue shall be transported to the newly-built industrial solid waste landfill for landfilling, and the quantity of landfill is about 93.1 thousand cubic meters.

6.4Treatment program for heavy-metal contaminated sediment

6.4.1 Remediation scale

In the project scope, the total area of 26 ponds to be remedied is 0.17 square kilometers, and the quantity of contaminated sediment is 173.0 thousand cubic meters.

Moreover, according to the estimation of water volume in dry season, the accumulating water volume in ponds is 259.5 thousand cubic meters. Because the water in ponds meet the requirements of Class-V standard specified in *Environmental Quality Standards for Surface*

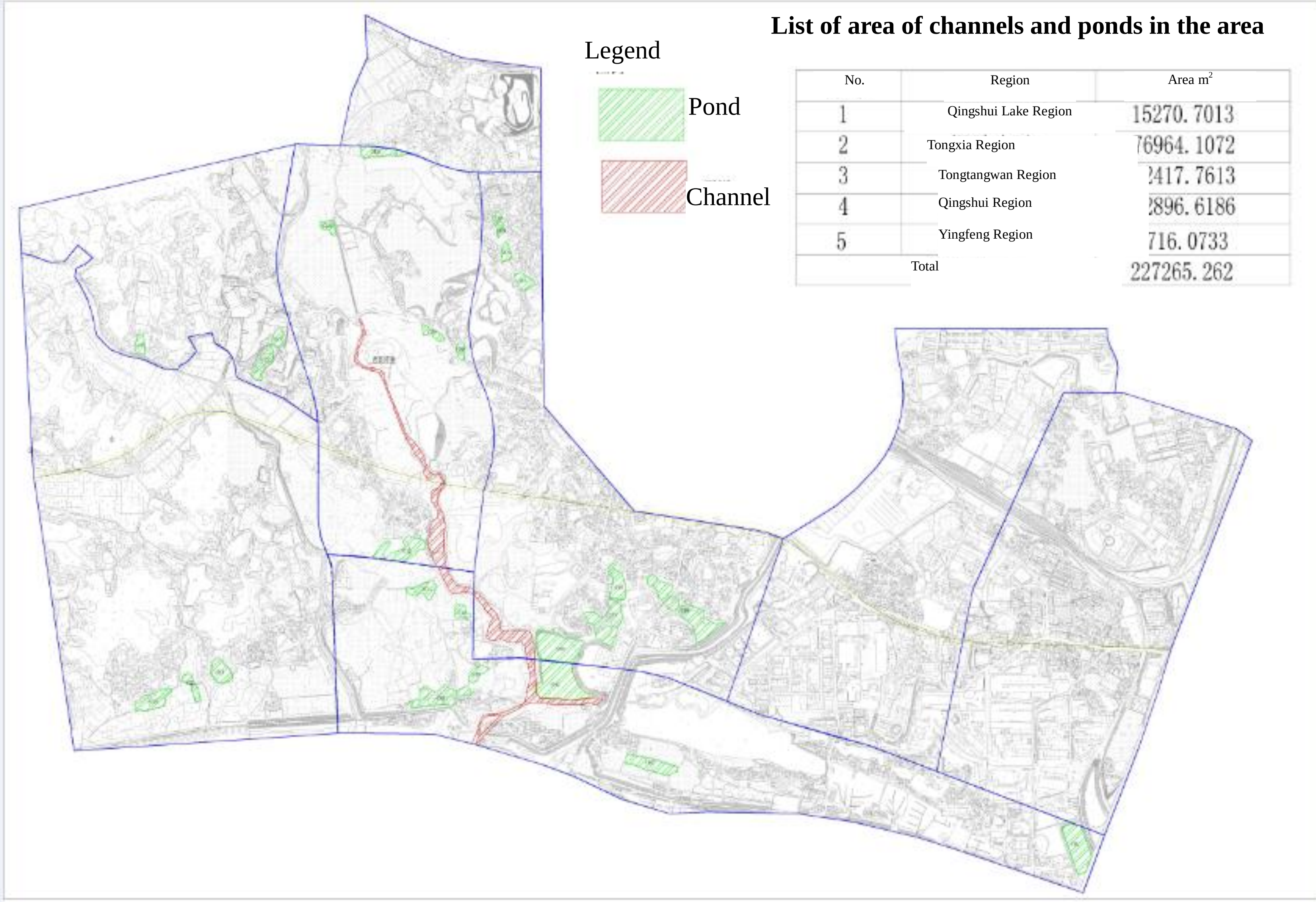
Water (GB3838-2002), it can be directly discharged to the channels nearby.

Table 6.4-1Quantity of pond remediation

Pond No.	Area of pond (m^2)	Water volume (m^3)	Sediment volume (m^3)
ST01	13216.9	19825.4	13216.9
ST02	8453.9	12680.9	8453.9
ST03	21365.5	32048.2	21365.5
ST04	11453.2	17179.8	11453.2
ST05	2631.0	3946.4	2631.0
ST06	17159.1	25738.6	17159.1
ST07	13282.1	19923.2	13282.1
ST08	18042.5	27063.7	18042.5
ST09	6437.3	9655.9	6437.3
ST10	2382.6	3573.8	2382.6
ST11	4594.8	6892.3	4594.8
ST12	9603.3	14404.9	9603.3
ST13	5437.0	8155.6	5437.0
ST14	3003.1	4504.6	3003.1
ST15	6908.9	10363.4	6908.9
ST16	2341.5	3512.3	2341.5
ST17	5009.0	7513.5	5009.0
ST18	2365.5	3548.3	2365.5
ST19	2457.2	3685.8	2457.2
ST20	1623.3	2435.0	1623.3
ST21	3245.3	4868.0	3245.3
ST22	2118.1	3177.2	2118.1
ST23	1473.6	2210.5	1473.6
ST24	1139.9	1709.8	1139.9
ST25	1942.8	2914.2	1942.8
ST26	5298.7	7948.0	5298.7
Total	172986.2	259479.3	172986.2

Post –clean up ecological remediation of the Old Xiawangang Channel. Area: 54279m^2

See **Figure6.4-1** for ponds and channel&harbor to be remedied.



List of area of channels and ponds in the area

No.	Region	Area m^2
1	Qingshui Lake Region	15270. 7013
2	Tongxia Region	76964. 1072
3	Tongtangwan Region	2417. 7613
4	Qingshui Region	2896. 6186
5	Yingfeng Region	716. 0733
Total		227265. 262

Figure6.4-1 Diagram for remediation scope of channels and ponds

6.4.2 Desilting remediation

In this project, it is proposed to carry out channel drying and desilting for contaminated ponds, and the total quantity of desilting is about 235.6 thousand cubic meters. As the two channels are not part of the project, the volume of ponds sediments amount to 173,000m^3

6.4.3 Flow diversion

(1) Drying of ponds

Ponds shall be dried individually, and measures shall be taken to reduce disturbance to the bottom. The water extracted from the ponds shall be treated with mobile sewage treatment equipment, and will be discharged into Xiawangang when meeting the requiments of Class-V standard of surface water.

(2) Equipment parameter

Table 6.4-2 List of main equipment materials for cofferdam diversion

No.	Main equipment materials	Quantity	Remark
1	Submersible sewage pump Q=100 m^3/h, H=22 m, N=15 kW	10	
2	DN100 lining PVC diversion pipe	1500 m	Reusable
3	DN1000 HDPE diversion pipe	300 m	Reusable

6.4.4 Sludge dewatering

The project applies the method of gravity dewatering for sludge. The totao quantity of sludge requiring gravity dewatering is 173 thousand cubic meters, and 10 days will be a cycle after paving. The size of sigle roll of filter cloth is L×B=1×10 m, and the area is 10 square meters. 500 rolls will be required once, and totally 250 rolls.

6.4.5 Backfilling

After clean up of sediments in the ponds, backfilling sand, cobble and other materials that will facilitate aqua ecosystem recovery in those ponds. It is estimated around 0.26 million m3 of materials will be needed. Those materials will come from local sources, incusing commercial quarry or sands from the Xiang River.

6.4.6 Stabilization/solidification treatment of sediment

After being dewatered, contaminated sediment will be trasported to stabilization/solidification operation site for treatment.

See **Table 6.4-3** and **Table 6.4-4** for addition ratio and dosage of stablizing and solidifying agents.

Table 6.4-3Addition ratio of stabilizing agent/solidifying agent

Addition ratio of powder/%	Addition ratio of aqueous solution /%	Addition ratio of solidifying agent /%
2	4	5

Table 6.4-4Dosage of stabilizing agent/solidifying agent

Dosage of powder /t	Dosage of aqueous solution /t	Dosage of solidifying agent /t
2210.5	4421	5525

The total quantity of sediment in ponds and channels is 173 thousand cubic meters, and the volume will be reduced to60.5 thousand cubic meters after dewatering. The quantity of sediment after stabilization/solidification is 112.5 thousand cubic meters, and it will be transported to the newly-built industrial solid waste landfill for landfilling.

6.5Remediation program for uncovered soil in non-remediation area

The area of uncovered soil in non-remediation area requiring soil exchange is about 110855 sqaure meters, the depth of soil replacement is 05m, and the volume of clean soil for replacement is 55427.5 cubic meters.

Table 6.5-1Statistics of quantities of remediation of contaminated uncovered soil in non-remediation area

No.	Item	Quantity (m^3)
1	Excavation of contaminated uncovered soil in non-remediation area	55427.5
2	Transport to industrial land	26758.5
3	Ex-situ stabilization/solidification treatment	28669
4	Replacement with clean soil	55427.5

For the contaminated uncovered soil after being replaced, different remediation methods shall be applied according to contamination extents. The soil not exceeding the standard of non-sensitive land shall be transported to industrial land after excavation for treatment, and the quantity of treatment is 26758.5 cubic meters. The contaminated soil exceeding the standard of non-sensitive land shall be treated with the technology of ex-situ stabilization/solidification, and the quantity of treatment is 28669 cubic meters.

6.6Treatment works for soil remediation

Treatment works for soil remediation are used for stabilization/solidification treatment of contaminated soil, waste residue, channel and pond sediment requiring ex-situ treatment, and it is required to use the existing Xinqiao stabilization/solidification operation site and Xiawan dewatering site, and newly build Xinqiao dewatering site and temporary storage site (used for temporarily store solid wastes before completion of landfill). See **Figure6.6-1** for site locations.

6.6.1 Construction program for treatment sites

Ordinary solid waste contaminants in the project include contaminated soil, waste residue and sediment, and treatment sites shall be built for stailization/solidification treatment.

The total quantity of treatment is 584.7 thousand cubic meters: the quantity of soil requiring ex-situ stabilization/solidification is 387.5 thousand cubic meters(including 74.3 thousand cubic meters of soil in closed facilities, and 284.5 thousand cubic meters of soil in other contaminated areas and open soils exchange 28.7 thousand m3), the quantity of sediment after being dewatered is 112.5 thousand cubic meters, and the quantity of waste residue is 84.7 thousand cubic meters.

Calculated by 5 years of project duration and 25 days of monthly construction, the total number of days for construction is: $5\times12\times25=1500d$.

Total daily treatment capacity: $58.47\times10000m^3/15000d=389.8m^3/d$. Take value $400m^3/d$.

After stabilization and solidification, the soil of 643.2 thousand cubic meters shall be transported to the landfill for landfilling.

Because a treatment site was built for Xinqiao waste residue remediation project and the treatment equipment is complete and can run normally now, it can be used as the treatment site for this project.

Xiaoqin waste residue stabilization and solidification operation site is located at the northeast corner to the north of Tongxia Road and is mainly used for disposing the waste residue from Xinqiao waste residue site. The waste residue stabilization center to be built is a temporary workshop and will be dismantled after the project is completed and the land will be cleared and used as construction land according to land planning. The floor area is 4000 square meters, and the maximum daily treatment capacity is 400m³/d, and at present the operation is good.

Table 6.6-1List of existing equipment in Xinqiao treatment site

No.	Name	Quantity	Unit	Remark
1	Crusher	2	Set	Feeding and crushing
2	Agitator	2	Set	
3	Vibrating screen	1	Set	
4	Belt conveyor	7	Set	
5	Helical conveyor	2	Set	
6	Feed bin	1	Set	
7	Chute	1	Set	
8	Feeding funnel	2	Piece	
9	Agent agitator tank	1	Set	
10	Agent buttering tank	1	Set	
11	Silo	2	Piece	

Using the existing Xinqiao waste residue site mainly has the following advantages:

a) Reducing the construction period of solidification site. The ground of the existing site is hardened, water and electricity connected, life and management facilities complete, and access roads open, and equipment can enter the site directly for installation and commissioning.

b) Thoroughly using existing equipment and reducing investment

c) The site is close to the solid waste landfill, convenient for landfiling of solid wastes after being treated;

d) Convenient transportation, and close to Tongxia Road;

e) Good for project duration. The site can be put into operation as long as the project is commenced.

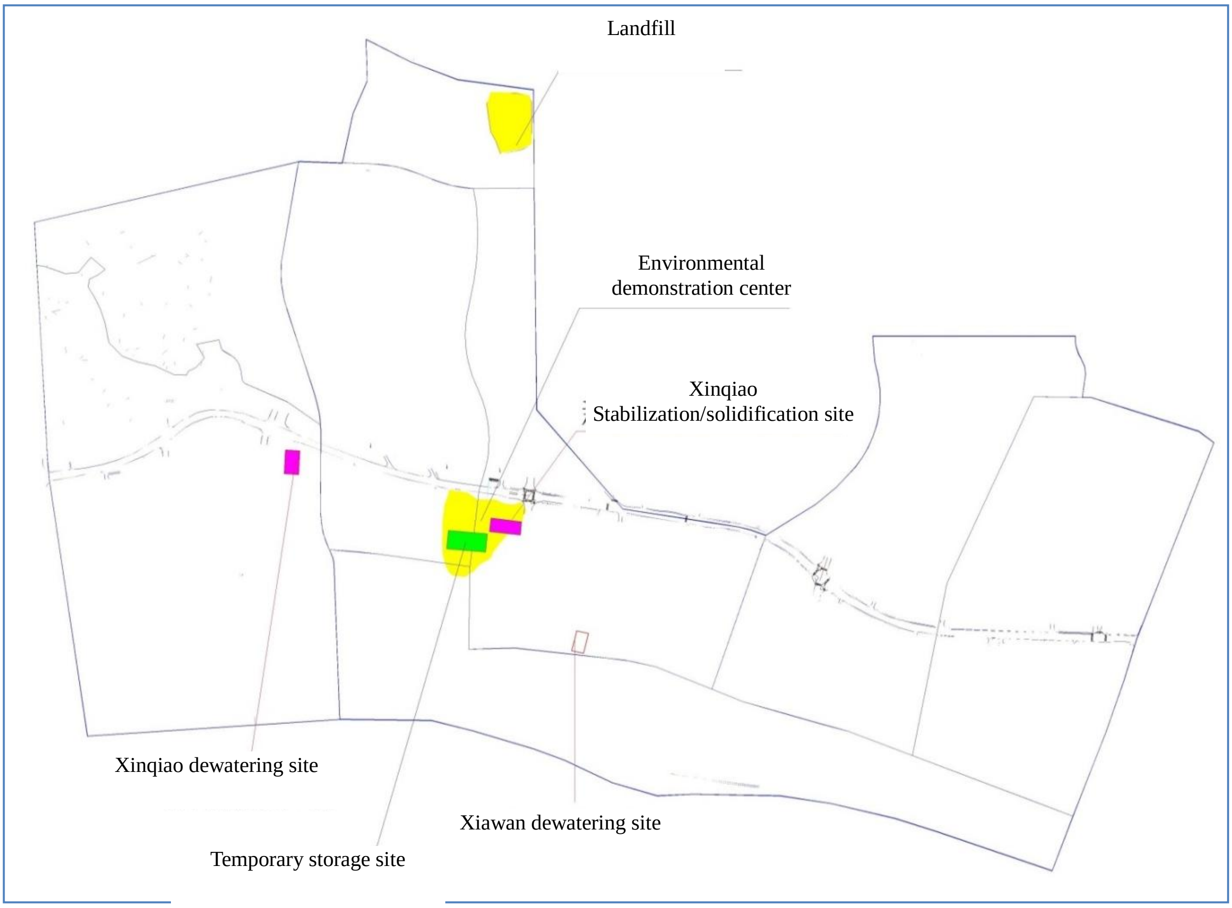


Figure6.6-1 Location map for sites

6.6.2 Construction program for dewatering site

According to technical routes, the heavy-metal contaminated sediment in contaminated ponds and channels in the project all need dewatering. The project will use the existing Xiawangang dewatering site and newly build a dewatering site.

Xiawangang dewatering site is near Brothers Industry on the west of Xiawangang (close to the river mouth), and the floor area is 5500 square meters, including 400 square meters of dewatering site and 1500 square meters of temporary storage site.

The newly-built sediment dewatering site is close to Xinqiao stabilization/solidification operation site, and the waste land between low-discharge channel and the old Xiawangang, near Tongxia Road, with convenient traffic. See **Figure6.6-2** for current situation of location. See **Figure6.6-1** and **Figure6.6-3** for location of the treatment site. The floor area is 4200 sqaure meters, including 4000 square meters of dewatering site and 200 square meter of temporary storage site.

Figure6.6-2 Current situation of dewatering and temporary storage sites.

Figure6.6-3Location map for the dewatering site

For the convenience of drainage of dewatering site, a certain drainage slope not less than 2% shall be set at the bottom of the site, and drains of 0.4m wide and 0.6m deep and water-collecting wells shall be built surrounding the site, in order to collect the waste water from the site. The dewatering platform is constructed as below:

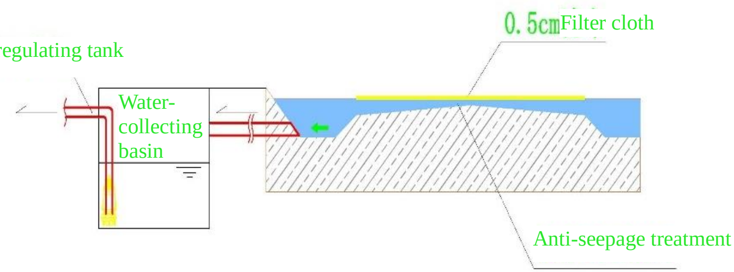


Figure6.6-4Construction program for dewatering platform

6.6.3 Construction program for temporary storage site

According to the project progress arrangement, the remediation project will be commenced in January 2016, and the construction period of landfill is longer, and the landfill can be put into operation until June 2018. In order to avoid interfering the project progress, a temporary storage site will be built near the stabilization and solidification operation site, and the area is about 10000 square meters and the quantity of temporarily stored industrial solid wastes is about 150 thousand cubic meters.

Figure6.6-5 Location map for temporary storage site

In order to prevent scattering of solid wastes, the project uses prefabricated buildings to temporarily store solid wastes, and the area of prefabrication buildings is about 10000 square meters.

In order to prevent solid wastes and waste water from contaminating surrounding soil and groundwater, anti-seepage treatment shall be carried out for the site. The anti-seepage system uses the same arrangement method as the dewatering site, i.e. the anti-seepage system includes from top to down: geotextile tube – 300mm rubble drainage layer - 600 g/m^2 PP long-fiber non-woven fabrics – 2mm glossy HDPE geomembrane - 600 g/m^2 PP long-fiber non-woven fabrics – foundation.

6.6.4 List of main equipment for site remediation

Table 6.6-2List for main equipment for site remediation

No.	Category	Name	Type & specification	Unit	Quantity	Remark
1	Crushing of construction wastes	High-altitude dismantling machine	Height ＞25m	Set	2	
2		Mobile crushing station	280t/h, 164kw	Set	2	
3		Feeding & loading machine	Bucket capacity 2.7m³ discharge height＞3m	Set	2	
4	Transport	Transportation vehicle 1	5m³	Set	24	Used for transportation of construction wastes and soil
5	Excvation and remediation of contaminated soil	Excavator	Bucket capacity 1.2m³	Set	8	
6		Transportation vehicle 2	Enclosed 5m³	Set	5	
7		Road roller 2 sets	Single drum 22t	Set	2	
8		Stiring and sieving equipment	Bucket capacity 1.5m³	Set	2	
9		Mobile water treatment vehicle	400m³/d	Set	4	
10		Watering cart	3000 litres	Set	1	
11		Chemical spraying vehicle	1000 litres	Set	1	

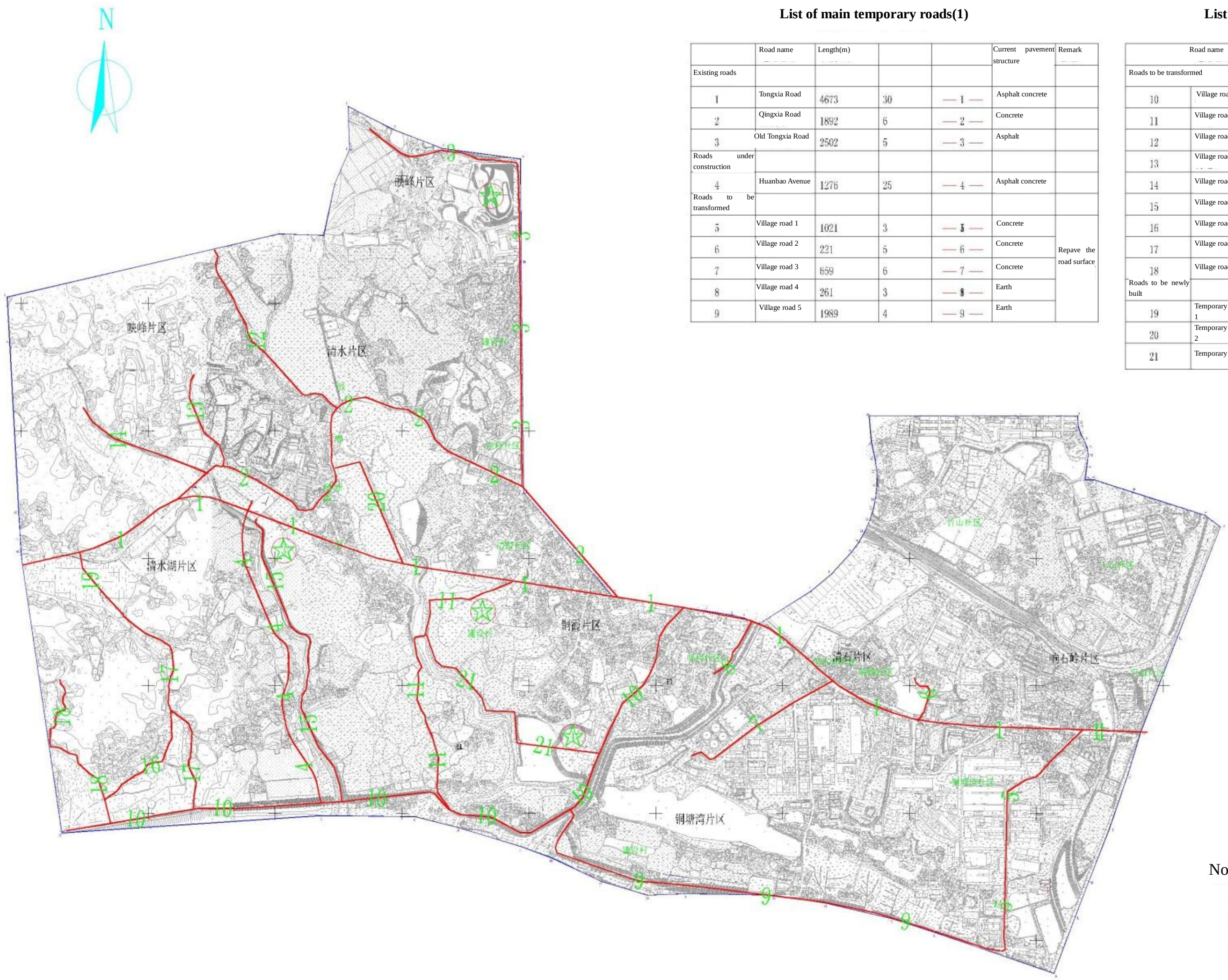
6.7Temporary roads and transportation routes

There is certain distance between both soil of excavation points and main backfilling areas and the stabilization operation site. According to the requirements of remediation, the project takes Tongxia Road, Qingxia Road, old Tongxia Road and under-construction Huanbao Avenue as the main transportation routes and other village roads as the auxiliary routes. The soil transportation will be carried out on the basis of using the existing roads, properly transforming village roads and building some temporary roads.

Table 6.7-1 List of construction of transportation roads

No.	Road name	Length (m)	Pavement structure
Existing roads			
1	Tongxia Road	4673	Asphalt concrete
2	Qingxia Road	1892	Concrete
3	Old Tongxia Road	2502	Asphalt
Under-construction roads			
4	Huanbao Avenue	1276	Asphalt concrete
Roads to be transformed			
5	Village road 1	1021	Concrete
6	Village road 2	221	Concrete
7	Village road 3	659	Concrete
8	Village road 4	261	Earth
9	Village road 5	1989	Earth
10	Village road 6	3000	Asphalt/Earth
11	Village road 7	1273	Concrete
12	Village road 8	844	Earth
13	Village road 9	406	Earth
14	Village road 10	566	Earth
15	Village road 11	1450	Concrete/Rubble
16	Village road 12	493	Earth
17	Village road 13	915	Earth
18	Village road 14	734	Earth
Roads to be newly built			
19	Temporary road 1	304	Rubble/Asphalt
20	Temporary road 2	529	Rubble/Asphalt
21	Temporary road 3	969	Rubble/Asphalt
合计		25977	

See **Figure6.7-1** for transportation routes.

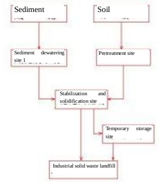


List of main temporary roads(1)

	Road name	Length(m)			Current pavement structure	Remark
Existing roads						
1	Tongxia Road	4673	30	—1—	Asphalt concrete	
2	Qingxia Road	1892	6	—2—	Concrete	
3	Old Tongxia Road	2502	5	—3—	Asphalt	
Roads under construction						
4	Huanbao Avenue	1276	25	—4—	Asphalt concrete	
Roads to be transformed						
5	Village road 1	1021	3	—5—	Concrete	Repave the road surface
6	Village road 2	221	5	—6—	Concrete	
7	Village road 3	659	6	—7—	Concrete	
8	Village road 4	261	3	—8—	Earth	
9	Village road 5	1989	4	—9—	Earth	

List of main temporary roads(2)

	Road name	Length(m)			Current pavement structure	Remark
Roads to be transformed						
10	Village road 6	3000	3	—10—	Asphalt/ Earth	Widen/reinforce the pavement
11	Village road 7	1273	2. 5	—11—	Concrete	
12	Village road 8	844	3	—12—	Earth	
13	Village road 9	406	3	—13—	Earth	
14	Village road 10	566	3	—14—	Earth	
15	Village road 11	1450	2. 5	—15—	Concrete/ Rubble	
16	Village road 12	493	2	—16—	Earth	
17	Village road 13	915	2	—17—	Earth	
18	Village road 14	734	2	—18—	Earth	
Roads to be newly built						
19	Temporary road 1	304	4	—19—	Rubble/ Asphalt	
20	Temporary road 2	529	4	—20—	Rubble/ Asphalt	
21	Temporary road	969	4	—21—	Rubble/ Asphalt	



Transportation program

Legend

Stabilization and solidification site

Industrial solid waste landfill

Sediment dewatering site 1

Pretreatment site/ Temporary storage site

Notes

1. This figure is the program for transportation roads for soil remediation project of Qingshui Road;
2. Principle of transportation road arrangement: on the premise of not interfering surrounding resident life, try best to use the existing roads;
3. Because the road is narrow, try best to carry out one-way soil transportation;
4. Pavement grade shall be determined according to transportation vehicles;
5. The roads drew in this figure are grade-I transportation roads, and the capillary roads shall be determined during construction organization design.

Figure6.7-1 Map for transportation routes

6.8Earthwork

Earthwork shall be consistent with the overall project progress and the regional development sequence, in order to reduce earth transfer and temporary storage, avoid unnecessary earth backfilling and consolidation and completely eradicate excavation. Strictly follow construction program and acceptance standards, confirm reasonable construction boundary and depth and strictly prohibit mixed excavation and transportation of different technical routes; comprehensively plan the earth balance in the remediation area, avoid stacking and abandoning earth randomly, reduce long-distance transportation of earth, and avoid contamination along the transportation route; prior to earth excavation, the measure of water cutting-off and diversion shall be taken; as for bare ground after excavation, if it can be utilized within a short time, only dust-proof covering is needed; otherwise vegetation covers shall be taken to prevent dust flowing and water and soil erosion; double supervision system shall be taken for the earthwork, and the matters related to construction quality such ass earthwork quantity, excavation range and depth shall be in the charge of construction supervision engineer, and the matters related to environmental quality shall be in the charge of environmental supervision engineer.

The overall construction program of the earthwork is detailed as below:

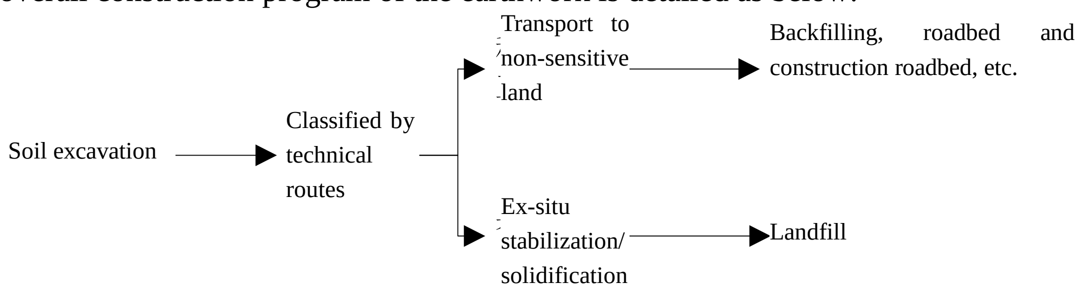


Figure6.8-1Overall construction program of the earthwork

The earthwork balance of the project is shown as below:

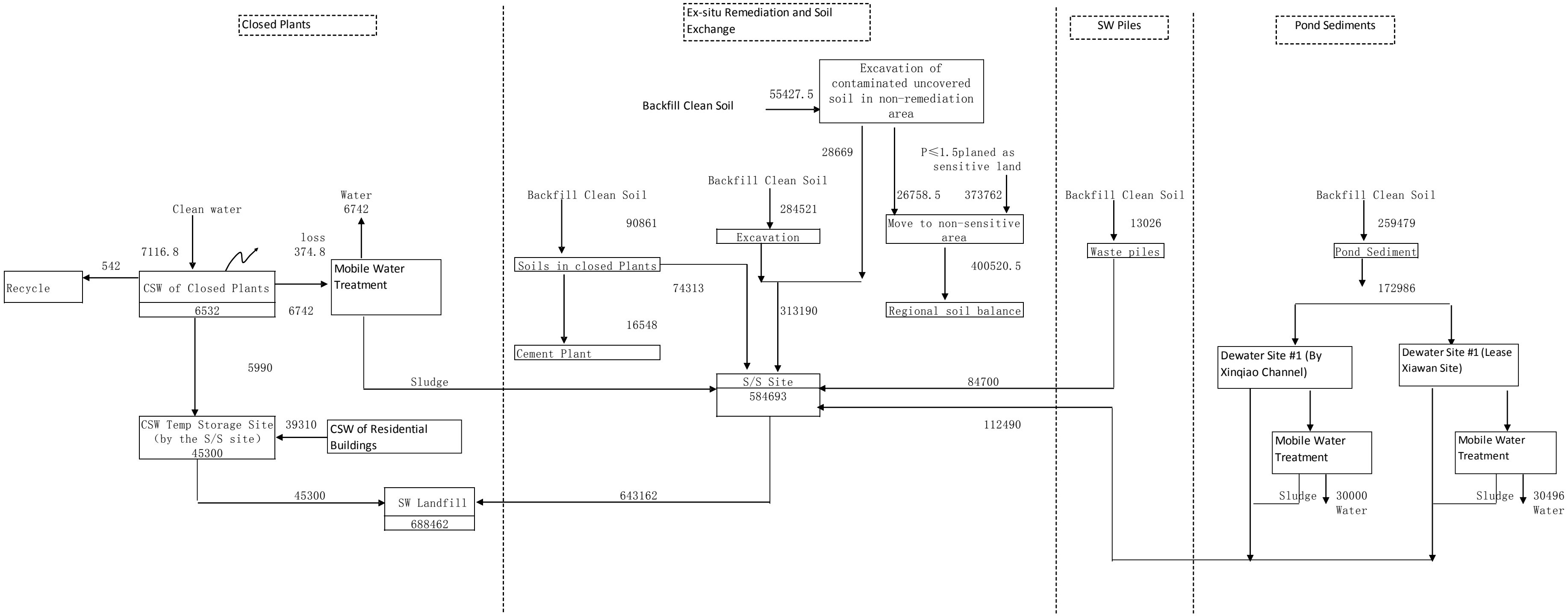


Figure6.8-2 Earthwork balance (unit: 10 thousandm³)

a) Preparatory work prior to excavation

After winning the bidding, re-prepare the implementary construction organization design and work out the excavation program and transportation routes.

Set boundary piles for roadbed and special position piles for side ditches according to costruction plan, construction technology and relevant regulations.

Transform and remove the existing houses, roads, ditches, communication facilities, water supplies and sewers, tombs and other structures within the construction scope; trees and bushwoods within the land scope shall be transplanted or removed prior to construction.

Ponding water in low-lying point shall be dried prior to excavation.

Prior to excavation, intercepting ditch shall be made and anti-seepage treatment shall be taken according to soil properties. Temporary drainage system shall be combined with permanent drainage system, avoiding causing siltation and erosion.

In particular, for the soil to be transported to the planned industrial land, if it will be used as the packing materials for roads and construction roadbeds, tests shall be taken for soil properties according to relevant regulations prior to excavation.

b) Excavation

According to the conclusions of site contamination investigation, the average contamination depth of the ex-situ remediation area is 0.6 meters, and the depth of soil excavation is small. Besides reserving cleanup soil layer, one-through excavation shall be carried out, and secondary excavation shall be prevented.

During excavation, regular observation shall be carried out for horizontal control piles, benchmarks, foundation plane positions, levels and side-slope settlement and records shall be kept. In rainy season, working plane may not be too large and the work shall be completed stage by stage and phase by phase.

After acceptance of soil excavation, foundation construction, covering and vegetation protection shall be carried out according to the land development sequence, avoiding sun exposure and rainwater erosion.

Soil remediation may be combine with land development and utilization. On the premise of guaranteeing remediation effect, the depth of soil excavation and the thickness of backfilling may be adjusted to avoid secondary work.

During actual construction, if it is necessary to change the range and depth of soil excavation, it is required to obtain the approval of both construction and envronmental supervision engineers.

c) Acceptance of earthwork

When the excavation is done to the design elevation, acceptance shall be carried out. Acceptance of earthwork includes two aspects: the first is the acceptance of construction quality, according to *Code for Acceptance of Construction Quality of Building Foundation* (GB 50202-2002); and the other is the acceptance of soil environmental quality, according to *Technical Guideline for Acceptance of Contaminated Site Remediation* (DB11/T 782-2011) and the related regulations Section 10.3 in this report.

For soil reaching the standard, excavation may be stopped, and for soil not reaching the standard, excavation shall be continued, until the heavy metal concentration in the soil meets relevant standards.

d) Whereabouts of ex-situ excavated earth

For the soil in planned residential and educational area, if 1<P≤1.5, the soil will be transported to non-sensitive plot or landfill for industrial solid waste. The excavated soil in non-sensitive area will serve for the roads to be constructed in the area.

According to the level of road network in Plan and the level of completed Tongxia Road, the level of roads in the area will be 6m to 9m higher than current road level, which requires a large volume of filling earthwork. According to road plan, it is estimated that filling earthwork for Zhuye Road would be 263,500 m^3, Shugang Road 552,000 m^3. See the table below for details.

Table 6.8-1Volume of Filling Earthwork Required for Subgrade of the Road in Subregion

Road	Width (m)	Length of filling earthwork (m)	Width of road main line (m)	Range of current level (h)	Range of planned level (H)	Volume of filling earthwork (m^3)
Zhuye Road	30	779	25	38.97-63.36	49.37-53.62	263545.8
Shugang Road	35	1865	32	40.30-54.50	47.70-63.23	552040

Notes: 1. Road side slope of 1:1 is considered in the calculation. 2. Groundwater level is 29.01-32.5m, therefore, earthwork filling area is below groundwater level.

In case that soil transported to non-sensitive area cannot match the road construction progress, such soil will be transported to landfill for industrial sold waste.

6.9 Site restoration after remediation

According to the requirements of *Regulatory Detailed Planning for the Core Zone of Qingshuihu Eco-city in Zhuzhou City,* the planned area of the core zone of Qingshuihu Eco-city is about 16 square kilometers, and it is planned to build Qingshuihu waterfront characteristic and integrated ated service center, mainly undertaking urban public services and characteristic sportes and recreation functions and becomes an important functional link of Zhuzhou City. In term of spatial structure, it is focused on catering, recreation, retails and resot hotels , and will be built into a liable city with waterfront public spatial environment in combination with the sports and recreation park around Qingshui Lake. See **Figure6.9-1**for the planning drawing.

The project is located in the core zone of Qingshui Lake Eco-city. The remediation of heavy-metal contaminated soil will eliminate heavy-metal contamination, bu the large-area uncovered soil after remediation has potential hazard to regional ecologcial system, atmospheric environment, water environment and conservation of water and soil: in the dry season, the dust on the bare ground will diffuse with wind, contaminating air; in the rainy sean, overland runoff, especially water and soil loss caused by rainstorm, will damage water ecological system and water landscape, reduce biological diversity sharply in the region and lower the functions of ecological system. Therefore, in order to prevent te heavy metal in the soil in non-sensitive land from transferring to the sensitive land, site restoration will be carried out for the remedied area according to *Regulatory Detailed Planning for the Core Zone of Qingshui Lake Eco-city in Zhuzhou City,* and the regional development progress.

a) For the area to be developed after remediation, site restoration will be carried out to the planned elevation according to the planned land properties;

b) For the area with lagging development after remediation, vegetation covering will be carried out to prevent water and soil loss;

c) After remediation, Qingshui Lake ecological wedland (not included in the project) will be built in Tongtangwan District, for restoring the ecological environment in the remediated area and regulate regional water resources.

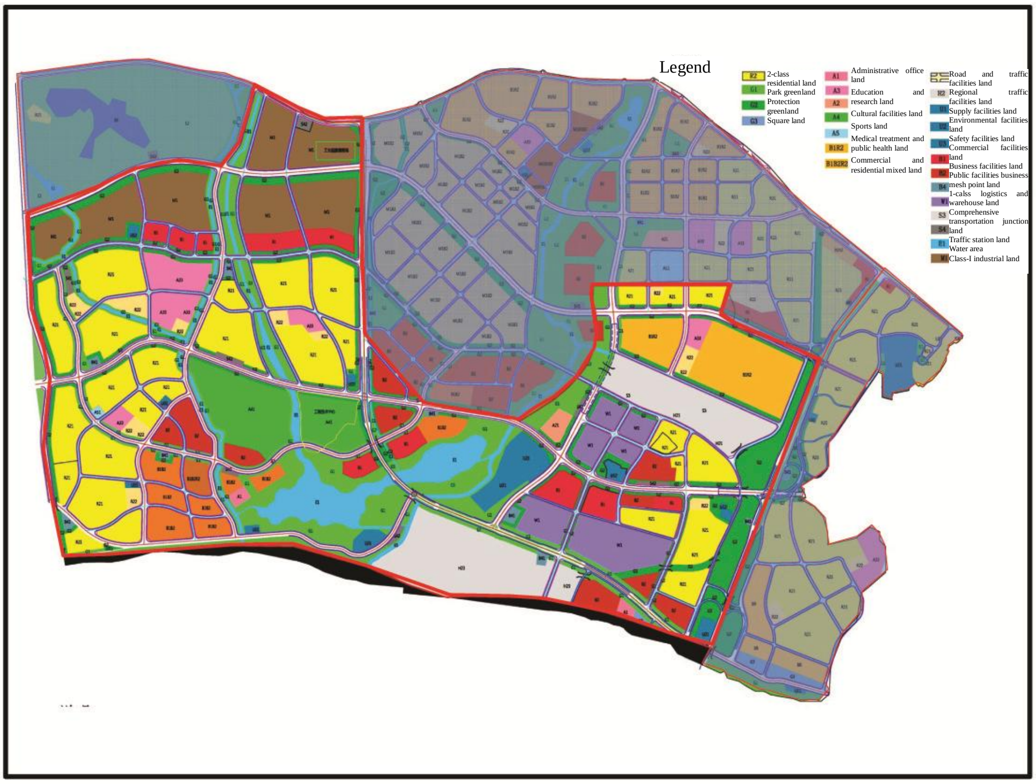


Figure6.9-1Map for regulatory detailed planning for the core zone of Qingshui Lake eco-city in Zhuzhou City

6.10Disposal work of solid waste landfill

6.10.1 Location selection of solid waste landfill

In the project, it is proposed to build a solid waste landfill, for landfilling construction wastes, part of remedied soil, sediment and waste residues caused during remediation. Acccording to the testing report for leaching of Xiawangang sediment after stabilization and solidification treatment (see the attachment), the remedied sediment belongs to Class-II general industrial solid waste, so the new landfill will be built according to the regulations for Class-II ordinary solid wastes. According to the comprehensive analysis and demonstration based on investigation on regional landform, geology, hydro meteorology, industrial and agricultural distribution, urban and rural planning and current situation of natural protection areas as well as the background information on basic environmental elements like local atmosphere, water bodies and soil, the obsolete stone pit of the original Hehua Cement Plant on the west of Qingshuitang Industrial Zone is selected as the site of the landfill.

6.10.2 Construction conditions of proposed landfill

6.10.2.1 Construction location and storage capacity

The obsolete stone pit of the original Hehua Cement Plant on the west of Qingshuitang Industrial Zone is located to the north of Sanbeitang and to be north of Nanxinqiao Village, and around the site is entirely farmland, with smooth terrain, belonging to the collectively-owned land of Qingshui Village. To the west of Qingxia Road and about 500m away from Zhuzhou Chemical Industry Group is hilly land and valley. The area of obsolete stone pit is about 225 meters long and 150 meters wide, and the maximum depth of quarrying is about 60 meters. See **Figure6.6-1**and **Figure6.10-1**for site location.

Figure6.10-1Location of the landfill

The floor area of the landfill is about 38265 square meters (57.39mu), and the obsolete stone pit of the original Hehua Cement Plant is used to build the landfill. The total available capacity of the pit is 2000 thousand cubic meters, and it can contain 3000 thousand tons of solid wastes (the compacted volume weight of solid wastes is calculated by 1.5t/m³).

6.10.2.2 Engineering geology

The planned location of the landfill is in Qingshuotang Industrial Zone north of Zhuzhou City. The location belongs to the erosion terrace of Xiang River, the basement is tertiary red sandstone, the low hilly landform is formed through erosion and stripping, and the natural ground elevation is 58~66m. The proposed site has the landform of erosion structure, the surface layer of 0~25m is yellowish-brown clay, containing fragments of slate eluvium, and 2.5~23.4m inward is limestone.

Qingshuitang Industrial Zone is of tectonic erosional redstone hills and tectonic erosional sand and shale hills. The formation consists Daijiaping clastic rocks of cretaceous system, sand and shale of devonian system and carboniferous system. The rocks are soft, vulnerable to weathering. The altitude of redstone hills is 100-180m, with a shallow cut depth of 30 to 60m. The formation of glutenite and conglomerate at the edge of basin is relatively higher. However, the sandy mudstone formation at the center of basin features gentle terrain with small relief and isolated round hill. Attitude of bedrock is similar with that in flat ground. The top of hill is gentle with a slope of 10 to 25 degree and a relative height of 20 to 00m. Low hills stretch along with high hills, with an altitude of 80 to 100m and slope of 10 to 20 degrees. Altitude of sand, shale hills is 200 to 350 m, relative height 50 to 100m. Ridges stretch significantly with coniform hill top and slope of 20 to 25 degrees. The ridges are convex or linear. In the area, denudation-planation surface of 300 to 350m steadily exists.

According to the *Earthquake Intensity Zoning Map of China*, the basic intensity of the proposed location is 6 degree, and the buildings shall be constructed according to the earthquake-resistance standards for ordinary projects.

6.10.2.3 Surrounding water, electricity and traffic conditions

1) There are urban water supply networks near the site, and the existing residents use urban tap water, which can be connected to Hehua Cement Plant and used as water supply for production and life.

2) The landfill is close to Hehua Cement Plant, and the capacity of the transformer in this plant is 2500KVA and can meet the requirement for power.

3) The surrounding traffic conditions are good, and the east side and the north side of the site are adjacent to roads, providing good transportation conditions.

6.10.3 Engineering design of solid waste landfill

6.10.3.1 Project scale and service life

According to the quantities of sediment, soil and waste residue after ex-situ stabilization and solidification treatment described in the previous chapter, the total treatment quantity of ex-situ stabilization and solidification is 584.7 thousand cubic meters: (the quantity of soil requiring ex-situ stabilization and solidification is 387.5 thousand cubic meters, the quantity of sediment after ex-situ stabilization and solidification is 112.5 thousand cubic meters, and the quantity of waste residue is 84.7 thousand cubic meters). The capacity-increasing ratio of volume after solidification is about 1.1, and the quantity of waste requiring landfilling is 643.2 thousand cubic meters.

Table 6.10-1List of scales of industrial solid wastes to be landfilled

No.	Source of solid waste	Quantity of landfilling (10 thousand m^3)
1	Contaminated soil remediation	42.63
2	Contaminated sediment remediation	12.37
3	Heavy-metal waste residue remediation	9.37
	Total	64.32

Service life: landfill period is from Nov 2017 to December 2026. The landfill period of this period is up to December 2021,. The service scope of this landfill include general industrial solid wastes produced during soil remediation in Qingshuitang District, and exclude industrial solid wastes produced from enterprise production.

Because the volume of the obsolete pit is 2000 thousand cubic meters, and the quantity of landfilling materials in this project is only 643.2 thousand cubic meters, which cannot meet the requirements, it is acceptable to consider the wastes produced from future enterprise relocation such as Zhuzhou Smelter Group and Zhuzhou Chemical Industry Group, the estimated quantity of which is 1250 thousand cubic meters.

The floor area of the landfill is about is about 38265 square meters (57.39mu).

Table 6.10-2 Predicted annual utilization quantity of the landfill area

(10 thousand m^3)

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026
Single-year landfill quantity	10	18.41	18.41	18.41	25	25	25	25	25

6.10.3.2 Treatment of ponding water in the landfill

6.10.3.2.1 Pumping drainage of ponding water

Since stopping quarrying from the late 1990s, the intercepting system around the stone pit has been obsolete, and rainwater continuously flowed into the pit, and now the whole pit is full of ponding water, and the estimated quantity is about 2000 thousand cubic meters. If the pit will be used as the solid waste landfill, the water in the pit shall be drained.

The depth of ponding water in the pit is about 60 meters (Yellow Sea height datum is -2m ~58m), and the Yellow Sea height datum of the pit top is 65m. To drain the water, drainage pump station shall be installed, and the drainage head shall be 5~68m. According to the characteristics of large head change, pontoon pump station shall be used.

The design pumping period is 1 year, and the pontoon pump station will be equipped with three pumps, dual-use and one-backup. Because the head changes significantly, in order to avoid power waste, during the process of water level falling caused by pumping, pumps will be changed twice and the waterlevel elevation will be 40m and 60m. discharging pipe will use flange-joint steel pipe DN200, and will be laid along the road on the rock face in the pit.

The pontoon pump station is composed of floating pontoon and Y-type mobile rocker (double-rocker) connection pipes. For the initial installation, the floating pontoon will be equipped with three horizontal contrifugal water intake pumps, two for use and one for backup, and the unit capacity is 13.5kw. On the water intake pontoon, pump house, installation and maintenance house, distriution room (high and low-voltage switch house) and control room will be arranged, and necessary measures for heat preservation and ventilation will be taken.

According to the arrangement, the design specification of the pontoon is: pontoon length: 26m; pontoon height: 13m; deck width: 13m; moulded depth: 2m; immersion depth: 1m. The hull design is a steel-structure pontoon with single steel bottom, single deck and transverse framing system, and the main body is of box type. Y-type mobile rocker connection pipe is a special device used for connecting the water pipe on the bank with the water intake pump on the pontoon in the floating pump system. Y-type mobile rocker connection pipe is DN steel pipe, with one end flexibly connecting to the discharging pipe on the pontoon and the other end flexibly connecting to the intake and delivery pipe laid along the road on the rock face. The length of the pipe is 45m ,and the maximum rocker angle is 22°, meeting the requirements of the maximum pontoon fall of 20m. In order to meet the requirements of maintenance of rocker pipe, the rocker connection pipe shall be connected to the delivery pipe on the rock face with reinforced concrete bent frame.

Figure6.10-2 Diagram for pontoon pump station

Table 6.10-3 List of main equipment materials

No.	Name	Type& specification	Material	Unit	Quantity
1	Pontoon	26×13m	Steel	Set	1
2	Y-type rocker		Steel		1
3	Pump 1	N=13.5kw		Set	3
4	Pump2(first replacement)	N=36.3kw		Set	3
5	Pump3 (secondary replacement)	N=55.9kw		Set	3

6.10.3.2.2 Treatment program for ponding water

Sampling testing was carried out for the ponding water in the pit in 2004, and the results are detailed in **Table 6.10-4**.

Table 6.10-4Quality of ponding water in the stone pit of Hehua Cement Plant

Unit: mg/L

Item	pH	Cu	Pb	Ni	Cr	Cd	Hg	As	Ammonia nitrogen
Concentration	12.11	0.0082	0.0007	0.095	0.0005	0.0002	0.0016	0.0005	30.6
Integrated Wastewater Discharge Standard Table 4 – Class-I standard	6-9	0.5	1.0	1.0	1.5	0.1	0.05	0.5	15

According to the testing results, except ammonia nitrogen and pH which exceeding the standard, other indicators all meet Class-I standard in Table 4 in *Integrated Wastewater Discharge Standard*. Therefore, treatment shall be carried out for pH and ammonia nitrogen in the ponding water, and the water may be discharged only when up to the standard.

Chemical method will be used for disposing ammonia nitrogen. A 500m³ reinforced concrete pool will be built on the west of the landfill as breakpoint chlorination reaction pool, and when up to Class-I standard in Table 4 in *Integrated Wastewater Discharge Standard* after reacting in the breakpoint chlorination reaction pool, the ponding water from the pit will be discharged into the stream beside Qingxia Road and finally flow into Xiang River. The discharge pipe uses DN200 PVS pipe, and the length is about 490 meters.

A chlorination workshop of 200 square meters will be built, and the height is 7.5m.

Table 6.10-5List of main quantities

No.	Name	Type&specification	Material	Unit	Quantity
1	Single-beam electric crane	2t	Steel	Set	1
2	Chlorinator		Steel	Set	2
3	Residual chlorine tester			Set	3

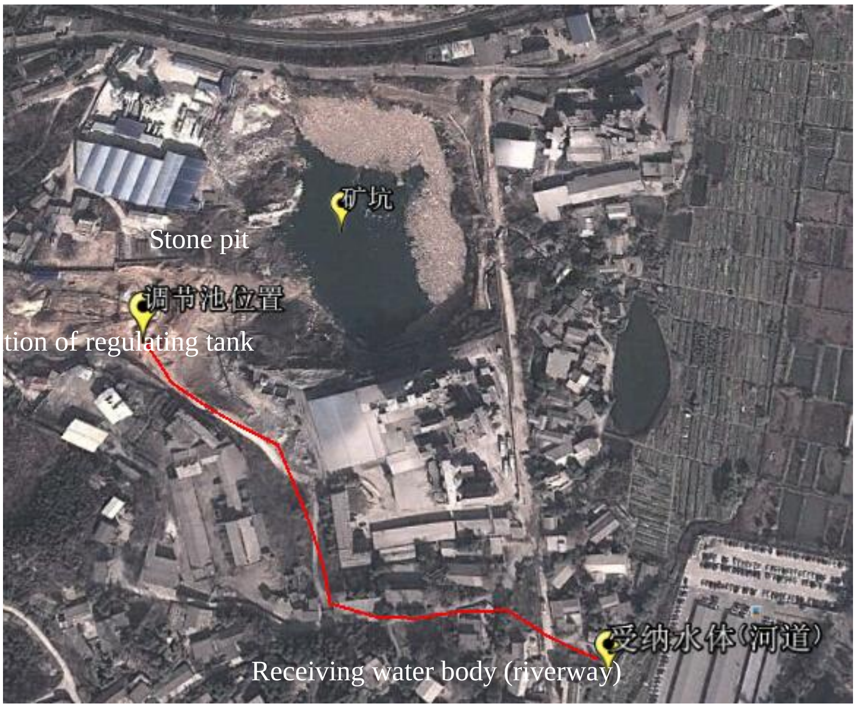


Figure6.10-3 Diagram for discharge route of ponding water

6.10.3.3 Base treatment of the landfill

6.10.3.3.1 Foundation treatment

The geological survey of landfill field refers to the data of a close spot (ZK12). ZK12 is close to proposed landfill (mining pit). Therefore, its relevant data can provide reference value. Bore holes have shown that shale or limestone is present at the depth from 15.61m to 295.57m. Such geological condition possess good bearing capacity and compressibility. The proposed landfill requires a foundation that has a bearing capacity of 2000Kpa. The current foundation bearing capacity is larger than what the landfill needs. Therefore, good foundation condition is present for proposed landfill.

Figure6.10-4 The relationship between landfill and ZK12

孔号	揭露地层及岩性					揭露溶洞				含水段				试验口径(mm)	水位(m)	
	地层代号	岩石名称	分层孔深(米)			顶板深度(m)	底板深度(m)	溶洞高度(m)	充填情况	顶板深度(m)	底板深度(m)	岩性	厚度(m)		抽水前	抽水后
			自	至	厚										埋深/标高	埋深/标高
ZK3	Q	亚砂土及碎石	0	10.26	10.26							砾岩、砂岩		130	+0.43	
	D[illegible]	泥质砂岩及砂质粘土岩	10.26	16.72	4.64											
	D[illegible]	石英砾岩,石英砂岩	16.72	61.11	44.39											
		泥质砂岩	61.11	152.90	91.79											
ZK10	Q	粘土	0	6.73	6.73					7.84					2.16/47.20	
	D[illegible]	灰岩	6.73	120.22	113.49											
ZK11	K_{dnd}	砂岩、砾岩	0	33.56	33.56					22.00	107.00	灰岩	85.00	130	1.90/60.10	
	D[illegible]	页岩、泥灰岩、灰岩	33.56	121.97	88.41											
		石英砂岩	121.97	137.37	15.40											
		页岩、灰岩	137.37	150.33	12.96											
		断层破碎带(砂岩)	150.33	152.07	1.74											
	D[illegible]	灰岩	152.07	201.00	48.93											
ZK12	Q	粘土	0	1.68	1.68					90.82	295.57	灰岩	204.74	91	9.13/52.87	
	K_{dnd}	粉砂岩、砾岩	1.68	15.61	13.93											
	D[illegible] + D[illegible]	页岩、灰岩	15.61	295.57	279.96											
		变质页岩、灰岩	295.57	367.68	72.11											
		砂岩、灰岩	367.68	370.65	2.97											

Figure6.10-5 The geological survey of landfill field refers to the data of ZK12

It is recommended to conduct geological survey in the area. If survey results show that, foundation has large burial depth, karst cave has thick cover plate and consists of small karst caves that have enough bearing capacity, foundation cannot be treated; if results show that, foundation has small burial depth, karst cave has thin cover plate and consists of full-filled karst caves that have not enough bearing capacity, high-pressure grouting can be employed to improve the bearing capacity of foundation. If results show that, foundation has small burial depth, karst cave has thin cover plate and consists of non-full-filled karst caves that have not enough bearing capacity, cover plate of karst caves will be crushed to enhance foundation, so as to improve the bearing capacity of foundation to standards.

In addition, drainage during construction period and service period of landfill is carried out in following wyas:

1) Effective drainage measures for natural water shall be prepared in design plan and construction plan to prevent natural water from entering landfill during construction and service. EA Consultant suggests that, a ponding drainage plan for landfill shall be prepared based on survey results after the completion of geological survey, so as to avoid cave collapse caused by pumping under unknown hydrogeological conditions.

2) A mechanical pumping and draining system shall be established and manually controlled during construction.

3) A mechanical pumping and draining system shall be established and automatically controlled during service period.

4) A mechanical pumping and draining system for leachate shall be established and automatically controlled.

6.10.3.3.2 Construction waste landfill

Because the capacity of the landfill is larger than the total quantity of stabilized soil and sediment, in order to save project cost, the construction wastes of 19916m³ caused by site remediation will be filled in the bottom of the obsolete stone pit after being washed and crushed, to raise the bottom elevation by 19m. The particle size of crushed construction wastes may not be larger than 10cm.

A clay layer of 1.0m will be laid on the surface of the construction wastes and be compacted by layer, with compaction coefficient ≥0.95, and then artificial anti-seepage construction shall be carried out on the clay layer at the bottom of the landfill.

6.10.3.4 Anti-seepage works

The proposed landfill shall meet the requirements for Class-II general industrial solid waste landfill. Because the landform in this project is complicated, with steep side slope and bare rocks, in order to ensure the safety and the long-term stability of the project, double-layer anti-seepage structure shall be taken at the bottom, and net-hanging shotcrete anchorage handling shall be carried out for the base course of the side slope.

(1) Bottom seepage proofing

a) Lay a layer of 4800g/m^2 GCL on the clay of 1.0m thick, then lay a layer of long-fiber non-woven geotechnical cloth of 600g/ m^2 on it, then lay a layer of 2.00 mm HDPE film and a layer of 2.0mm HDPE film, and finally layer a layer of long-fiber non-woven geotechnical cloth of 600g/ m^2, as the anti-seepage structure of the leaching.

b) Lay combined geotechnical drainage network of 7mm thick on the main anti-seepage system to accelerate drainage, and lay 0.3mm thick grading gravel mixig HDPE pipe on it as the leaching collecting system.

c) Lay a layer of woven filtering geotechnicl protection layer of 200g/ m^2 on the leaching collecting system, and landfill solid wastes on it.

Table 6.10-6List of main materials

No.	Name	Specification	Quantity
1	GCL	4800g/m^2	38265
2	Long-fiber non-woven cloth	600g/m^2	76530
3	HDPE film	2mm	38265
4	Complex geotechnical drainage network	7mm	38265
5	Woven geotechnical cloth	200g/ m^2	38265

(2) Side-slope seepage proofing

a) Clear the surface vegetation on the side slope in the planned landfill area. Carry out net-hanging shotcrete anchorage treatment and ensure flat and smooth surface

b) In general, the side slope of valley or pit-type landfill will adopt the anti-seepage method similar to the reservoir bottom, i.e. laying HDPE film. The film shall be positioned and fixed through anchoring on two ends of each section of slope. For rock-soil foundation anchorage groove usually is adopted, and for concrete, masonry structure and reliable batholith, cinch bolts, drive pins and special HDPE embedded locking bars are usually adopted. In this project, the reservoir has a large side slope with compact rocks, and it is difficult to excavate anchorage groove. Besides the surface is extremely rough and other anchorage methods are unfeasible. Even shotcrete cannot meet the requirements for overall flatness of ordinary concrete and masonry brick structure, which is adverse to laying the film. Thereby, special anti-seepage treatment shall be carried out for the side wall of the landfill reservoir. According to the characteristics of the project, concrete plus inorganic anti-seepage agent is used for side wall seepage proofing, that is, filling the cracks in the rock with cement mortar, then pour C_{30} concrete of 3cm thick, and finally lay a layer of inorganic anti-seepage agent of 1mm thick 1.2kg/m^2.

6.10.3.5 Transportation program for solid wastes

The planned landfill is a pit-type landfill, and the difference from other landfills of the same type is: the maximum depth of the reservoir is 70m, far exceeding the depth of ordinary pit-type landfill. In order to ensure the smooth transportation of wastes, road transportation is selected.

Based on the low-cost road previously built for quarrying, a new road of 5m wide will be built, and will meet 3-class standard for surface mine road specified in *Code for Design of Roads in Factories and Mining Areas*, and the pavement structure will adopt concrete surface.

6.10.3.6 Leaching treatment

(1) Diversion system of clean ad waste water

In order to ensure the flood control safety of the solid waste landfill, reduce the runoff of rainwater and minimize leaching, a intercepting ditch will be built around the solid waste reservoir. According to *Code for Design of Urban Flood Control Project* (GB/T50805-2012), the flood control standard for this project will be designed by 50-year return period and verified by 100-year return period. According to the characteristics of the surrounding landform on the top of the pit, the intercepting ditch will adopt trapezoidal section with lower width 300mm, upper width 800mm, depth 50mm and slope 1‰～5‰. Rainwater intercepted shall be discharged nearby.

If the slope of the obsolete pit is small enough, intercepting ditches will be built by contour lines of 30m, 40m, 50m, and 60m. At the early stage, intercepting ditch at 30m will be built to discharge solid wastes out of the reservoir; when the landfilling height of solid waste reaches 30m, the previous ditch will be embedded in the solid wastes, and will be transformed to a blind drain to discharge leaching. Besides, the intercepting ditch at 40m has been built and is connected to the reserved intercepting ditch outside of the slope of the solid wastes. The cycle repeats until the intercepting ditch at 60m becomes a permanent ditch.

Table 6.10-7List of main equipment for rainwater collecting and drainage

No.	Name	Specification	Unit	Quantity
1	Pump	$80m^3/H$,70m,	Set	2

(2) Leaching collecting system

In order to increase the diversion and collection of landfill gas and leaching in the heap, an intermediate drainage rubble blind ditch is arranged every 30m in the heap. DN200UPVC pipe shall be laid in the ditch, and the outside is filled with rubbles of 30~100mm, and then a layer of anti-filter geotechnical cloth of $150g/m^2$ shall be added. Because the intermediate blind ditch is on the intermediate covering layer, the leaching gathering on this layer will flow into the gabion well through the blind ditch, and finally flow into the blind ditch collecting system at the bottom of reservoir.

Two main blind ditches for collecting leaching will be built at the bottom of the landfill site, and one is laid from south to north and the other from east to west. The main blind ditch on the upper platform will connect to the main blind ditch on the lowest platform through DN300HDPE pipe. The main blind ditch will adopt trapezoidal section, with lower width 500mm, upper width 1250mm and depth 500mm. DN300 perforated HDPE pipe will be embedded in the main blind ditch, and around the diversion pipe are rubbles of 20~50mm, and rubbles of 9~20mm will form a anti-filter structure, and then rubbles and medium-corse sand are backfilled to the top of the ditch, to form a longitudinal main blind ditch. Branch blind ditch transversely crosses with the main blind ditch, and adopts trapezoidal section, with lower width 400mm, upper width 1000mm and depth 400mm. Other measures are the same as the main blind ditch. The slope of both main and branch blind ditches may not be less than 2%.

(3) Leaching collecting pool

According to the characteristics of the landform of the landfill site, leaching collecting wells will be built in the northwest corner and on the south of the site, respectively. the size of the collecting well is 4×2.0m, and the wellbore will adopt prefabricated concrete and be heightened prograssively with landfiling. Each collecting well will be equipped with two submersible pump, with single-set flux of $50m^3/h$, head 95m and power 45kW.

Table 6.10-8List of main equipment for leaching collecting

No.	Name	Specification	Unit	Quantity
1	Pump	$50m^3/H$,95m, 45kw	Set	4

(4) Effluent quality and treatment process

Because the soild wastes in the planned landfill are Class-II general industrial solid wastes, the concentration of contaminants in the leaching is lower than the maximum allowable effluent concentration in integrated wastewater discharge standard, and no treatment is needed. And the leaching can be discharged into the collecting pipe of industrial wastewater treatment plant. However, in order to control the risk, a new emergency treatment pool will be built for the project, which will carry out simple treatment for leaching in emergency.

(5) Treatment scale

The quantity of leaching of solid wastes are significantly affected by external factors. Because the groundwater is supplied by atmospheric precipitation, it can be considered that the quantity of leaching of solid wastes changes with atmospheric precipitation. Therefore, the estimation of leaching quantity is mostly based on the estimation of precipitation amount. There are a lot of estimation methods, and at present the common reasonable formula is as below:

$$Q=0.001\ (C_1A_1+ C_2A_2+ C_3A_3)\ I+\ddot{O}$$

where, Q – quantity of leaching, m^3/d;

A_1 – area which is under landfilling and for which the surface water is difficult to be eliminated, m^2;

A_2- area for which landfilling has been finished and the surface water can be eliminated, m^2;

A_3- area of water accumulating zone outside of the landfill, m^2;

C_1- permeation percentage of A_1 area, mm^2/m^2;

C_2- permeation percentage of A_2 area, mm^2/m^2;

C_3- permeation percentage of A_3 area, mm^2/m^2;

I- precipitation intensity, mm/d;

Ö-volume of groundwater, m^3/d.

Through calculation, after regulating by the regulating tank, the maximum quantity of leaching is $400m^3/d$.

(6) Treatment devices

Because all contaminated soil and sediment are of properties of Class-II industrial solid wastes, there is no leaching exceeding the standard. When draining the ponding water, the newly-built $500m^3$ regulating tank can be changed to emergency reaction tank of leaching. In normal condition, the leaching will be discharged directly, and in emergency agent will be added into the leaching before discharging.

6.10.3.7 Waste gas treatment

Industrial solid waste solids contain a small quantity of organic matters, the environmental pH of solid wastes in the landfill site is kept at 8~10, and the microbial activity is extremely low, so the content of methane and hydrogen sulfide caused by anaerobic reaction in the landfill gas is low. However, in order to prevent odour of different degrees, cover plates or green belts may be adopted for the place with concentrated odor sources, to isolate main structures producing odor. Meanwhile, in the design, it is considered to position of facilities and structures which will produce ordour at the downwind area, and build green belts and plant flowers and trees around them, which will beautify the environment and isolate the ordor, effectively reduce the effect of odor on the environment.

6.10.3.8 Covering works

Covering works may be divided into three kind according to different landfilling stages: daily covering, intermediate covering and final covering. When finishing daily operation, cover the working plane, to prevent the landfilling matters from contaminating the atmosphere; when finishing the landfilling of each subarea, carry out intermediate covering; when reaching the design elevation, carry out final covering.

a) Daily covering: intermediately carry out daily covering after compacting the solid waste layer. Covering materials are anti-seepage film ad clay. First, lay a layer of anti-seepage film and then cover it with clay. The thickness of clay usually is 0.2～0.3m.

b) Intermediate covering: when the thickness of the whole subarea reaches 4m, carry out intermediate covering. The thickness of soil is 0.3 meters.

c) Final covering and closing top covering. The thickness of soil is more than 1 meter.

After absorbing the waste residue and soil from this project, the landfill will be used for landfilling the industrial solid wasters caused by the site restoration project, and the landfill period is 2022~2026, and the quantity of landfilling is 1250 thousand cubic meters.

After landfilling all contaminated soil, closure construction will be carried out, according to the requirements of *Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001) and in combination with the actual situation of the project.

1) The surface slope of closure is 1:3;

2) One step will be built when the elevation rises by every 5m. the width of the site is 1.5m, with a transverse slope of 3%;

3) In order to prevent solid wastes from direct exposure and rainwater from permeating into the heap, the surface of closure shall be covered with two layers of soil. The first layer is barrier layer, covered with compacted clay of 45cm thick, and the secondary layer is concrete

surface of 20cm, preventing rainwater from permeating into the heap of solid wastes. On the upper, rainwater diversion and drainage measures shall be taken and the following landfilling shall be carried out as soon as possible;

4) The elevation of closure after landfilling is 56m~58m.

6.10.4 Landfilling conditions

The planned landfill is a landfill site for general industrial solid wastes, and there are certain restrictions for solid wastes entering into the landfill. According to the requirements of *Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes* (GB18599-2001), the solid wastes the concentration of the leaching from which is lower than the specified value in *Integrated Wastewater Discharge Standard* (GB8978-1996) can enter into the landfill.

6.10.5 Landfilling works

Reasonably divide landfill units, and carry out landfill works by plan, determine landfill area and daily working plane according to the daily treatment quantity of solid wastes, and try best to control the range of bare area of solid wastes, which is convenient for landfill works and collection of leaching from solid wastes and diversion of rainwater and sewage, and can reduce contamination on environment and project cost.

The division of landill units mainly follow the principles as below:

Fully consider the effective operating radius of landfilling equipment (dozer and compacting machine). In general, the operating radius of dozer is about 60m.

According to the quantity of solid waste landfilling of 2800 thousand t/a, 5t transporting vehicle will be used and work for eight hours every day and one vehicle is unloaded every 3 minutes, and then one operating point will smoothly carry out landfilling work.

The daily working plane may not be too large.

The working unit may not be too small, in order to prevent increasing civil engineering cost.

Based on the principle of contamination control, the planned landfill has eight landfill units, and the area of each unit is 4783 square meters. The slope in the reservoir is 1:1, and roads will be built around the landfill area and between units, with top elevation +3m and top width 4.0m.

6.10.6 Power supply and communication

The total capacity of the electric equipment is 185KW, among which, the capacity of common equipment is 95KW and the required capacity is 76KW (See **Table 6.10-9** for the calculation of common load).

Table 6.10-9List of electric load calculation

No.	Name	Project (KW)		
		Common	Backup	Capacity
I	Sewage pump	90	90	180
II	Others	5	0	5
	Subtotal	95	90	100KVA

The load of electric equipment in this project is Grade III, and there is no special requirement for power supply. The voltage of electric equipment is 380/220V, the substation in the plant is designed to supply power to electric equipment in the way of radial wiring, and the low-voltage distribution board is installed in the duty room. The project is close to Hehua Cement Plant, and the capacity of the transformer in the substation of this plant is 2500KWA, with surplus and reliable performance. Because the electric load of this project is not large and the grade of load is not high, one circuit of 380kW power line leading from this substation from the project area can fully meet the requirements.

For this project, one administrative telephone shall be installed, directly connecting to local call system.

6.10.7 Implementation progress plan for the landfill

The construction of the landfill site is closely related to the time of remediation progress. The reasonable planning of implementation progress of the landfill is conductive to implementing the remediation project in an orderly way and reducing the quantity of temporary storage of remedied soil. Therefore, the implementation progress of the landfill is planned as below:

（1）October 2015 – December 2015 Preparatory work for the project (application for land use permit, water drainage permit and the like);

（2）November 2015 – January 2016 Engineering design and review of the landfill water accumulation treatment;

（3）February 2016 – June 2016 Engineering design and review of the landfill;

（4）February 2016 – May 2016 Water supply, power supply and road building: water treatment building (structure) (including monitoring facilities), top flood control ditch;

（5）June 2016 – May 2017 Pump drainage of accumulated water

（6）June 2017 – August 2017 Removing original sludge deposit in the mine and ground treatment;

(7) September 2017 – October 2017 Anti-seepage treatment of landfill;

(8)November 2017 Receiving up-to-standard soil and sediment after stabilization.(Because the internal area of the pit is large and landfilling of construction wastes and bottom anti-seepage treatment will be carried out by partition, so the partitional operation can begin before completing the whole anti-seepage treatment project).

Table 6.10-10 Schedule of implementation progress of the landfill

No.	Contents	2015	2016	2017	2018~2022
		10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	Preliminary works at landfill (land use license/drainage license., etc)	Preliminary works			
2	Design and evaluation of standing water treatment project	Design and evaluation of standing water treatment project			
3	Design and evaluation of landfill project	Design and evaluation of landfil			
4	Construction of three supplies, water treatment buildings (structures) (including monitoring facilities), and top flood ditch	Construction of water treatment supplies			
5	Drainage of the ponded water		Drainage of the ponded water		
6	Removal of sediment in pit and foundation treatment			Construction of water treatment supplies	
7	Anti-seepage measures treatment			Anti-seepage measures treatment	
8	Start ro backfill the remediation soil, sediment.,etc			Backfill the solid waste	

6.10.8 List of equipment in the landfill

Table 6.10-11List of equipment in the landfill (during operation)

No.	Name	Type&specification	Unit	Quantity
1	Dozer	120 Hp	set	1
2	Solid wastes compacting machine	$5m^3$	set	2
3	Landfilling compacting machine	BC601RB	set	2
4	Excavator	$1m^3$ hydraulic	set	2
5	Loading machine	$1m^3$	set	2
6	Watering cart	3000 升	set	1
7	Chemical spraying cart	1000 升	set	1
8	Closed dump truck	4.5t	set	6
9	Wheeled truck crane	10t	set	1
10	Tool wagon	Load 1.25t	set	1
11	Leaching lift pump	$Q=50m^3/h$ H=75m, N=45kw	set	4
12	Rainwater drainage pump	$Q=80m^3/h$ H=70m	set	2

6.11Construction works of Qingshui Lake

According to the *Regulatory Detailed Plan for Qingshui Laike Eco-city in Zhuzhou City* and the *Regulatory Plan Subject for Water Environment in the Core Zone of Qigshui Lake Eco-city* (the Plan and the Subject for short), it is needed to build a clean water lake at the junction of Tongxia District and Tongtangwan District, i.e. between Xiawangang and old Xiawangang, undertaking the functions of rainwater regulation and storage and landscape recreation in Qingshuitang District.

According to the Plan and the Subject and in combination with the actual situation of contamination, the project proposes building a ecological purification system in Qingshui Lake, including construction of ecological wetland, riparian overground water filtration tank area, pond on the bank and purification islands; building a good ecological system while realizing the original planned functions, giving consideration to the purpose of continuously reducing contaminants in the area, arousing the public enthusiasm in environmental protection and playing the role of demonstration.

The main construction routes are shown in **Figure6.11-1**:

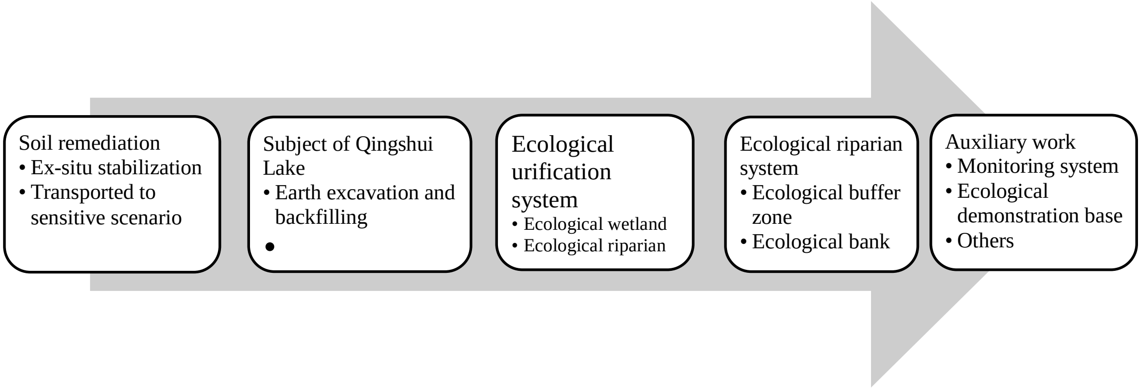


Figure6.11-1Flow chart for construction sequence of Qingshui Lake

6.12Construction program for environmental demonstration center

6.12.1 Primary objectives

Relying on the support and demands of Zhuzhou Qingshuitang brownfield remediation project and organized by ZREIDC, an environmental demonstration center will be built. The construction direction of the center includes: a). construction of environmental integrated database platform;b). construction of environmental protection exchange center;c). construction of environmental protection museum;d). construction of later environmental monitoring predicting system. The primary objectives of the center are described as below:

(1) During project construction, provide services for project construction as information management platform, technical service center and publicity and education center; build project environmental information database management and application collaboration platform; carry out publicity and education about environmental protection, and improve the public’ s understanding and support to the project; build Qingshuitang Environmental Protection Museum, review the course of pollution and show the remediation results and look forward to the future development of environmental protection.

(2) After completion of the project, supervise the later-period management and maintenance as later-period management and maintenance center, monitoring control center and old Qingshuitang industrial zone environmental protection exhibition base.

6.12.2 Development of environmental demonstration center

(1) The environmental demonstration center will open regularly free of charge, and provide services for local and surrounding publicity and education about environmental protection.

(2) Future 5-10-year construction planning: incorporate the environmental demonstration center into Qingshuitang environmental service industrial park under planning, and support the construction and long-term operation of the environmental service industrial park; build the center into the most characteristic integrated environmental information database management platform for heavy-metal contaminated site remediation in old industrial zones in Xiang River basin in Hunan Province and the most distinctive environmental protection museum, play an important role in Hubei provincial and national key environmental protection projects, and realize the value of information collaboration, environmental protection and social education.

6.12.3 Location selection

The environmental demonstration center is proposed to be located in Xinqiao slag site at the junction of Qingshui Region and Tongxia Region, and the floor area is about 71934 square meters (107.9mu). The site is close to Tongxia Road on the north and to Qingxia Road on the east, and the west boundary is Old Xiawangang, with convenient traffic and conditions for water supply, power supply, information exchange and collaboration. The shape of the site is a inverted triangle, the east-west length about 310 meters, the south-north length about 340 meters, and the original elevation 34.35-43.30m. At present, the remediation of Xinqiao slag site has been finished, and the stabilization and solidification zone in the site will continuously provide service for this project, and will be transformed to environmental protection museum after the project is completed. After remediation is completed, the site will meet the requirements for environmental demonstration center construction land, laborary land, greening land and environmental purification, and development land will be reserved. See **Figure6.6-1** for site location.

6.12.4 General layout

The planned environmental demonstration center is composed of environmental demonstration center building, environmental protection museum, service building, entrance ecological landscape zone and engineering testing ground, and the total planned building area is about 7970 square meters.

The environmental demonstration center building is designed to be a single-floor building, located in the northwest corner, and the design building area is 820 square meters.

The environmental protection museum is planned to be transformed for existing waste residue treatment equipment of steel structures, and original process equipment will be reserved to be transformed into the museum for visiting delegations and local residents, and the design building area is 7150 square meters.

The technical pilot test and demonstration base is designed to be located on the south of the site, and the floor area is 40000 square meters.

See **Figure6.12-1** for the plane layout.

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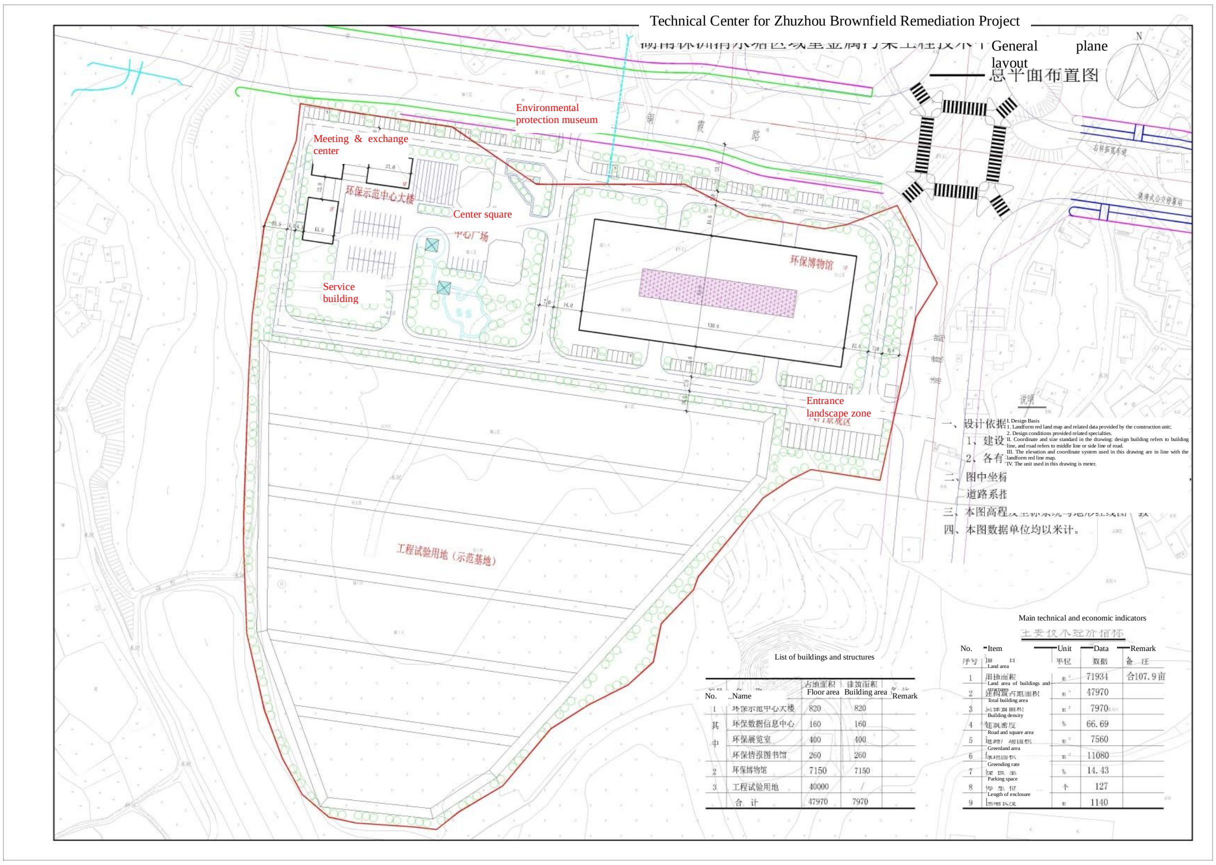

Figure6.12-1 Plane layout of environmental demonstration center

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7 Environmental Impact Factor Analysis

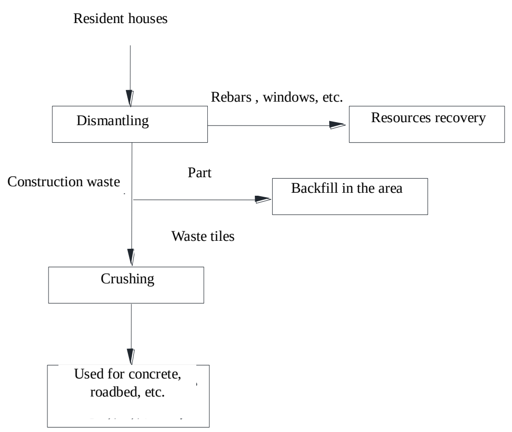
7.1Environmental impact factors during construction

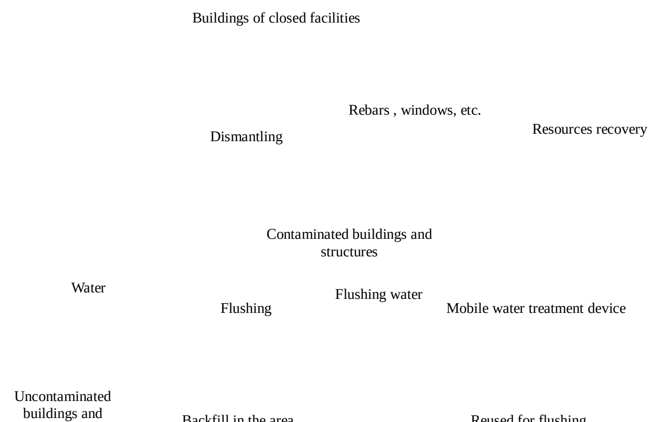
7.1.1 Technical process and pollution links during construction

The construction period of the project involves site cleanup in the project scope, construction of dewatering site, temporary storage site, landfill and environmental demonstration center, excavation of soil to be remedied, interception, diversion and desilting of and ponds.

7.1.1.1 Soil surface cleanup

Prior to remediation of contaminated soil in the remediation site, site cleanup shall be carried out. The cleanup involves dismantlement of buildings of closed facilities and resident houses and removal of sundries including trees, stumps, tree roots, bushes and garbage in the treatment site. Meanwhile, the contaminated buildings and structures in the closed facilities shall be flushed, and the flushing water shall be collected and be discharged through pre-sedimentation tank into mobile water treatment devices for treatment, and will be reused for flushing, but not discharged to the outside.





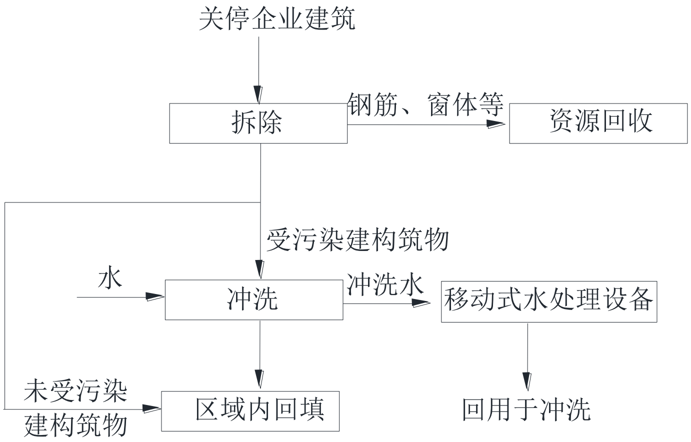


Figure7.1-1 Cleanup route in the remediation site

7.1.1.2 Construction of dewatering site and temporary storage site

A new dewatering site will be built to dewater contaminated sediment, and a new temporary storage site will be built to temporarily store solid wastes before the landfill is built.

The construction of dewatering site and temporary site mainly involves:

(1) Site levelling and cleanup: use dozer for primary levelling of the site, adopt paving mode and make the earth compact through vibration rolling;

(2) Ground cement hardening and bottom seepage-proofing;

(3) Construction of prefabricated buildings;

(4) Construction of steel structure sheds

7.1.1.3 Construction of landfill

The construction of the landfill mainly involves site leveling and cleanup, foundation excavation and backfilling, and main body construction.

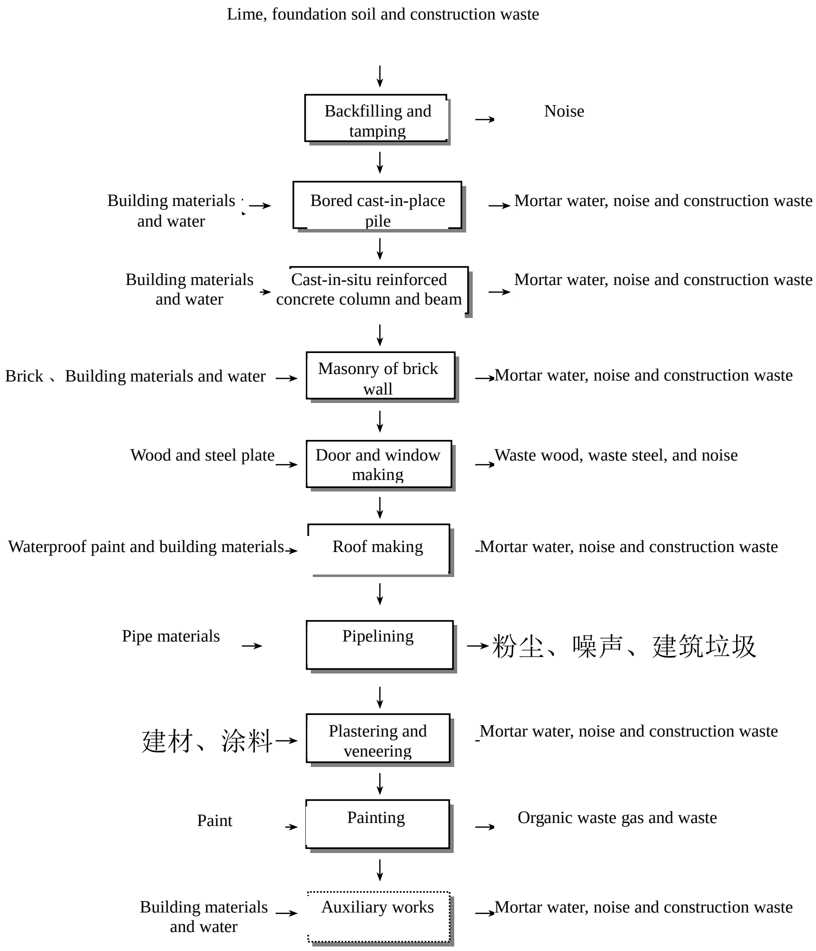
Site levelling and cleanup: because drainage culvert pipes and artificial anti-seepage layer shall be laid at the bottom of the site, use dozer for primary levelling of the site, adopt paving mode and make the earth compact through vibration rolling.

Foundation excavation and backfilling: adopt the combination of mechanical and manual excavation. Use large-sized excavation machinery for large-area excavation,, and use back digger for construction of foundation pit. Adopt the combination of mechanical and manual excavation for backfilling, and use dozer to pave and level the soil and make it compact with vibration roller. For earth excavation, try best to avoid rainy season, and implement rain-proofing and drainage measures, in order to prevent rainwater from gathering in the foundation pit which will influence construction progress and quality and conservation of water and soil.

Main body construction: include laying of drainage culvert pipes and artificial anti-seepage layer, construction of drainage well, surrounding interception construction, construction of leaching collecting tank, and laying of leaching recycling pressure pipelines.

7.1.1.4 Construction of environmental demonstration center

See **Figure7.1-2** for the flow chart for construction of environmental demonstration center



Note: auxiliary works include roads, enclosures, sewage treatment facilities, pit wells and sewers.

Figure7.1-2Flow chart for construction of environmental demonstration center

7.1.1.5 Technical process and pollution links during excavation of soil to be remedied

The soil to be remedied will be excavated by excavators and transported by vehicles. Heavy-metal contaminated soil will be transported to the stabilization and solidification site for treatment, and organic contaminated soil will be transported by closed vehicles to Zhuzhou Cement Co., Ltd. for incineration.

The pollutants produced during soil excavation include flowing dust and noise, and organic waste gas resulted from contaminated soils excavation.

7.1.1.6 Technical process and pollution links during in-situ remediation

The ecological restoration in in-situ remediation mainly is vegetation covers, and ecological capping requires laying adsorbing packing layer and pebble layer. The pollutants include flowing dust and noise.

7.1.1.7 Technical process and pollution links during interception and diversion of channels and ponds and desilting

The measure of drying ponds and desilting will be taken for Old Xiawangang, low discharge channel and other contaminated ponds in the project area, and the total amount of desilting is 173thousand cubic meters. The construction mainly involves pond drying. See Section 6.4 for details.

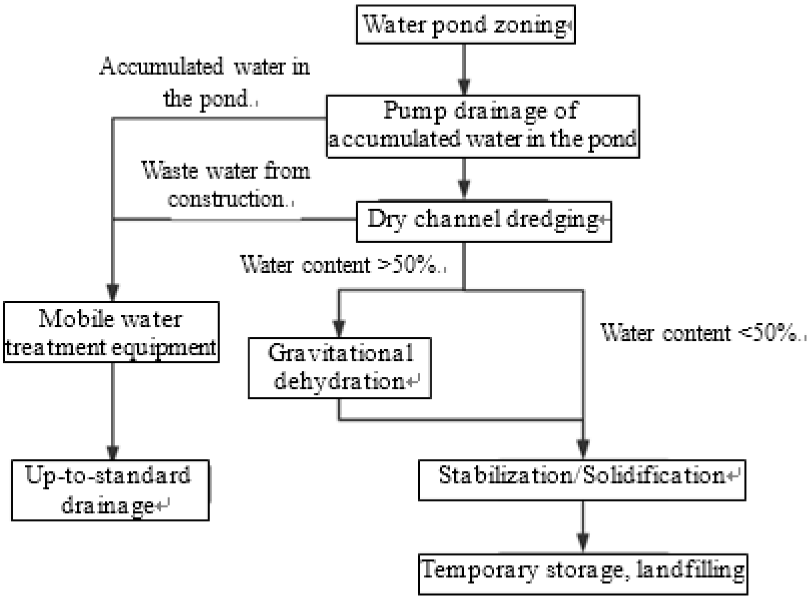


Figure7.1-3 Technical process and pollution links during interception and diversion of ponds and desilting

Main pollutants include flowing dust, desilting wastewater, pond water, noise and affects on water body and vegetation ecology.

7.1.2 Pollution sources during construction

See **Table 7.1-1** for main environmental impacts caused during construction.

Table 7.1-1Summary of environmental impacts during construction

Environmental element		Project type	Nature of impact	Environmental impact
Ecological environment		All projects	Short-term, reversible and adverse	Impact of permanent and temporary land occupation on cultivated land, wood land and grass land; Soil excavation and filling may damage surface vegetation and increase regional soil erosion; Excavation may damage the ecological environment of animal habitats, and construction may disturb wild animals and force them to leave from their original habitats.
Sound environment		All projects	Short-term, reversible and adverse	Noise sources mainly include construction machinery and vehicles, which may impact surrounding sound environment. Noise in the period of earthwork is mainly from loading and unloading machines and transportation vehicles.
Air environment		All projects	Short-term, reversible and adverse	Soil blending, concrete stirring and vehicle transportation may cause flowing dust; Organic waste gas caused during excavation of organic contaminated soil is discharged in a disordered way; Exhaust from fuel machinery and construction vehicles; Stink caused by desilting.
Water environment	Surface water	All projects	Short-term, reversible and adverse	Domestic sewage caused by construction workers: initial rainfall, wastewater from vehicle and machinery washing, and wastewater containing heavy metal caused by flushing buildings and structures; Waste water produced by desilting of channels and ponds; And ponding water in the stone pit in the landfill.
	Ground water	All projects	Short-term, reversible and adverse	Impact on groundwater quality caused by impact on surface water quality; Slight impact of soil excavation on groundwater level;
Solid wastes		All projects	Short-term, reversible and adverse	Construction wastes like soil and sand Construction of dismantlement; Sludge produced by wastewater treatment

7.1.2.1 Characteristic analysis on ecological environmental impacts

Ecological environmental impacts during construction mainly shows in engineering land occupation, vegetation damage and soil erosion. Engineering land occupation involves construction machinery, temporary construction site and sediment staging land occupation; soil excavation will damage the existing vegetation system, and may influence local resident income to a certain extent. The quantity of earthwork is large, which may intensify regional soil erosion.

7.1.2.2 Characteristic analysis on sound environmental impact

A variety of machinery will be used for Dismantlement of resident houses and closed facilities, soil excavation, structures construction, and include loading machine, excavator, dozer, concrete stirring machine and vibrating machine, and heavy-duty crane, which are main noise sources. Besides, earthwork allocation and equipment and materials transportation require a large quantity of transportation vehicles, which have high noise radiation intensity, especially heavy-duty trucks, and will significantly disturb the surrounding environments of construction sites, roads and highways. According to the existing monitoring and statistic information, noise source intensity and range attenuation of common construction machinery are detailed in **Table 7.1-2**.

Table 7.1-2 Noise source intensity of common construction machinery

Machinery type	Model	Distance between test point and construction machinery (m)	Max. sound level Lmax (dB)
Wheel loader	ZL40	5	90
Wheel loader	ZL50	5	90
Land leveller	PY160A	5	90
Vibrating roller	YZJ10B	5	86
Double-wheel double-vibrating roller	CC21	5	81
Tri-wheel roller	/	5	81
Pneumatic tyred roller	ZL16	5	76
Dozer	T140	5	86
Pneumtic tyred hydraulic excavator	W4-60C	5	84
Paver (UK)	fifond311 ABG CO	5	82
Paver (Germany)	VOGELE	5	87
Generator set (two sets)	FKV-75	1	98
Percussive well drill	22 type	1	87

According to**Figure7.1-4**, the road transportation routes include Tongxia Road, Qingxia Road, Old Tongxia Road and Huanbao Avenue under construction, and affected resident areas include Qingshuitang Community, Yingfeng Community, Jianshe Village, Qingxia Community, Tianshuiiaoxia and the living quarter of Hard Alloy Plant; and the affected resident areas by which the transportation village roads pass mainly include Damapo and Shengfeng Nursing Home.

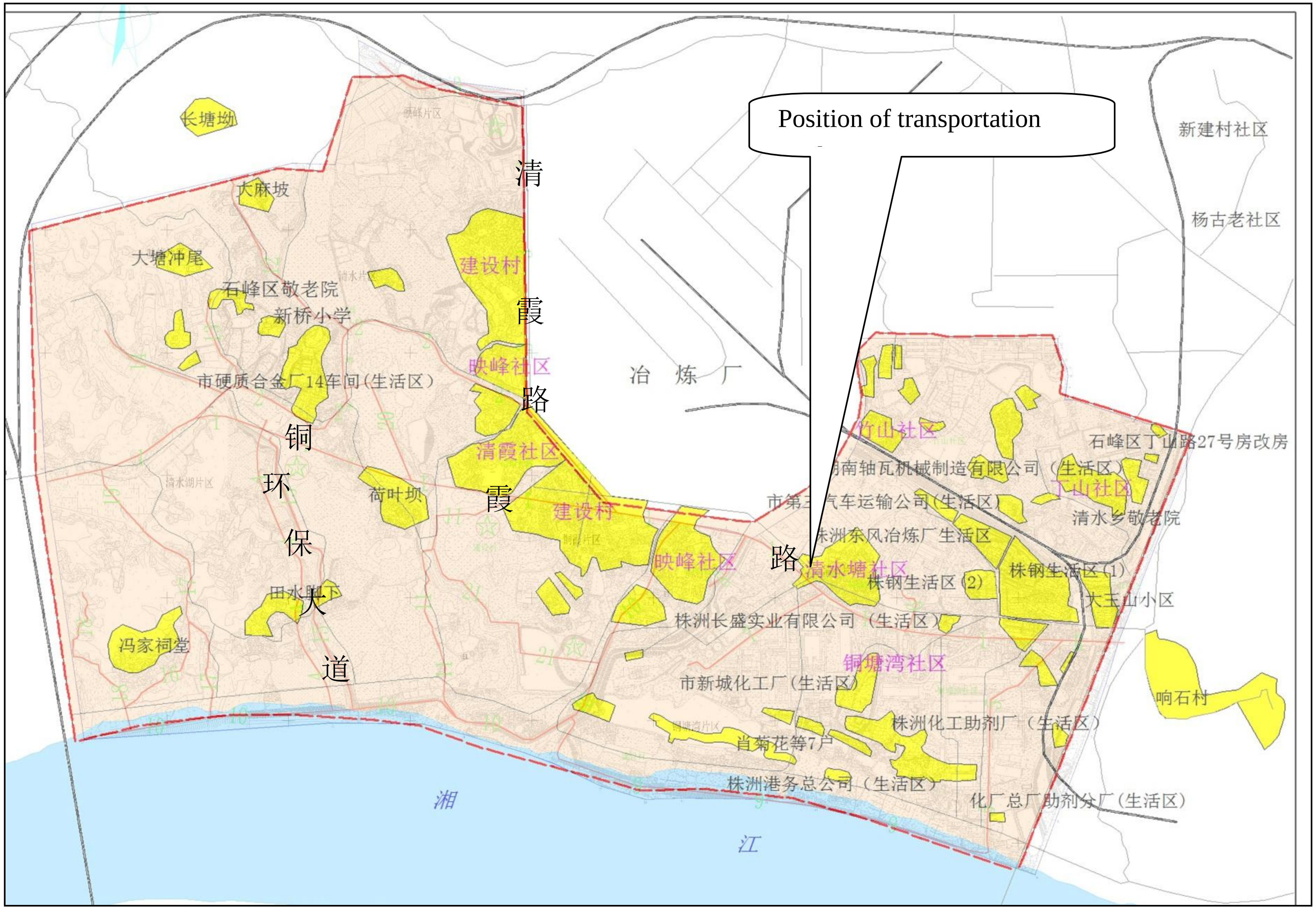


Figure7.1-4Location map for sensitive spots of transportation routes

7.1.2.3 Characteristic analysis on air environmental impacts

Air pollution sources during construction mainly include flowing dust, organic waste gas, exhaust of construction vehicles and sediment stink

(1) Flowing dust

Construction flowing dust: flowing dust caused when construction vehicles run on dirt roads and caused by material scattering; flowing dust caused when loading and unloading slag soil; flowing dust caused by soil surface and powder construction materials like cement and lime after vegetation and ground surface in the construction site are damaged. The amount of flowing dust is related to the dry degree of air and the wind speed. The drier the air, the lower the water content in soil or materials, the higher the wind speed, and the higher the flowing dust concentration. According to the analog data, TSP concentration may reach0.2～0.3mg/m^3 at the place 40m away from the construction site.

(2) Organic waste gas caused by excavation of organic contaminated soil

The excavation of organic contaminated soil may disturb the contaminants in soil, and some volatile organic compounds will spread into the air. According to the site investigation by Tiancheng Chemicals, the organic matters mainly include aniline and benzopyrene.

(3) Exhaust of fuel machinery and construction vehicles

During the construction of the project, fuel machinery like dozer and loading machine and construction vehicles will produce a certain amount of fuel exhaust, but the emission is not large and only has a small range and low extent of impact on ambient air quality.

(4) Desilting stink

In the course of desilting, putrefactive sewage and sediment will stink, and main pollutants are ammonia and hydrogen sulfide. The long-term decomposition of organic matters by microorganisms will produce reducing repugnant substance which will be discharged into the air through sediment disturbance, and the emission mode is disordered plane source emission.

7.1.2.4 Characteristic analysis on surface water environment

The wastewater during construction mainly includes domestic sewage of construction workers, initial rainfall, wastewater from vehicle and machinery washing, wastewater containing heavy metal caused by flushing buildings and structures, wastewater produced by desilting of channels and ponds, and ponding water in the stone pit in the landfill.

1.Domestic sewage of construction workers: the construction workers will be live in neighboring resident areas, and no construction camps will be built, therefore, the amount of newly-increased domestic sewage is small.

2.Initial rainfall: during construction, when construction materials stacked in the site and outdoor machinery are flushed by rainwater, wastewater containing suspended solids of high concentration will be produced. The initial rainfall will be collected by rainwater pipe and discharged into initial rainwater collecting tank for temporary storage, and will be reused for building and structure flushing but not discharged to the outside.

The amount of initial rainfall in the project is calculated by using the format of rainstorm intensity in Zhuzhou City.

q=1108(1+0.95lgP)/t0.623

where, P – recurrence interval of design rainfall (a); P = 2 years;

t- duration of rainfall (min); take 15min.

Calculated by the amount of rainfall collected during the first 15 minutes, the maximum amount of initial rainfall is 75m^3/time.

As per the construction design, when flushing closed facilities, build drainage ditches and collecting tanks surrounding the buildings. Initial rainfall may be collected by the drainage ditches and into the collecting tank (not smaller than 100 m^3), and will be used for flushing buildings.

3.Wastewater from vehicle and machinery washing: flush vehicles at certain places and produce wastewater containing suspended solids and petroleum.

4.When dismantling enterprise facilities, building flushing will produce wastewater containing heavy metal: flushing water will be introduced from municipal water supply network, and the water consumption will be about 7116.8m^3. The main contaminants include SS, Cd, Hg, Zn, Pb, As and Cu. The wastewater will be collected by grooves into the pre-sedimentation tank and the clean water after sedimentation will be treated by mobile water treatment devices and reused for flushing.

e). Wastewater produced by desilting of channels and ponds:

The total amount of desilting wastewater is about 19333 m^3 , and the average annual amount is 32 m^3/d.

The main contaminants are suspended solids. See **Table 7.2-3** for concentration of contaminants.

Because the ponds are scattered and the amount of desilting wastewater of each pond is relatively small, it is proposed to use mobile sewage treatment devices for treatment of desilting wastewater. When reaching Calss-1 standard in Table 4 in *Integrated Wastewater Discharge Standard* (GB8978-1996), the water will be directly discharged into the rivers nearby.

f). Ponding water in the stone pit in the landfill

Since stopping quarrying from the late 1990s, the intercepting system around the stone pit has been obsolete, and rainwater continuously flowed into the pit, and now the whole pit is full of ponding water, and the estimated volume is about 2000 thousand cubic meters. Calculated by 1 year of construction period, the average daily volume is 5479 m^3/d. If the pit will be used as the solid waste landfill, the water in the pit shall be drained.

According to the water quality in the stone pit in **Table 6.10-4**, the concentration of ammonia nitrogen is 30 mg/L, and treatment shall be carried out for ammonia nitrogen in the ponding water before discharging.

Table 7.1-3 Concentration of contaminants in pond water (mg/L)

Contaminant Water body	COD	CN	Ammonia nitrogen	TP	Hg	Cd	TCr	Cu	Zn	As	Pb
Old Xiawangang	14.75	0.0248	0.56	0.043	0.00007	0.0022	0.0058	0.00617	0.68	0.029	0.020
Xinqiao low discharge channel	15.0	0.0287	-	0.05	0.00006	0.003	0.0153	0.006	1.65	0.006	0.0173
Pond water	23.8	-	-	-	0.00006	0.0041	0.015	0.0106	0.115	ND	0.0177
Environmental Quality Standards for Surface Water GB3838-2002 Class-Ⅴ standard	40	0.2	1.5	0.4	0.001	0.01	0.1	1	2	0.1	0.1

7.1.2.5 Characteristic analysis on groundwater environmental impacts

The approaches of affecting groundwater quality mainly include leakage of construction wastewater in construction sites, sewage treatment facilities, sewage pipes and drainage pipes; and the infiltration of leaching caused by temporary staging of contaminated solid wastes may also affect groundwater quality.

7.1.2.6 Characteristic analysis on environmental impacts of solid wastes

Solid wastes during construction mainly include construction wastes, building wastes caused by dismantlement and sludge caused by sewage treatment.

Construction wastes are wastes of building materials, such as soil, sand, and so on;

Building wastes caused by dismantlement mainly are rebars and windows which may be reused, and also include unrecoverable wastes containing heavy metal residues or not containing heavy metal contamination.

In addition, excavation work may produce waste slag and soil.

7.2Environmental impact factors during operation

7.2.1 Technical process and pollution links during operation

7.2.1.1 Technical process of soil remediation for heavy-metal contaminated site and pollution links

(1) Technical process of stabilization/solidification technology and pollution links

Stabilization technology is selected as the remediation method for heavy-metal contaminated soil and sediment in the project area.

(1) See **Figure7.2-1** for technical process of soil stabilization and pollution links.

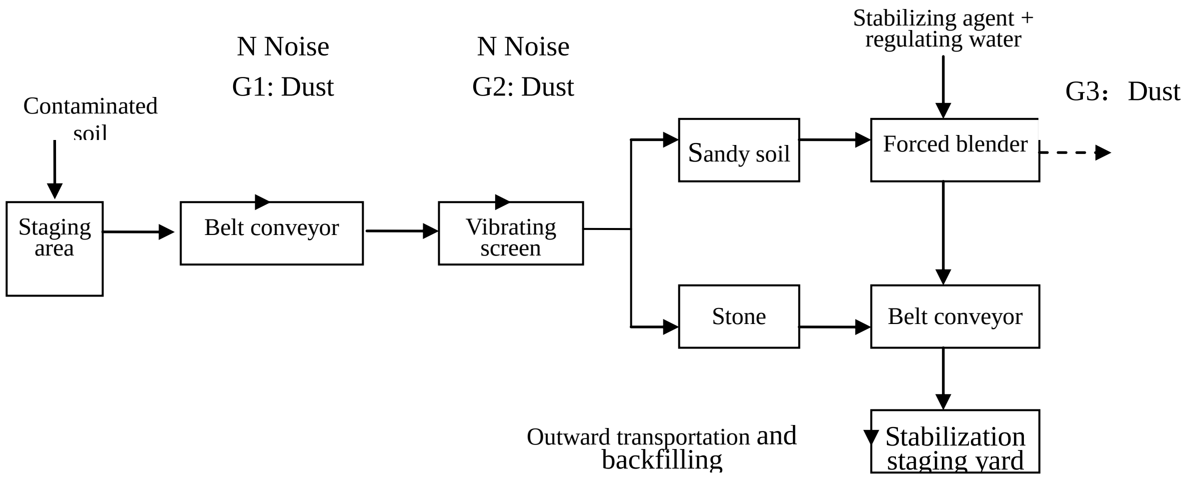


Figure7.2-1 Technical process of soil stabilization and pollution links

(2) Description of flow of remediation process

1.Excavate contaminated earth and load it on the truck, and transport it to the staging area in stabilization/solidification site for treatment;

2.Convey the contaminated soil by belt conveyor to the screening workshop and use vibrating screen to sort out stones and foreign matters with grain size ＞30mm which will be used as building materials and foundation materials;

3.Send the soil after screening into the forced blender after being quantified by vibrating feeder, and then add regulating water to control the water content in soil at 60~65%, and finally add stabilizing agent and fully blend it;

d). After being mixed forcibly for 3~5min, discharge the soil by the outlet hopper at the tower bottom;

e). After evenly mixing, use belt conveyor to convey the soil containing stabilizing agent to the stabilization staging area for curing. The curing time shall not be less than two days, in order to ensure the complete stabilization reaction.

6.After curing is completed, stabilized soil will be sampled for leaching toxicity testing and analysis, and will be transported for backfilling if it reaches the target value of remediation;

⑦ Stabilized soil up to standard will be landfilled safely.

The soil stabilization center is a temporary workshop. After the project is completed, it will be dismantled and the land will be levelled into construction land according to the land use plan. Auxiliary treatment devices may be used for construction and mining or used for other contaminated soil remediation projects.

7.2.1.2 Technical process of organic contaminated site treatment

The main technology adopted for organic contaminated soil treatment is incineration.

The quantity of organic contaminated soil is about 16548 cubic meters, and the remediation time is about two months, and Sinoma Zhuzhou Cement Co., Ltd. will be entrusted for treatment. The treatment flow is as below:

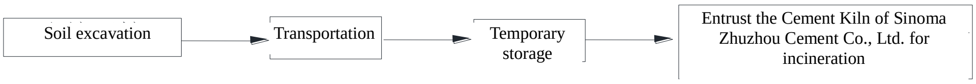


Figure7.2-2Flow chart for organic contaminated site treatment

7.2.1.3 Technical process of heavy-metal contaminated sediment and pollution links

In this project, the measure of drying ponds and desilting will be taken for Old Xiawangang, low discharge channel and contaminated ponds, and the total quantity of desilting is about 173thousand cubic meters. The sediment will be transported to the dewatering site and the volume will be reduced to 60.5 thousand cubic meters after dewatering, and the quantity of sediment after stabilization/solidification will be 112.5thousand cubic meters which will be transported to the newly-built industrial solid waste landfill for landfilling.

The dewatering process mainly produces dewatering wastewater. See 7.2.1.1 for pollution links in stabilization and solidification process.

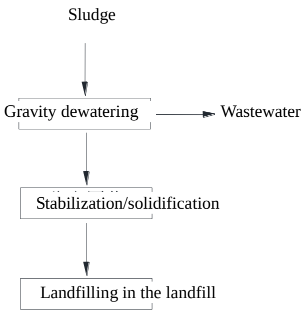


Figure7.2-3 Techinical process of sediment remediation and pollution links

7.2.1.4 Technical process of waste residue remediation and pollution links

The typical contaminants in contaminated waste residues are consistent with those in contaminated soil. Therefore, waste residue remediation process mainly adopts stabilization/solidification technology.

The remaining waste residues in the project area will be excavated and transported to the stabilization/solidification site for treatment, and then transported to the industrial solid waste landfill for landfilling.

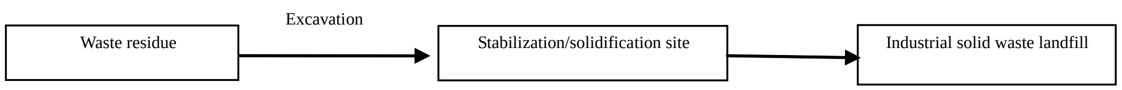


Figure7.2-4 Technical process of waste residue remediation

7.2.1.5 Technical process of landfill and pollution links

See **Figure7.2-5** for techical process of landfilling:

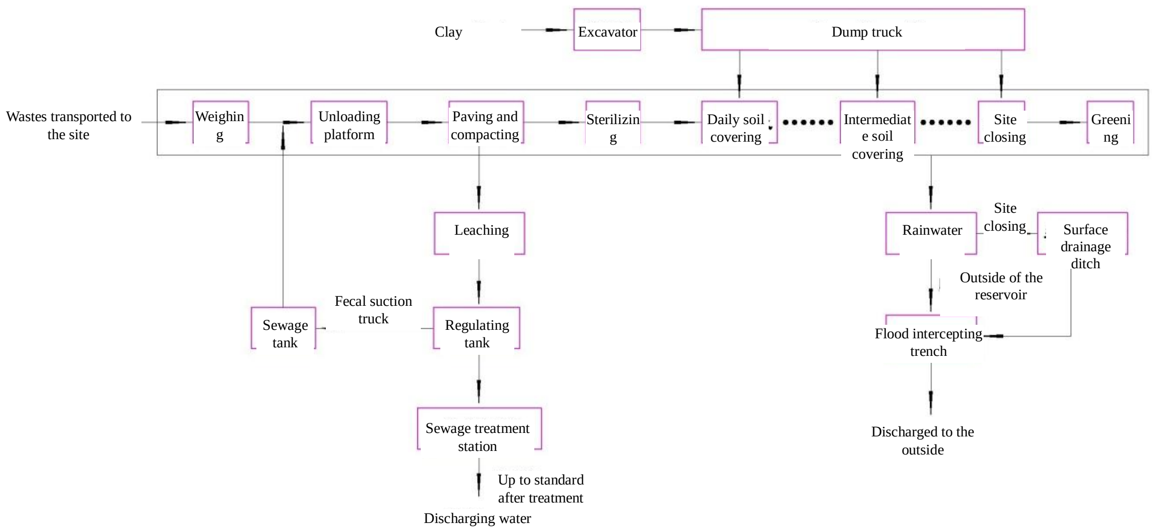


Figure7.2-5 Technical process of landfilling

Landfilling process: weighing→dumping→flattening→compacting→covering.

The operation mode of the landfill is zoning and subdivision landfilling. On the premise of zoning and subdivision landfilling, layered landfilling is considered. In the process of landfilling, the landfill subzone is uncovered, and shall be covered every day after daily operation is completed in order to prevent contamination spreading. Daily covering adopts film covering or soil covering, and other zones adopt intermediate covering or temporary covering.

The first working area is the bottom of landfill reservoir after being flattened. In the process of landfilling, consider the implementation in combination with the temporary working roads. First, divide the landfill site into several zones and divided each zone into several units by 4×5m as per the daily quantity of wastes. Unload the wastes at the specified working point, and pave the wastes with dozers and compact them with rollers. When reaching to the specified height through layered compacting, cover it with clay and then repeat the foresaid process. Rolling shall be carried out by layer, and the compaction thickness of each layer may not exceed 50 centimeters. The rolling machine shall roll the solid wastes for at least 3~4 travels. The compaction density of solid wastes shall be ≥1.5 t/m^3. When the compaction thickness reaches 2.3 meters, cover it with soil of 20cm thick to form a landfill unit of 2.5m thick. The landfilling shall be carried out from right to left and then backward. The connecting lines among left, middle and right shall be circular arc, to make water on the covering surface to smoothly flow into drainage ditches or side ditches and prevent rainwater from infiltrating into the wastes. The connecting line among front, upper and back shall have a certain slope. The outer slope shall be 1:4, and the top slope shall not be smaller than 2%. When the unit thickness reaches the design thickness, temporarily close the zone and cover it with clay of 45~50cm thick, which shall be compacted evenly. Six landfill zones will compose a landfill sub-layer of 15m high, and in order to drain the surface runoff on the layer and reduce the quantity of leaching, each sub-layer shall form a cambered slope to flood intercepting ditches or collecting pipes on the side. The outer slope of the sub-layer shall be 1:3, and a control platform of 10m wide shall be built between sub-layers for landfilling machinery running. The control platform shall be equipped with drainage pipes to intercept the runoff from the slope and discharge the collected water into the flood intercepting ditches around the reservoir.

The first layer of solid wastes adopts pit filling method, namely, dumping solid wastes down on one side of the landfill unit, and laying roadbed boxes on it after forming a certain working area, enable vehicles to run forward to the working area. When the first layer is completed the operation of the second layer shall begin and the second layer adopts inclined plane healing method.

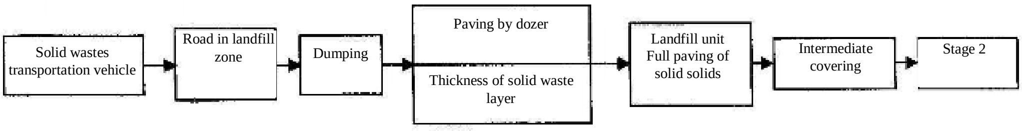


Figure7.2-6 Technical flow for landfilling at the first stage

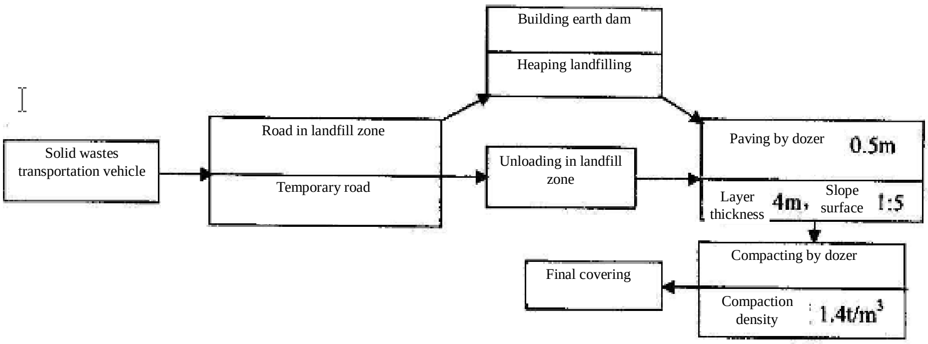


Figure7.2-7 Technical flow for landfilling at the second stage

Pollution links: Main contaminants produced in the process of landfilling include flowing dust, noise and leaching.

7.2.1.6 Technical process and pollution links of environmental demonstration center

Main contaminants produced by the environmental demonstration center conclude office and domestic sewage and solid wastes.

7.2.2 Pollution sources during operation

7.2.2.1 Wastewater

(1) Wastewaster produced by heavy-metal contaminated sediment treatment

The volume of the wastewater produced by dewatering heavy-metal contaminated sediment is 79.8 thousand cubic meters.

According to the testing results, the leaching concentration of heavy metals in sediment doesn't exceed the values in Integrated Wastewater Discharge Standard (GB8978-1996), and the contaminants in the wastewater mainly include COD, SS, ammonia nitrogen, TP, Cd, As and Pb, and the initial concentration is COD 50mg/L, SS 200mg/L, ammonia nitrogen

10mg/L, TP 2mg/L, Cd 0.02 mg/L, As 0.006 mg/L and Pb 0.02 mg/L.

The wastewater produced by sediment dewatering will be treated by mobile water treatment devices, and be discharged to the downstream when reaching the standard.

(2) Initial rainfall of the sites

The project will rent Xinqiao Stabilization/solidification Site, newly build Xinqiao Dewatering Site, rent the existing Xiawan Dewatering Site, and newly build a temporary storage site. The floor area of each site is 4000m^2, 4200m^2, 5500m^2 and 10000m^2, respectively.

In rainy season, initial rainfall will retransfer heavy metal contaminants, which will cause secondary contamination.

The calculation format for initial rainfall is described in Section 7.1.2.4, and the calculated amount of initial rainfall of each site is 60m^3/time, 60m^3/time, 78m^3/time and 141m^3/time, respectively. The main contaminant is SS.

Drainage ditches and collecting tanks (not smaller than 75 m^3, 75 m^3, 100 m^3 and 180 m^3 respectively) will be built in Xinqiao Stabilization/solidification Site, Xinqiao Dewatering Site, Xiawan Dewatering Site and Temporary Storage Site, and anti-seepage treatment will be carried out. After being collected by rainwater pipes, initial rainfall will be discharged into the initial rainwater collecting tank for temporary storage. The initial rainwater in the stabilization and solidification site will all be used for stabilization, and that in the dewatering site and the temporary storage site will be treated by mobile water treatment devices and then be used for watering of roads, but not discharged to the outside. Later rainwater and the rainwater in other areas will be discharged by rainwater diversion pipes to the outside.

(3) Leaching of the landfill

By calculation, the output of leaching is about 400 m^3/d.

Because the solid wastes in the planned landfill are Class-II general industrial solid wastes, the concentration of contaminants in the leaching is lower than the maximum allowable effluent concentration in the integrated wastewater discharge standard, and no treatment is needed. And the leaching can be discharged into the collecting pipe of industrial wastewater treatment plant. However, in order to control the risk, a new regulating tank of 500 m^3 will be built and transformed into the leaching regulating emergency reaction tank which will carry out simple treatment for leaching in emergency.

(4) Domestic sewage

In this project, no dwelling or canteen will be built, and the working personnel will live in neighboring rented houses. Domestic sewage will be discharged into the urban sewer network. Therefore, quantitative analysis will not be carried out.

There are 30 staff in the environmental demonstration center. The total domestic water consumption is 934t/a, and if the water discharge is calculated by 80% of the total water consumption, the sewage volume will be 934t/a. Contaminants in the sewage mainly include COD, SS, ammonia nitrogen and TP, and initial concentration is COD 350mg/L, SS 200mg/L, ammonia nitrogen 25mg/L and TP 4mg/L, respectively. The estimated output is 0.327t/a, 0.187t/a, 0.023t/a and 0.0037t/a.

7.2.2.2 Waste gas

Waste gas in the project mainly include dust produced by mixing and screening during stabilization, dewatering of sediment, stink during stabilization and solidification (ammonia and hydrogen sulfide) and flowing dust in the land, and all of them are discharged in a disordered way.

(1) Stink

Dewatering of pond sediment and heaping storage in stabilization and solidification site cause stink, and the emission mode is disordered plane source emission.

The quantity of sediment in the project is 173 thousand cubic meters. Calculated by average density of 1.6g/cm^3, the weight of sediment is 2768t. See **Table 7.2-2** for source intensity of ammonia and hydrogen sulfide in each site.

(2) Dust caused by mixing and screening

the staging area and the mixing area will be away from residential area, and full-automatic electronic-control mixing devices will be used for automatic weighing and feeding. The devices will be installed in closed workshops and the quantity of powder discharged in a disordered way is small.

(3) Flowing dust in the landfill

The waste gas produced during the operation of the landfill is flowing dust.

Wind speed causing dust emission is related to grain size and water content, and the spreading and dilution of flowing dust in air depends on weather conditions like wind speed and also is related to its own sedimentation velocity. See **Table 7.2-1** for the amount of flowing dust during loading and unloading with different water contents. In this project, the water content in waste residues and soil to be landfilled is about 15%.

Table 7.2-1Amount of flowing dust during loading and unloading with different water contents

Unit: kg/t·a

Water content	4%	8%	10%	15%	20%	30%
Q	0.252	0.242	0.237	0.225	0.214	0.193

See **Table 7.2-2** for source intensity of disordered waste gas.

Table 7.2-2 Source intensity of disordered waste gas

No.	Location	Contaminant	Emission load (t/a)	Length of plane source (m)	Width of plane source (m)	Height of plane source (m)
1	Xinqiao Waste Residue Solidification/solidification Site	Ammonia	**0.12**	66	60	6
2		Nitrogen sulfide	0.01	66	60	6
3		Dust	1.256	40	30	6
4	Dewatering Site new Xinqiao Stabilization/solidification Site	Ammonia	0.08	70	60	6
5		Nitrogen sulfide	0.0058	70	60	6
6	Xiawangang Dewatering Site	Ammonia	0.1	78	70	6
7		Nitrogen sulfide	0.008	78	70	6
8	Landfill	TSP	11.835	225	150	6

7.2.2.3 Noise

The noise level of crusher, blender and vibrating screen used in Xinqiao Stabilization/solidification Site is about 88-93 dB(A), the noise level of excavator and dozer used in the landfill is about 80-90 dB(A), ad the noise level of transportation vehicle is about 65-85dB(A).

Table 7.2-3Noise source intensity

Equipment	Noise level dB(A)	Number	Location	Min.distance to the site boundary (m)	Treatment measure	Noise reduction effect (dB(A))
Crusher	88	2 sets	Xinqiao Stabilization/solidification Site	N, 20	Sound insulation and vibration damping	20
Blender	92	2 set		N, 20	Sound insulation and vibration damping	20
Vibrating screen	93	1 set		N, 20	Sound insulation and vibration damping	20

7.2.2.4 Solid wastes

There are 30 permanent staff in the project, and their daily life may produce a certain quantity of domestic wastes. Calculated by 1kg/d per capita, the total quantity of domestic wastes will be 30kg/d.

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7.3 Site restoration after contamination remediation and closure of the landfill

7.3.1 Site restoration after remediation

(1) Purpose of site restoration

In order to prevent the heavy metal in the soil in non-sensitive land from transferring to the sensitive land, site restoration will be carried out for the remedied area according to *Regulatory Detailed Planning for the Core Zone of Qingshui Lake Eco-city in Zhuzhou City*, and the regional development progress.

1.For the area to be developed after remediation, site restoration will be carried out according to the planned land properties;

2.For the area with lagging development after remediation, vegetation covering will be carried out to prevent water and soil loss;

(2) Design of site restoration

The area with lagging development after remediation is about 1682841m^2, and Bermuda grass and ryegrass will be planted for vegetation covers.

7.3.2 Periodical coverage of the landfill

According to the project situation, the landfill work shall be carried out in region-division and period-division. The amount of solid waste of this project shall be considered as phrase I. When all the contaminated soil (643,200 m^3) of this project is landfilled, interim cover work can start. It is designed to be covered by clay with an overburden of more than the 30cm, and a 2mm HDPE geomembrane shall be on top of it. Interim cover is able to discharge the water on its top outside of the landfill.

7.3.3 Closure of the landfill

After the landfill dissolves the project's sediments and soil, it will be used for landfilling the industrial solid waste of the site governance project: the landfilling period is from July 2018 to December 2026, and it has an effective volume of about 2 million m^3.

When landfill reaches its design capacity, the closure work can get started. Following the requirements of Standards for Pollution Control of Disposal Site and Storage of General Industrial Solid Waste (GB18599-2001), and combing the actual project situation:

(1) Before the closure, relevant closure plan shall be prepared, and this plan shall get the approval from the environmental protection administrative departments at or above the county level. Besides, pollution prevention measures shall be adopted.

(2) When in closure, its surface slope shall be 1:3. A rise in elevation of 5M will require corresponding step, and its width shall be a 1.5M cross slope (3%) and it shall be able to withstand heavy rains.

(3) After the closure, maintenance has to be continued until it is stabilized. This is to prevent soil subsidence and cracks which cause increasing of leachate, and to prevent landslides and other accidents caused by pile instability.

(4) After the closure, markers shall be installed, indicating the closing or sealing time and matters needing attention in the use of the land.

(5) To prevent solid waste from direct exposure and the rain into the waste body, when in closure, two layers of soil shall be used for the cover work. The first layer is a barrier layer covered with 45cm compacted clay. The second layer is a 20cm concrete surface which is

used to prevent rain from penetrating into the waste body; in its upper part the drainage measures shall be taken; meanwhile, the subsequent landfill work shall get started as soon as possible.

(6) After the closure, the monitoring system for landfill leachate and its processing emissions shall maintain normal operation until the water quality is stabilized. Meanwhile, the groundwater monitoring system shall maintain its normal operation.

(7) The elevation of closure after landfilling is 56m~58m.

8 Analysis of Alternatives

8.1 Zero solution analysis

See **Table 8.1-1** for analysis of “with project” and “without project” alternatives .

Table 8.1-1List of "with project" and "without project" analysis

Category	Implement this project program	Without this project program
Main advantages	(1) Qingshuitang Industrial Zone in which the project is located is a national key remediation area specified in Xiang River Basin Heavy-Metal Contamination Remediation Implementation Program approved by the State Council; (2) Eliminate pollution sources, solve regional environmental issues, improve environment quality, benefit the people with science and technology, build ecological livable city and realize sustainable development; (3) Improve regional investment environment in combination with the overall urban planning; (4) Facilitate regional economic development and boost economic structure adjustment; (5) Develop and utilize advantageous resources and expand urban development space; (6) Excavate historical and cultural resources and extend the historical context of Zhuzhou City; (7) Building technological demonstration works and promote environmental industrial development.	(1) Don't change land utilization value (don't occupy farmland or wood land) (2) Maintain the current situation, and don't cause vegetation damage, soil erosion and other ecological environmental problem; (3) Don't cause environmental pollution like flowing dust, noise and waste residues.
Main shortages	(1) Occupy land and change status of land utilization. Permanent land occupation is irreversible impact and temporary land occupation is reversible impact. (2) Vegetation is damaged, causing soil erosion. (3) Three wastes during construction cause environmental pollution; (4) During contamination remediation, flowing dust, wastewater, traffic noise, vehicle exhaust and solid wastes cause certain impact on environment.	(1) Residential area and industrial area are mixed, and living environment is bad. (2) Industrial air pollution will continuously affect adversely the people's health. (3) Heavy contaminants in soil exceed standards, and prohibition of planting and breeding cannot be implemented effectively. Agricultural and sideline products containing excessive heavy metal continuously flow into the market, and the safety of food cannot be guaranteed. (4) Threaten the safety of drinking water at the downstream of Xiang River. (5) Obstruct the follow-up planning and development of Qingshuitang Region and the construction of harmonious society.
Comprehensive analysis	The implementation of the project mainly cause land occupation and environmental pollution during construction and during remediation; Pollution problems of three wastes during construction and during operation may be solved with reasonable environmental protection measures to minimize the environmental impacts. Conclusion: The implementation of the project brings more positive benefits than environmental impacts. In the long run, it is suggested to implement the project.	

8.2 Comparative selection of site location alternatives

8.2.1 Comparative selection of alternative site locations of environmental demonstration site

According to the construction background and the main construction contents of the environmental demonstration center, two alternative site locations are selected for comparative selection.

The first site location is Xinqiao slag site at the junction between Qingshui Region and Tongxia Region. At present, Xinqiao slag site has been finished remediation.

Figure8.2-1Site location 1 of environmental demonstration center

The second site location is near the stone pit in Hehua Cement Plant, and will be construction in combination with the solid waste landfill.

Figure8.2-2 Site location 1 of environmental demonstration center

According to the site investigation of two locations, comparative selection is made in terms of traffic conditions, water and electricity conditions, and distance to the core remediation area. See **Table 8.2-1** for comparison.

Table 8.2-1 Comparison of alternative site locations for environmental demonstration center

No.	Item compared	Site I (recommended)	Site II
1	Location	Xinqiao Landfill in Tongxia and Qingshui Sub-region	Hehua Cement Plant in Yingfeng Sub-region
2	Land occupation and demolition	No land requisition or structure demolition is required	Land requisition and structure demolition are required
3	Traffic conditions	Close to the newly built Tongxia Road which is double-way 6-lane road with a width of 42m, convenient for vehicles	Traffic is convenient; connected to country road that stretches to Tongxia Road
4	Water and power supply	Waste residue treatment is being carried out there at present and water and power supply facilities have been provided	Water and power supply facilities of the former Hehua Cement Plant are available for use
5	Distance from the core remediation area	Located near the core remediation area and close to the treatment plant; easy for installation of on-line monitoring equipment and favorable for carrying out environmental monitoring of the project	Located in the north most of the project area and far from the core remediation area, unfavorable for environmental monitoring and the like
6	Difficulty level of management	Favorable for environmental monitoring and work management	Located faraway and unfavorable for management
7	Demands on equipment procurement	Large stabilization/solidification equipment has been installed, which can be taken as important components for the environmental protection museum after service; procurement of only office, test and service equipment will be required	Removal, transport and re-installation of ex-situ stabilization/solidification equipment will be required, procurement of office, test and service equipment will also be required

No.	Item compared	Site I (recommended)	Site II
8	Investment cost	This site has advantages in traffic, distance and management; procurement and transport of large equipment are reduced; no land requisition or structure demolition is required; all in all, project cost is reduced	This site is far away from the project location and cost for construction, maintenance, and transport will be high
	Construction	Construction area of Environmental Protection Center: 7,970 m^2, including 820 m^2 of EPC Building and 7,150 m^2 of Environmental Protection Museum	Construction area of Environmental Protection Center: 7,970 m^2, including 820 m^2 of EPC Building and 7,150 m^2 of Environmental Protection Museum
9	Opinion from comprehensive analysis	Site I is located in the core remediation area, which, if selected, will require no land requisition and structure demolition; it is close to the treatment plant and will be favorable for subsequent environmental monitoring. Therefore site I is recommended.	

According to the comparison between site locations, the environmental demonstration center will be built in Xinqiao slag site at the junction between Qingshui Region and Tongxia Region. The remediation of Xinqiao slag site has been finished, the site will meet the requirements for environmental demonstration center construction land, laboratory land, greening land and environmental purification, and development land will be reserved. The site is close to Tongxia Road to the north, and the west boundary is Old Xiawangang, with convenient traffic and conditions for water sources, energy and information exchange and collaboration.

8.2.2 Comparative selection of alternative site locations of the landfill

8.2.2.1 Comparative selection of site locate alternatives

According to the principle of selecting site location and the field investigation, an obsolete stone pit in the project area may be selected as the location. Meanwhile, according to *Regulatory Detailed Planning for the Core Zone of Qingshui Lake Eco-city in Zhuzhou City*, the southwest corner in Qingshui Region will be planned to greenland and can also be used as the site of the landfill of ground man-made pallet.

(1) Alternative 1: obsolete stone pit

The obsolete stone pit is located in Zhuzhou Hehua Cement Plant, about 500m away from Zhuzhou Chemical Group to the north. The site is hilly valley land. The length of the pit is about 225m, width 150m and maximum quarrying depth about 60m. The floor area is about 57.39m (about 38265m^2) and the effective capacity is about 2000 thousand m^3.

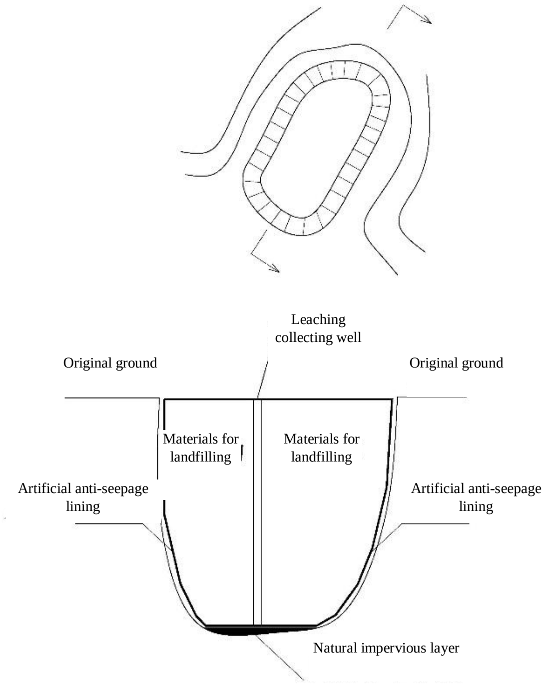


Figure8.2-3Diagram for pit landfill

The advantages of this location include:

a) The land of the stone pit is planned as industrial land. According to the planning, backfilling shall be made, and backfilling of soil after solidification is consistent with the national guideline for integrated environmental remediation and integrated resource utilization;

b) The capacity is large and the effective capacity reaches 2000 thousand cubic meters;

c) Traffic condition is good, and access roads are available. It is only needed to repair the existing roads;

d) It is far away from Xiang River.

e) The geological conditions are good.

The disadvantages include:

a) The capacity of the stone pit is large, and for this period, 45.8 thousand m³ of construction wastes and 584.7 thousand m³ of contaminated soil, sediment and waste residues may be landfilled. Compared with the total capacity of 2000 thousand m³, the quantity is smaller.

b) The maximum depth of the stone pit is 60m, and it is boring to transport contaminated soil from the top of the pit to the bottom;

c) If backfill cannot reach the ground elevation at once, the amount of gathered rainwater will be large and the leaching drainage management is complicated with high power consumption.

d) At present, there is a great amount of ponding water in the pit. If the testing results exceed the standard, carry out treatment before discharging the water.

(2) Alternative 2: Landfill of greendland man-made pallet

According to *Regulatory Detailed Planning for the Core Zone of Qingshui Lake Eco-city in Zhuzhou City*, the southwest corner of Qingshui Region is planned as Greenland, and the area is 140 thousand square meters and the difference between the planned elevation and the current elevation is +4.0~8.0m, completely suitable for overground landfill.

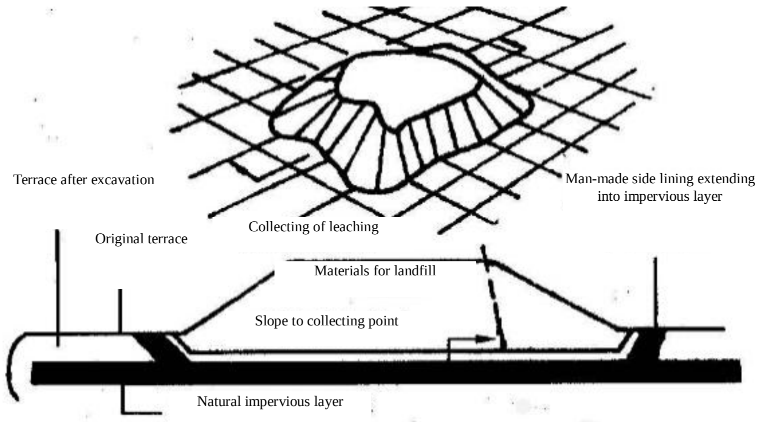


Figure8.2-4 Diagram for landfill of man-made pallet

The advantages of this location include:

a) It is convenient for landfilling, and the construction difficulty is small;

b) Landfilling can be carried out at the same as closure work, to minimize the leaching during construction. After closure of the site, it is not required to collect and treat leaching.

c) Traffic conditions are good, suitable for large-area paving and landfilling;

d) Anti-seepage area is small;

f) Located above the groundwater level.

The disadvantages include:

a) Basic dam should be built;

b) Bottom soil mostly is contaminated soil, which shall be cleared prior to the construction of the landfill.

c) The bottom surface area is large, and the cost of foundation treatment is high;

d) Close to Xiang River.

f) Because the landfill depth is small and most of the area is of frequent human activities, the probability of anti-seepage film breaking is higher than Alternative 1, ad the breaking of anti-seepage film has great impact on surrounding environment.

(3) Comparative selection and conclusion

Carry out technical and economic comparison between two alternatives (see **Table 8.2-2**). According to the geological conditions of alternative site locations and in accordance with the principle of the progressive ecological restoration of the landfill consistent with the urban planning and the development plan of surrounding factories, the comparative selection is carried out as below:

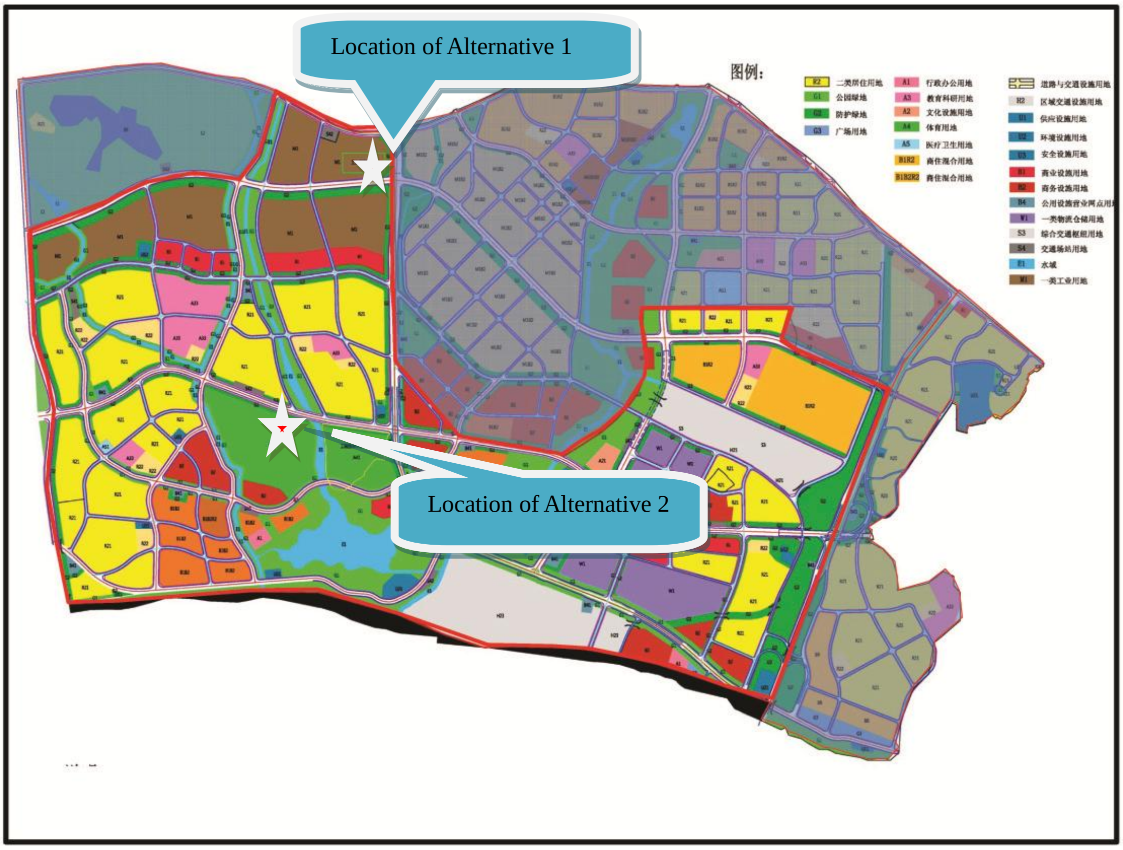


Figure8.2-5 Location map for landfill alternatives

Table 8.2-2 Comparison of site location alternatives of the landfill

No.	Item	Alternative 1 (Hehua Cement Plant)	Alternative 2 (Xiawan Building Materials Plant)
1	Landfill type	Underground, large landfill difficulty	Overground, small landfill difficulty
2	Geological condition	Bottom plate and side slope are of limestone, and no foundation treatment is required.	Bottom plate is sandy soil, and foundation treatment is required.
3	Surrounding situation	Planned as industrial land, small impact on surrounding environment	Planned as Greenland, high probability of contacting human
4	Capacity	Large capacity, 2000 thousand m^3, larger than the amount of contaminated soil	The most suitable capacity can be calculated as per the amount of contaminated soil
5	Economic cost	No dam is required, but anti-seepage treatment on walls is needed.	Dams shall be built
6	Planned land usage	Industrial land	Greenland
7	Distance to river	Far away from Xiang River (quantitative distance)	Close to Xiang River
8	Follow-up management	Have leaching treatment facilities	No leaching treatment facilities
9	Land property right	CNSG Zhuzhou Chemical Group and Hehua Cement Plant	Qingxia Community

Because the obsolete stone pit is within the project scope and is planned as industrial land, backfilling shall be carried out otherwise it will occupy a large area of construction land and have severe potential risks. In this project, contaminated soil after stabilization is used for backfilling, which realizes resource utilization and follows national safety policies. Besides, deep landfill only has small impact on surrounding environment. The construction wastes produced during site remediation may be filled on the bottom of the pit after being washed and crushed, realizing municipal utilization. Therefore, Alternative 1 is preferred solution.

8.2.2.2 Feasibility analysis of site location

According to the project design, this landfill is Class-II general industrial solid wastes landfill, and the site location shall meet the requirements of *Standard for Pollution Control on the Storage and Disposal for General Industrial Solid Wastes* (GB18599－2001) and the Bulletin 2013 N0. 6 published by the Ministry of Environmental Protection *Bulletin on Publishing the Modification List of National Control Standards for Three Contaminants in Standard for Pollution Control on the Storage and Disposal for General Industrial Solid Wastes (GB18599－2001)*. See **Table 8.2-3** for feasibility analysis of site location of the landfill.

Table 8.2-3Analysis of conformity of landfill site location to environmental protection requirements

Location requirement	Situation of the project	Conclusion
The location shall meet the requirement of overall local urban and rural construction planning.	The landfill is located in Shifeng District in Zhuzhou City, outside of the scope of urban planning of Zhuzhou City.	Meet the requirements of overall urban and rural construction planning
Determine the position of the site and the distance to the surrounding residential area according to the conclusions of environmental impact assessment, and report to the administrative department for approval, and use it as the reference of planning control	According to calculation, the hygienic protection distance is 50m, and within this distance there are four households, for which the land is planned as industrial land and office land, so the households have to be relocated. Before relocation, it is required to strictly control vehicle transportation during construction and operation, and flowing dust shall be restricted by water spraying and regular and quantitative watering. Transportation vehicles may not be overloaded, and leakage shall be avoided through covering the vehicle with tarpaulin. Strengthen highway management and repair damaged road section in time.	Meet the requirements after taking measures
Select the foundation meeting the requirements of bearing capacity, and avoid foundation settlement, especially uneven and local settlement.	The geology of the landfill area contains dark grey dolomite limestone, lime-bearing dolomite, dolomite, limestone, and sandy limestone with argillaceous limestone. Some part of the area contains chert nodule with thickness of about 135.1m. Considering the geological survey date in the surrounding areas, weak or medium karst development may exists in the area. According to the document HH[2010] No. 358 *Reply to Issues on Standard for Pollution Control on the Landfill Site of Municipal Solid Waste*, if it is impossible to avoid karst cave development zone of soluble rock such as limestone, site with stable geological conditions shall be selected through geological survey and effective engineering measures shall be adopted to further enhance the stability of the site.	Detailed geological exploration needs to be conducted for site selection at the landfill. If karst cave development zone of soluble rock such as limestone exists, site with stable geological conditions shall be selected through geological survey and effective engineering measures shall be adopted to further enhance the stability of the site. Only by doing this can the site selected meet the requirements
Avoid fault, fault fracture zone, karst cavern zone and zones affected by natural landslide or debris flow	The tectonic unit in which the landfill is located is the middle of Zhuzhou tectonic basin, and the major fault is Qingshuitang fault (F151). According to the Figure8.2-6, the location is not on Qingshuitang fault (F151).	Meet the requirements
It is forbidden to select beach land and flooded area below the highest water level of rivers, lakes and reservoirs.	The location is not in beach land or flooded area below the highest water level of rivers, lakes and reservoirs.	Meet the requirements
It is forbidden to select natural reserve area, scenic spots and other areas requiring special protection.	The location is not in natural reserve area, scenic spot or other area requiring special protection.	Meet the requirements
It is preferred to select obsolete mining pit and subsidence area.	The location is the obsolete stone pit of Hehua Cement Plant.	Meet the requirements
Avoid major groundwater recharge area and water bearing stratum of drinking water source	In the project area, there is no groundwater emerging, and it is not in major groundwater recharge area or water bearing stratum of drinking water source	Meet the requirements
Select foundation with good seepage-proofing performance. The distance betwee the surface of natural foundation layer and the groundwater level may not be less than 1.5m.	The buried depth of groundwater is 1~8m, and the maximum quarrying depth is about 60m. the landform conditions are complicated, with steep side slope and bare rocks. In order to ensure the safety and long-term stability of the project, double-layer anti-seepage structure shall be taken at the bottom, and net-hanging shotcrete anchorage handling shall be carried out for the base course of the side slope.	Basically meet the requirements after taking anti-seepage measures.

According to the abovementioned analysis, prior to the relocation of four households within the hygienic protection distance of 50m, vehicle transportation and flowing dust during construction and operation shall be strictly controlled to reduce the impact on residents; double-layer anti-seepage structure shall be taken at the bottom, and net-hanging shotcrete anchorage handling shall be carried out for the base course of the side slope. If karst cave development zone of soluble rock such as limestone is found in the area, site with stable geological conditions shall be selected through geological survey, and effective engineering measures such as high-pressure grouting shall be adopted for ground treatment. After the foresaid measured are implemented, the site location will meet the requirements of *Standard for Pollution Control on the Storage and Disposal for General Industrial Solid Wastes* (GB18599－2001) and the Bulletin 2013 N0. 6 published by the Ministry of Environmental Protection *Bulletin on Publishing the Modification List of National Control Standards for Three Contaminants in Standard for Pollution Control on the Storage and Disposal for General Industrial Solid Wastes (GB18599－2001)*. Therefore, in the view of environmental protection, the site location of the landfill is basically feasible.

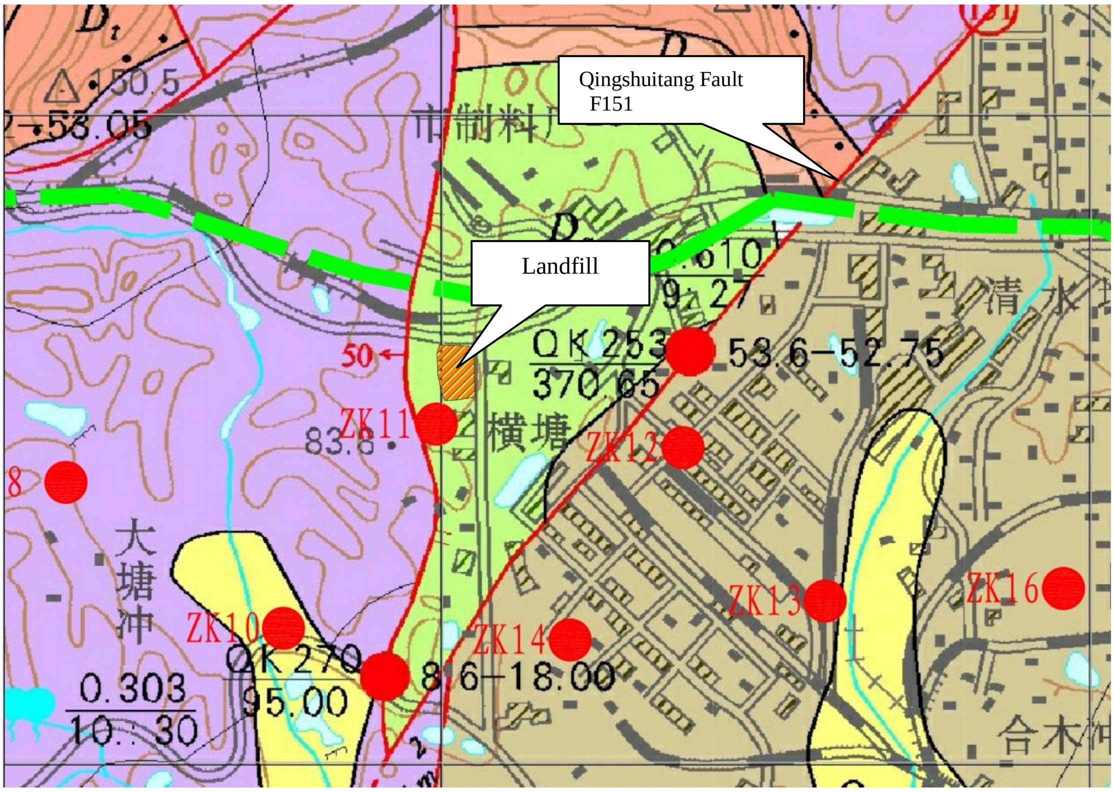


Figure8.2-6 Overlay map for landfill site location and Qingshuitang fault (F151)

8.3 Comparative selection of remediation technologies

8.3.1 Reference of comparative selection

Because the contamination area in the project scope is large with complicated composition of contaminants and the site is close to Xiang River, scientific and systematic assessment shall be implemented for comparative selection of remediation technologies. Feasibility assessment and selection of remediation technologies shall be carried out according to the results of field contamination investigation of Qingshuitang Area and in combination with remediation technologies applicable to key contaminants. The procedures of comparative selection of site remediation technologies are described as below:

(1) Objective of remediation technology selection

For determining the objective of remediation technology selection for Zhuzhou Qingshuitang contaminated site, it shall refer to the framework of USEPA in super fund plan besides referring to relevant Chinese and foreign specifications.

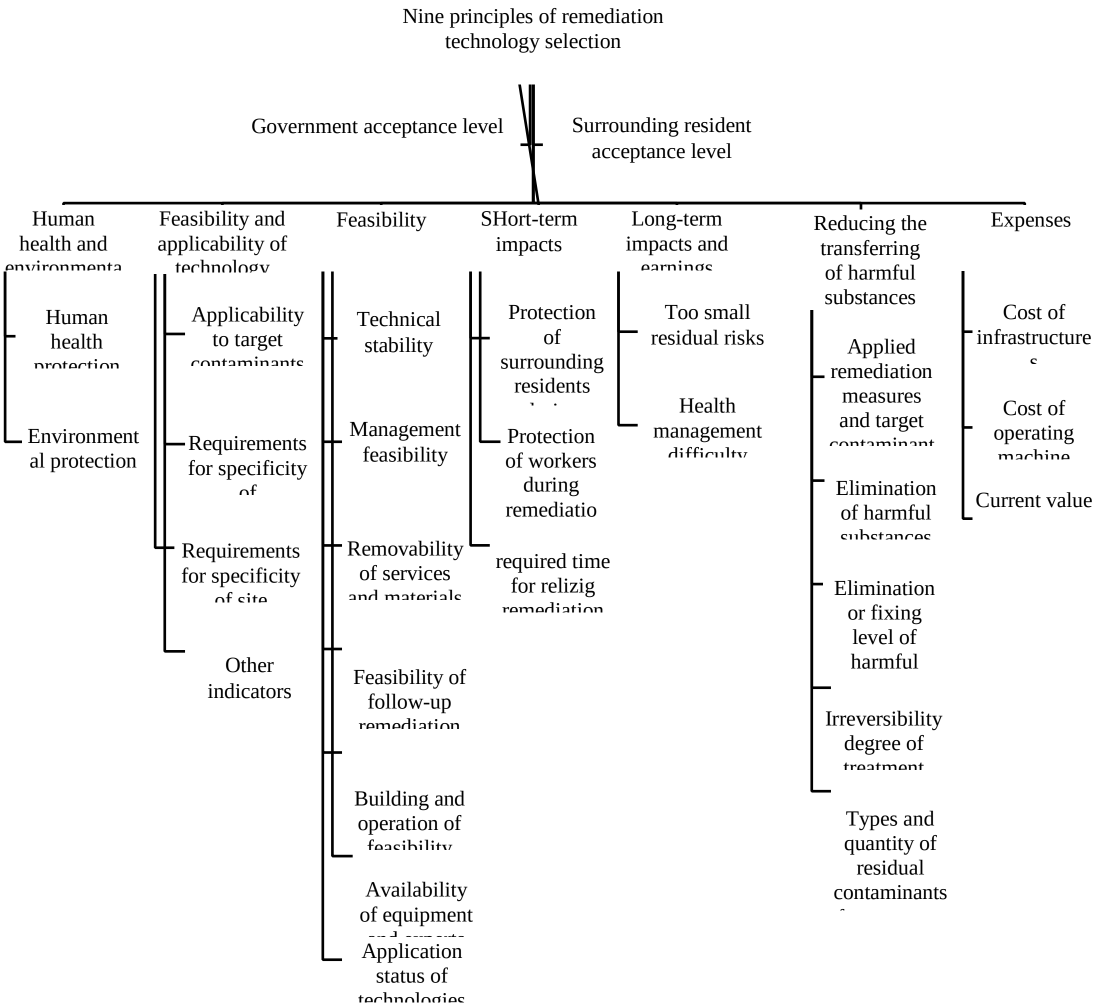


Figure8.3-1 Nine principles for site remediation technology selection in USEPA in Super Fund Plan

In order to realize the objective, the selected remediation programs shall meet the following requirements:

- Site risks are acceptable, and it is only needed to restore until the site reutilization risk can accept the corresponding contaminant concentration;
- In the premise of actual feasibility, first solve the major threats caused by the site;
- Remediation technology is easy to operate and control, and the probability of accident during remediation is low;
- Impact on surrounding environment is small;
- When innovative technology is available to provide equivalent or between treatment efficiency and cause lower adverse impact or lower construction cost, such technology shall be adopted, especially green sustainable technology;
- Project scale and investment are reasonable;
- Minimize remediation time without wasting investment.

In conclusion, the consideration indicator system for site contamination remediation technology selection for Qigshuitang is described as below:

Table 8.3-1 List of consideration indicators of remediation technologies

Technical indicator		Definition of indicator
Technical indicator	Technical operability	Compatibility between site condition to which remediation technology is applicable and the actual site situation
	Remediation time	The time required for remediation
	Technical maturity	Number of cases in which site remediation is successfully completed.
Social and environmental indicator	Secondary pollution	Spreading of contaminants during remediation, and impact on surrounding sensitive receptors
	Acceptability	Acceptability of surrounding residents to disturbance caused during remediation and government's attitude to technical implementation
Economic indicator	Expenses	Total expenses required for implementation of remediation technology
	Resource demand	Energy and materials consumption during remediation

1.Site operability: consider three natural interference conditions during implementation: soil physical properties (permeability coefficient, water content and particle size distribution), contamination medium properties (whether or not in saturation region, contamination depth etc.), and soil chemical properties.

2.Technical maturity: The number of sites in which remediation technology is applied in contaminated site remediation in USEPA Super Fund Plan is taken as the reference.

3.Total expenses: The information about expenses for remediation technology is mainly from related conclusions and literatures for remediation technology information.

4.See the table below for remediation time, resource demand, acceptability and secondary pollution.

Table 8.3-2Assessment on remediation time, resource demand, etc.

	1	2	3	4	5
Remediation time	＞5 years	2-5 years	1-2 years	6-12 months	3-6 months
Resource demand	Biological treatment	Utilization of local resources	Physical and chemical treatment	Ex-situ treatment	Heat treatment
Acceptability	High	Relatively high	Medium	Relatively low	Low
Secondary pollution	Low	Relatively low	Medium	Relatively high	High

(2) Primary screening of remediation technologies

Firstly, according to the characteristics of the site and the contaminants, possible remediation technologies are put forward. Because each technology has its own advantages and disadvantages, and single technology usually cannot reach the expected effect, it will be better to adopt the combination of two kinds of technologies or multiple kinds. Referring to the mode adopted in the remediation technology feasibility survey in USEPA Super Fund Plan, the applicable combination of remediation technologies will be screened out gradually from remediation strategy.

In general, contaminants are divided into eight types: non-haloid volatile organic compound, haloid volatile organic compound, non-haloid semi-volatile organic compound, haloid semi-volatile organic compound, fuel substance, inorganic substance, radioactive substance and explosive substance.

Table 8.3-3List of contamination remediation technologies

No.	Type of contaminant	Common remediation technology
1	non-haloid volatile organic compound	Soil vapor extraction, thermal desorption, incineration and bioaeration
2	haloid volatile organic compound	Soil vapor extraction, thermal desorption, incineration and bioaeration
3	Non-haloid semi-volatile organic compound.	Biodegradation, incineration and excavation& ex-situ landfill
4	Haloid semi-volatile organic compound	Biodegradation, dehalogenation, incineration and excavation & ex-situ landfill
5	Fuel substance	Biodegradation, soil vapor extraction, incineration and low-temperature thermal desorption
6	Inorganic substance	Stabilization/solidification, excavation& ex-situ landfill, elution and vegetation covers

7	Radioactive substance	Separation, concentration and stabilization
8	Explosive substance	Biological treatment: biological reaction, composting, vegetation covers, and in-situ biological remediation; Heat treatment: incineration, open-type burning, and rotary incineration Others: solvent extraction, and Elution

According to the contamination investigation in Qingshuitang Area and the risk assessment, part of the remediation site is contaminated by Pb, Cd and Se and the area in Tiancheng Chemicals is contaminated by benzopyrene. According to the above table, the possible applicable technologies after primary screening include stabilization/solidification, excavation & ex-situ landfill, vegetation covers, Elution, biodegradation, incineration and excavation & ex-situ landfill.

(3) Feasibility of remediation technology combination

After screening individual remediation technologies for Qingshuitang Area and according to the assessment based on the abovementioned criterions and consideration indicators, it is suggested to adopt the combination of multiple technologies or carry out remediation by stage. Screen in-situ and ex-situ remediation technologies and carry out evaluation zone rating for possible remediation technologies according to the properties of different contaminants. The main evaluation indicators include operability indicator, technical indicator and environment. Therefore, as for how to combine remediation technology, the following factors shall be taken into consideration:

1) Stability of mutual combination of remediation technologies;

2) Complementarity of various remediation technologies, for dealing with different contaminants;

3) Whether it is easier to operate and maintain when remediation technologies are combined;

4) Whether it is easier to reach the remediation objective when remediation technologies are combined;

5) Whether cost and time will be saved when remediation technologies are combined;

8.3.2 Comparative selection of remediation technologies for heavy-metal contaminated soil

8.3.2.1 Remediation technologies for heavy-metal contaminated sites

Because the typical contaminants of contaminated soil, waste residues and pond and channel sediment are the same, technical comparative selection will be carried out in a unified way.

Technologies for primary selection include:

- Solidification/stabilization
- Excavation & ex-situ landfill
- Vegetation covers
- Elution

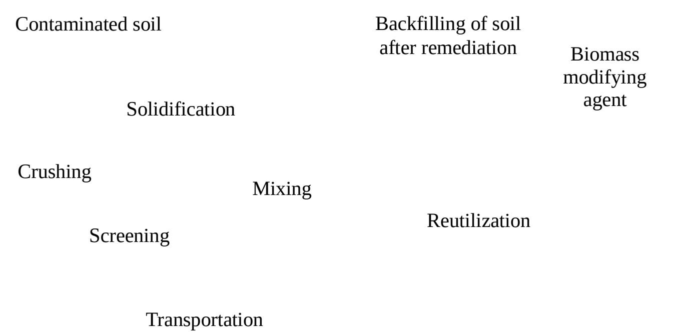
(1) Solidification/stabilization

The method of solidification/stabilization is to add modifying agent into soil to reduce the bio-availability of heavy metal through heavy metal adsorption, oxidoreduction and antagonistic action and sedimentation. The key of this technology is to select an economical and efficient modifying agent. Common modifying agents include lime, zeolite, calcium carbonate, phosphate, silicate and organic substances which accelerate reducing action, and different modifying agents have different action mechanisms for heavy metal.

The purpose of adopting lime or calcium carbonate mainly is to increase pH of soil and promote Cd, Cu, Hg, Zn and other elements in soil to form hydroxide or salt deposition of carbonate combined state. When pH of soil ＞6.5, Hg can form hydroxide or carbonate deposition.

There are many technical studies and reports about applying phosphate and silicate to solidify the heavy metal in soil, and it is generally acknowledged that such substances may make the heavy metal in soil to form insoluble deposition.

Solidification/stabilization may be carried out in situ or ex situ after excavation. It only changes the existing forms of heavy metal in soil, but metal elements are still reserved in the contaminated soil.



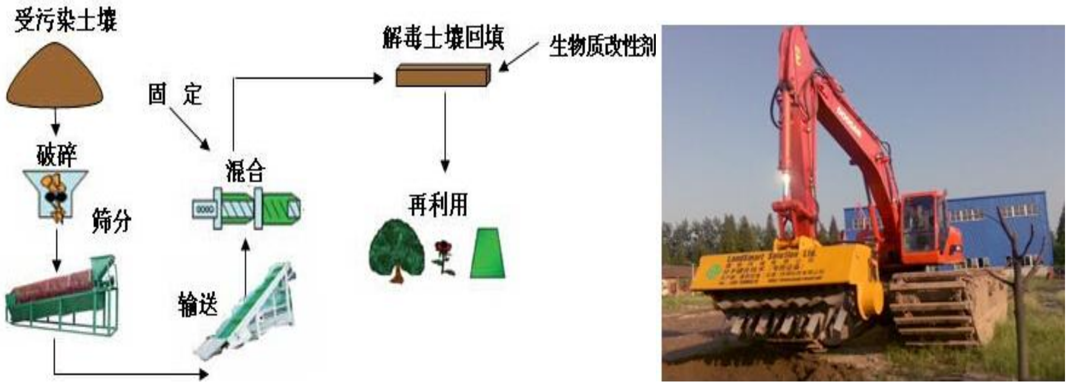


Figure8.3-2 Ex-situ and in-situ stabilization

(2) Excavation & ex-situ landfill

For contaminated soil with high amount of heavy metal and low leaching toxicity, the common remediation technology is excavation and ex-situ exchange backfilling or landfill. Remove heave-metal contaminated soil through excavation, and cut off the path of heave metal transferring into ecological environment through ex-situ landfill or through exchange backfilling will smaller area of exposure path. Reduce the amount of heavy metal transferring into the ecological system and further maintain the health risk caused by heavy metal within a controllable range. In this regard, Japan and many other countries have obtained successful experiences.

Excavation and ex-situ landfill or exchange backfilling is carried out ex situ, and it is easy to operate with low cost. Similarly, metal elements will be reserved in the contaminated soil.

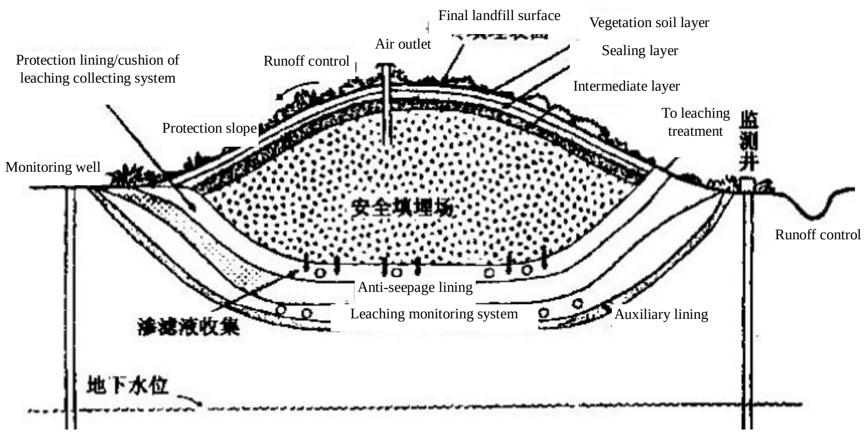


Figure8.3-3Ex-situ landfill

(3) Elution of soil

The mechanism of soil holding metal may be divided into two types: the first is that metal is adsorbed to the surface of soil component in ionic state, and the second is metal forms deposition of metallic compound. Elution of soil is a remediation method to use leacheate to transfer the heavy metal in soil solid phase into soil liquid phase, and then to reutilize the wastewater containing heavy metal. The technical key point of this method is to seek a kind of leacheate which can extract various states of heavy metal and will not damage soil structure. At present, there are a variety of leacheate for Elution of soil, including organic or inorganic acid, alkali, salt and chelating agent. Foreign experts have carried out testing on the effect of citric acid, malic acid, acetic acid, EDTA and DTPA on Indian leaf mustard absorbing Cd and Pb. Chinese studies have also found that ETA can significantly reduce the absorption of Cu by soil and the absorption rate and the desorption rate are obviously in negative correlation to the logarithm of the quantity of EDTA. Column elution or accumulation elution is more practical and economic, and it plays a certain role in promoting the commercialization of remediation technology. The soil elution technology still has to be improved, and the key is how to increase elution efficiency and reduce the cost.

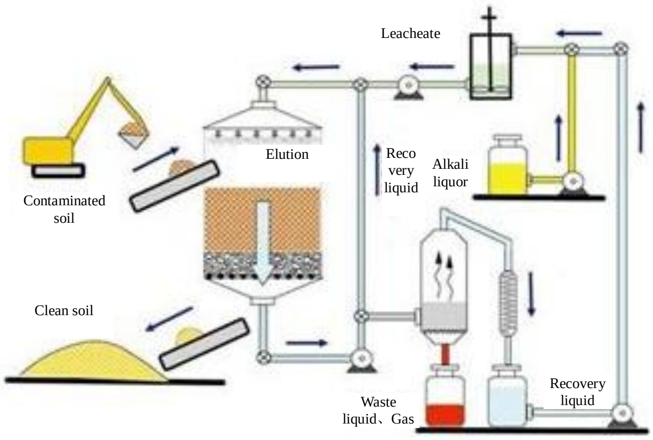


Figure8.3-4 Diagram for elution process

(4) Ecological restoration

Ecological restoration is a method of remedy contaminated soil with biotechnology. Use organisms to reduce and eliminate heavy metal in soil and reduce the toxicity of heavy metal. Because this method is of high efficiency, low cost and easy operation, and it can further restore the vegetation and ecological systems in the contaminated area, it has been paid more and more attention and become the hot point of contaminated soil remediation study.

Ecological restoration is a kind of technology using natural growing or genetic-bred plants to restore heavy-metal contaminated soil. According to its action process and mechanism, ecological restoration may be divided into three types: phytoextraction, phytovolatilization and phytostabilization.

1) Phytoextraction

Use heavy-metal hyperaccumulators to absorb metal contaminants from soil and then reap the overground parts for centralized treatment. Continuously grow such plants to reduce or eliminate heavy metal contamination in soil. At present, more than 700 species of hyperaccumulators have been found, and the accumulation amount of Cr, Co, Ni, Cu and Pb generally is more than 0.1%, and the accumulation amount of Mn and Zn may exceed 1%. Thlaspi calaminare is a species of hyperaccumulator of Zn and Cd which has been identified. Baker and NcGrath studies found that the content of Zn in the overground part of thlaspi carulescens reaches 16 times of that in soil when soil contains Zn by 444mg/kg. Some species of Salix can accumulate a large amount of Cd; the accumulation of Cd, Ni, Zn and Cu in Indian leaf mustard may reaches 58, 52, 31 and 17 times, respectively; mustard grass has strong accumulation capacity of Se, Pb, Cr, Cd, Ni, Zn and Cu; according to international reports, high-biomass Ni hyperaccumulator can extract 168kg of Ni per hectare; hyperaccumulators of alpine galerucine genere may extract high concentration of Cu, Co, Mn, Pb, Se, Cd and Zn. Chinese experts have also made a great number of research on phytoextraction. For example, a group of As hyperaccumulators have been in southern China; some experts use ten species of hyperaccumulators for remediation research on Cd contaminated soil; and some research showed that Indian leaf mustard have good remediation effect on soil contaminated by Cu, Zn and Pb.

2) Phytovolatilization

The mechanism is using plant roots to absorb metal and translate it into gaeous substances which will volatilize into air to reduce soil contamination. At present, the research is mostly focused on Hg and Se. Some plants in wetland may eliminate Se in soil, among which, elementary substance accounts for 75% and substance in volatile state for 20-25%. Volatile Se is mainly reduced into volatile $Se(CH_3)_2$ and $Se_2(CH_3)_2$ through the action of ATP sulfurylase in plants; foreign experts have ever introduced Hg reductase gene in bacterium-like body into mustard plants and obtained anti-Hg transgenic plant, which can absorb Hg from soil and reduce it into volatile elementary substance Hg.

3) Phytostabilization

Use anti-heavy-metal plants or hyperaccumulators to reduce the activity of heavy metal ad further reduce the probability of heavy metal transferring into groundwater through elution or spreading into air. The mechanism mainly is strengthening the solidification of heavy metal in sol through metal accumulation and deposition in roots or root surface absorption. For example, the exudates of plant roots can change riphzosphere environment in soil, change the valence states and the forms of Cr, Hg and As in multiple valence states and further affect their toxic effect. Root hair of plant can directly exchange and adsorb heavy metal from soil to enhance the solidification on root surface.

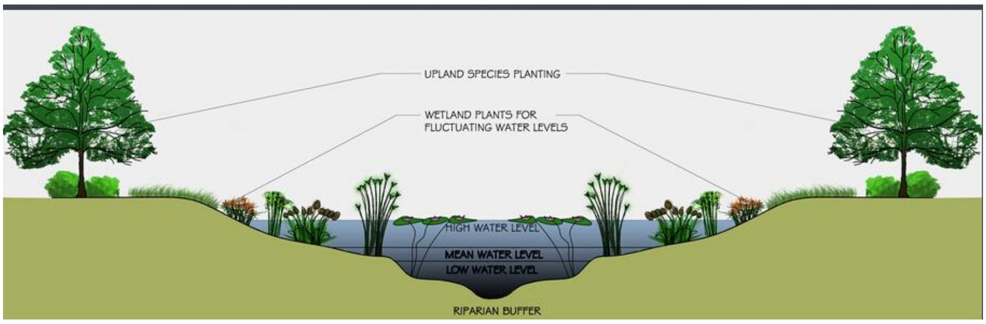


Figure8.3-5 Diagram for ecological restoration

8.3.2.2 Comparative selection of technical programs

Heavy-metal contamination remediation is a systematic project. Various restriction factors such as technical feasibility, remediation cycle, planned land usage and treatment economical efficiency shall be taken into consideration for comparative selection of technical programs. Therefore, prior to designing the heavy-metal contamination remediation program, basic treatment processes shall be screened according to the foresaid restriction factors, and the alternatives shall be defined in combination with specific pollution situation, technical feasibility and implementation difficulty. See **Table 8.3-4** for comparative selection of technical programs.

Table 8.3-4 Comparison of heavy-metal contamination remediation technologies

Remediation technology	Technical indicator							Economic indicator		Social and environmental indicator	
	Site operability					Technical maturity	Remediation time	Resource demand	Cost	Acceptability	Secondary pollution
	Applicability to pollution	Soil property	Water content	Permeability coefficient	pH/organic matter						
Stabilization / solidification	Leaching exceeding standard	---	50%	--	Acidity / low	High	Relatively long	3	100-350	High	Relatively low
Elution	---	Loam/sandy soil	--	High	Acidity /low	Low	Relatively long	2	300-600	Low	Low
Excavation and ex-situ landfill or exchange backfilling	Slight pollution	--	--	--	--	Medium	Short	4	80-150	Medium	Relatively high
Ecological restoration	Slight pollution, recovery after remediation	---	--	High	6-8/high	High	Long	5	60-100	Relatively high	Low

Because land usage of each zone is different, it has different requirements for remediation time and environment after remediation; meanwhile, probability of contacting human body and capacity of self-restoration is also related to the degree of remediation.

Table 8.3-5Requirements on remediation technologies of different kinds of land

<table>
<tr><th>Land</th><th>Land usage</th><th>Remediation time</th><th>Environmental requirements</th><th>Probability of contacting human body</th><th>Self-restoration capacity</th></tr>
<tr><td rowspan="3">Sensitive land</td><td>Residential and educational land</td><td>Short</td><td>High</td><td>High</td><td>Weak</td></tr>
<tr><td>Park and Greenland</td><td>Long</td><td>High</td><td>High</td><td>Strong</td></tr>
<tr><td>Riverway and water area</td><td>Short</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td rowspan="2">Non-sensitive land</td><td>Industrial and commercial</td><td>Short</td><td>Medium</td><td>Low</td><td>Weak</td></tr>
<tr><td>Road and public facilities</td><td>Short</td><td>Medium</td><td>Low</td><td>Weak</td></tr>
<tr><td>Current land</td><td>Current rivers and ponds</td><td>Short</td><td>Medium</td><td>Low</td><td>Weak</td></tr>
</table>

In conclusion, ex-situ solidification and stabilization technology will be used for waste residues in heavy-metal contaminated site. See Table 8.3-6 for remediation technologies for soil and pond and river sediment.

Table 8.3-6Remediation technologies for different kinds of land

<table>
<tr><th>Land</th><th>Land usage</th><th>Pollution extent</th><th>Applicable technology</th></tr>
<tr><td rowspan="6">Sensitive land</td><td rowspan="2">Residential and educational land</td><td>Low</td><td>Ex-situ landfill</td></tr>
<tr><td>high</td><td>Ex-situ solidification/ stabilization + safe landfill</td></tr>
<tr><td rowspan="2">Park and Greenland</td><td>Low</td><td>Ecological covers</td></tr>
<tr><td>high</td><td>In-situ stabilization + ecological covers</td></tr>
<tr><td rowspan="2">Riverway and water area</td><td>Low</td><td>Ex-situ landfill</td></tr>
<tr><td>high</td><td>Ex-situ stabilization / solidification + safe landfill</td></tr>
<tr><td rowspan="2">Non-sensitive land</td><td rowspan="2">Industrial and commercial, road and public facilities</td><td>Low</td><td>In-situ stabilization +in-situ capping</td></tr>
<tr><td>high</td><td>Ex-situ solidification/ stabilization + safe landfill</td></tr>
<tr><td>Current land</td><td>Current rivers and ponds</td><td>high</td><td>Ex-situ stabilization / solidification + safe landfill</td></tr>
</table>

8.3.3 Comparative selection for organic contaminated soil remediation technologies

8.3.3.1 Organic contamination remediation technologies

The organic contaminated site is distributed in the plant area of original Zhuzhou Tiancheng Chemical Industry Plant, and the typical contaminant is benzopyrene, which is non-haloid semi-volatile organic compound. According to the list of contamination remediation methods, the technologies for primary selection include:

- Bioodegradation
- Excavation and ex-situ landfill
- Incineration

(1) Biodegradation

Microorganism takes organic contaminants as the unique carbon source and energy source or carries out co-metabolism with other organic substances and further degrades organic contaminants. Microbial remediation technology developed with micro-biological degradation is a kind of common remediation technology for farmland soil contamination. Such biological remediation technology has been widely used for soil contaminated by pesticides or petroleum. In China, high-efficiency pesticide degrading bacteria screening technology, microbial remediation agent preparation technology and pesticide residue micro-biological degradation technology for farmland application have been developed; a large amount of PHC degrading bacteria has been screened out, a variety of microbial remediation fungcides compounded, bioremediation prepared bed and bioslurry reactor developed, and bioremediation patters put forward. Such technology is mainly applicable to the treatment of PAHs, non-halogen SVOCs and benzene series, and is also applicable to the treatment of PHCs and non-halogen organic matters. In general, the decomposition products are nontoxic.

During anaerobic remediation, the decomposition products of contaminants and the decomposition rate are uncertain, and the intermediate products are highly toxic. When the soil temperature is low, the remediation efficiency is low, and the technology is not applicable to the treatment of organic matters. During aerobiotic remediation, organic contaminants may be translated into carbon dioxide and water.

When organic contaminated soil contains toxic heavy metal, the rate of biodegradation is low and the effect is quite low.

(2) Excavation and ex-situ landfill

This method is mainly applicable to organic contaminants and low-volatility organic matters, namely excavating and transporting contaminated soil to the safe landfill, in order to prevent contaminants from spreading into the environment. This is an engineering isolation measure, but cannot thoroughly eliminate contaminants.

This method can efficiently prevent contaminants and their reaction products from spreading into the environment, and long-term monitoring for the landfill is required, including groundwater monitoring, in order to ensure the long-term effectiveness of landfill. The landfill is forbidden to be used for building construction and groundwater source.

(3) Incineration technology

Incineration technology is to use high temperature of 870～1200℃ (1400～2200°F) to volatilize and burn (under aerobic conditions) halogen compounds and other organic matters which cannot be degraded in contaminated soil. High-temperature incineration technology is a process of thermal oxidation. In this process, organic contaminant molecules will be cracked into gas or incombustible solid matters. Technical characteristics: incineration technology is mainly adopting multi-chamber air-controlled incinerator and rotary kiln incinerator, and contaminated soil remediation in combination with cement kiln is a widely used method in China. During incineration, fly ash and flue gas shall be tested, in order to prevent producing more toxic substances like TCDD. Usually, incineration technology requires auxiliary fuel to initiate and maintain combustion and the exhaust and the residues after combustion shall be treated.

Range of applicable range: incineration technology is applicable to deal with a great amount of high-concentration POPS contaminants and semi-volatile organic contaminants. The contaminants can be treated thoroughly and the clearance rate may reach 99.99%. If the treatment is carried out in co-processing with cement kiln, the contaminated soil shall be sorted, and the heavy metal in soil shall be tested, in order to guarantee the quality of cement produced meets relevant standards.

Figure8.3-6 Incineration in rotary kiln

8.3.3.2 Comparative selection of technical programs.

Various restriction factors such as technical feasibility, remediation cycle, planned land usage and treatment economical efficiency shall be taken into consideration for comparative selection of technical programs. Therefore, prior to designing the heavy-metal contamination remediation program, basic treatment processes shall be screened according to the foresaid restriction factors, and the alternatives shall be defined in combination with specific pollution situation, technical feasibility and implementation difficulty. See **Table 8.3-7**for comparative selection of technical programs.

Table 8.3-7Comparison of organic contamination remediation technologies

Remediation technology	Technical indicator							Economic indicator		Social and environmental indicator	
	Site operability					Technical maturity	Remediation time	Resource demand	Cost	Acceptability	Secondary pollution
	Applicability to pollution	Soil property	Water content	Permeability coefficient	pH/organic matter						
Biodegradation	PHCsa SVOC/ benzene series	Loam / sandy soil	2-5%	High	6-8/high	Relatively high	Long	5	50-200	High	Relatively low
Excavation and ex-situ landfill or exchange backfilling	Low volatility	--	--	--	--	Low	Short	2	150-200	Low	High
Incineration	--	---	--	High	6-8/high	High	Short	1	1200-2000	Relativey high	Relatively high

In conclusion, in terms of treatment scale, remediation time and treatment costs and other factors, incineration is more applicable to organic contaminated soil remediation, therefore, incineration technology is determined as the main remediation technology for organic contaminated soil in this project.

8.3.3.3 Feasibility analysis of entrusted treatment

(1) Treatment capacity

Sinoma Zhuzhou Cement Co., Ltd. is located in Huangtang Village, Xianyu Township, Hetang District, Zhuzhou City, and the direct distance to the project area is 18km. The company was put into production in 2008, and its cement clinker kiln is a new-type dry-process rotary kiln with Smith ATOX50 vetical mill, 5-level suspension preheater and decomposing furnace. The specification of the rotary kiln is m, and the design daily clinker production capacity is 5000 tons/day. Besides, there is a 9MW pure low-temperature exhaust-heat generating station. The design annual output of high-grade cement is 2000 thousand tons, ad the annual exhaust-heat generating capacity is 59256 thousand KWh.

See **Table 8.3-8**for consumption of raw and auxliary materials (2011 normal production year).

Table 8.3-8Consumption of raw and auxliary materials (2011 normal production year)

No.	Name	Consumption (10 thousand t/a)	No.	Name	Consumption (10 thousand t/a)
1	Limestone	192.1	6	Ferroalloy slag	1.004
2	Shale	16.9	7	Made limestone	7.95
3	Sandstone	16.5	8	Converter slag	4.25
4	Gypsum	9.328	9	Coal gangue	0.193
5	Granulating slag	3.96			

The quantiy of organic contaminated soil in this project is about 24.8 thousnd tons. Calculated by construction period of four years, the annual treatment capacity will be 6.2 thousand tone, accounting for 0.31% of the consumption of raw materials by Sinoma Zhuzhou Cement, which is acceptable to Sinoma Zhuzhou Cement.

(2) Sinoma production process

The main production process is described as below:

1. Crushing and prehomogenization of raw materials

Limestone is the raw material for cement production with the largest consumption. After being crushed by hammer crusher, limestone will be transported by belt conveyor to limestone prehomogenization site homogenize the components of raw materials and reduce quality fluctuation, in order to improve the production quality of clinker and stabilize the systematic production.

2. Preparation of raw meal

After being ground by roller mill and dried, raw materials will be transformed into raw meal.

3. Homogenization of raw meal

Raw meal will be mixed and homogenized intensively through air agitation and action of gravity in homogenization silo.

4. Preparation of pulverized coal

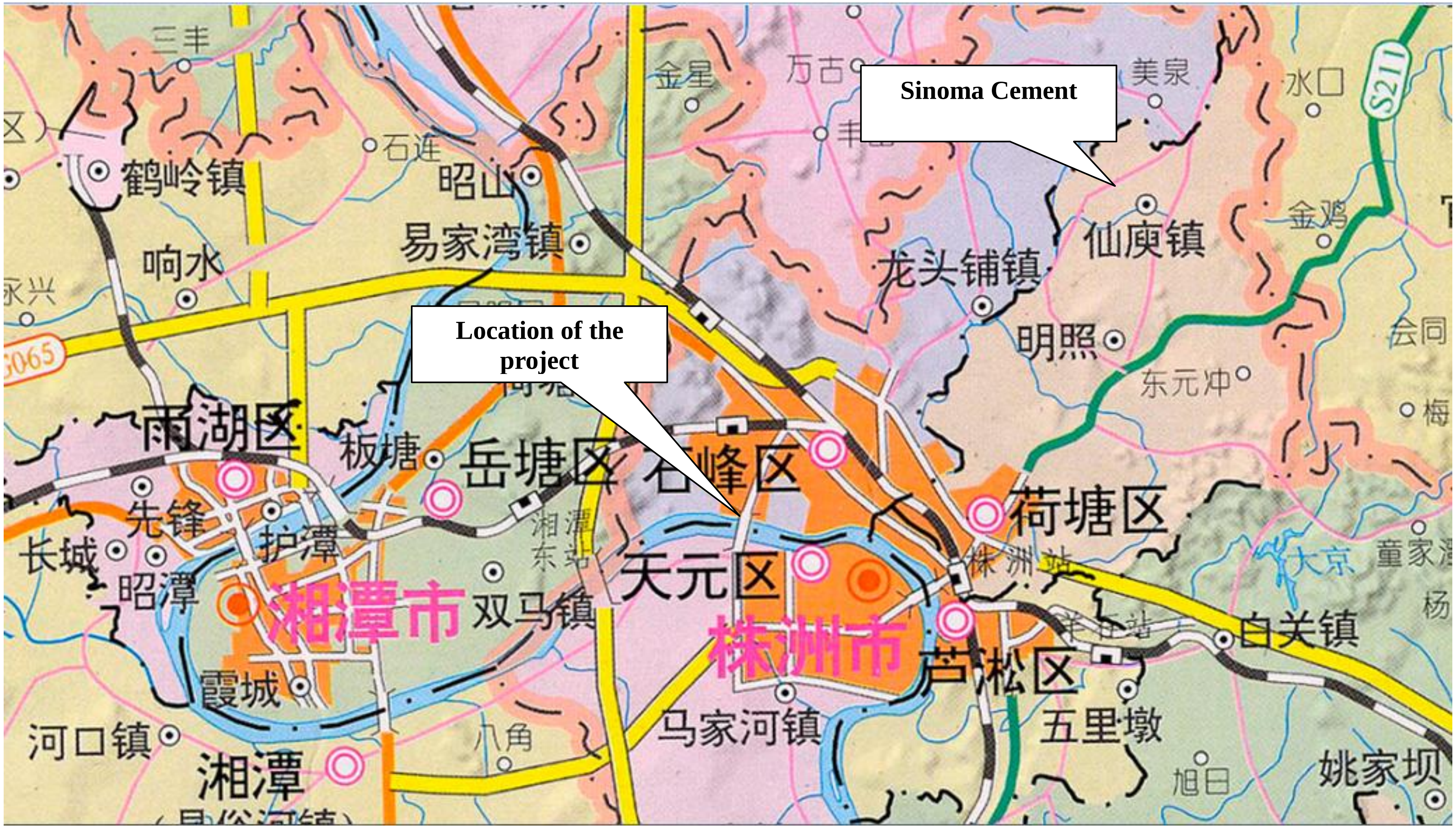


Figure8.3-7Relative position map for Sinoma Cement and the project

Roller mill is used for preparation of pulverized coal, and grate cooler is used for during raw coal.

5. Preheating and precalcining

After entering into the preheater, raw meal is fully heated by exhaust gas discharged by rotary kiln and decomposing furnace, to make part of carbonate decompose, and the raw meal enter into the decomposing furnace. The decomposing furnace is positioned between preheater and rotary kiln. It uses the uptake flue to inject the fuel to the device, and it makes the exothermic process of fuel burning and the endothermic process of carbonate decomposition fast in the decomposing furnace in the state of suspension or fluidization and increases the decomposition rate of raw meal exceed 90%.

6. Calcination of cement clinker

After preheating and precalcining, raw meal enters into the rotary kiln for calcination of clinker. In the rotary kiln, carbonate further decomposes rapidly and causes a series of solid-state reaction to produce cement clinker. After calcination of clinker, the temperature begins to fall, and the high-temperature clinker discharged from the rotary kiln is cooled by the grate cooler. And then the clinker is transported to the clinker silo by the conveyor and part of high-temperature clinker is reclaimed for exhaust-heat power generation.

7. Cement grinding

After adding gelatinizing agent and performance regulating materials, the cement clinker is ground by roller machinery and form cement products of different grades with certain grain grating.

(3) Remediation measures for pollution

a). Waste gas

Ordered waste gas

The gas contaminants discharged by the production line mainly include particulate matters produced during production and SO2, NOx and fluoride produced during clinker calcination. From limestone crushing to cement delivery, there are 44 orderly dust discharge points, and 44 dust catchers are installed. The head of calcining kiln adopts electrostatic dust collector and other dust discharge points adopt bag-type dust collectors. Most of SO2 produced during fuel burning in the rotary kiln will be absorbed by alkaline oxides in the materials like calcium oxide at 800-1000℃ and produces intermediate matters like calcium sulfate and calcium sulfite; the materials in the precalcining kiln contact the gas completely, and the sulfur absorption rate may exceed 98%.

According to the regular monitoring of Zhuzhou Environmental Monitoring Center on the company for recent two years, the monitoring results are detailed in **Table 8.3-9**.

Table 8.3-9Monitoring on emission of gas contaminants of Sinoma Cement for recent two years

Monitoring date	Monitoring point	Monitor project	Measured concentration (mg/m^3)	Reduced concentration (mg/m^3)	Standard limit (mg/m^3)	Whether or not
2014/11/24	Kiln tail gas outlet	SO_2	11.2	9	200	YES
		TSP	11.6	8.2	50	YES
		NO_2	371.7	296.6	400	YES
3 quarter of 2014	Kiln tail gas outlet	SO_2	8	7	200	YES
		NO_2	363	330	800	YES
		TSP	17.4	15.8	50	YES
2 quarter of 2014	Kiln tail gas outlet	SO_2	6.7	5.7	200	YES
		NO_2	446.5	380.2	800	YES
		TSP	16.7	14.2	50	YES
2014/2/24	Kiln tail gas outlet	SO_2	9	8.2	200	YES
		NO_2	354.5	322.9	800	YES
		TSP	20.1	18.6	50	YES
2013/10/22	Kiln tail gas outlet	SO_2	3	2.5	200	YES
		NO_2	361.7	698.4	800	YES
		TSP	17.7	14.7	50	YES
3 quarter of 2013	Kiln tail gas outlet	SO_2	13.2	11.9	200	YES
		NO_2	665.7	602.8	800	YES
		TSP	15.4	14	50	YES
2 quarter of 2013	Kiln tail gas outlet	SO_2	-	9.5	200	YES
		NO_2	-	220.3	800	YES
		TSP	-	21.5	50	YES

d) Treatment of wastwater contaminant and treatment process

Wastewater sources include production equipment cooling water, auxiliary production wastewater and domestic swage.

Production equipment cooling water will be used for water spraying of humidifying tower after deoiling and precipitation; auxiliary production wastewater will be discharged into the collecting tank after neutralization, filtration and precipitation and used for greening and road watering; domestic sewage will be stored in the collecting tank after two-stage biochemical treatment and used for greening and road watering, not discharged to the outside.

See **Figure8.3-8** for wastewater treatment process.

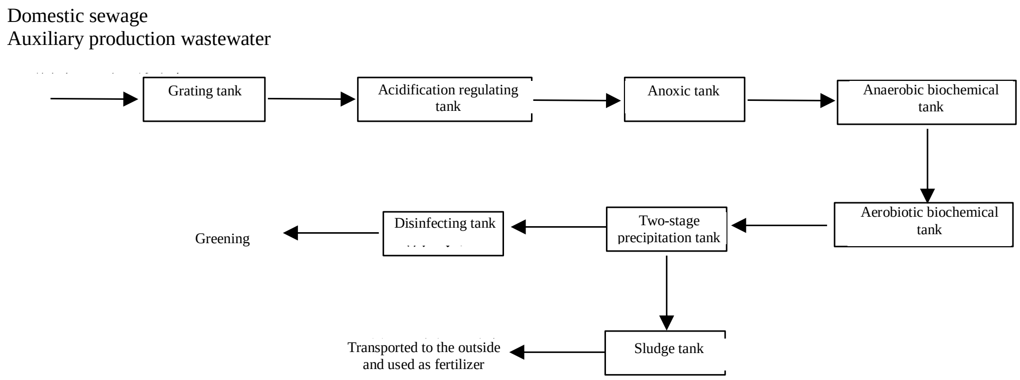


Figure8.3-8 Diagram for treatment process of wastewater from Sinoma Cement

According to the regular monitoring of Zhuzhou Environmental Monitoring Center on the company for recent three years, see **Table 8.3-10**.

Table 8.3-10 Monitoring on emission of wastewater contaminants of Sinoma Cement for recent three years

Monitoring point	Monitoring date	pH	SS	COD	Petroleum
1# rainwater drainage outlet	August 19, 2014	7.63	8	38.9	0.889
2# rainwater drainage outlet		7.38	6	45.4	0.036
1# rainwater drainage outlet	March 14, 2014	8.54			
2# rainwater drainage outlet		7.27			
Rainwater drainage outlet	August 14, 2013	7.9	6	15.3	0.251
Rainwater drainage outlet	August 28, 2012	8.46	10	39.8	0.894
		7.71	7	23.9	0.103

3. Solid wastes

The solid wastes mainly include waste belts, waste iron, waste refractory bricks, (chrome-magnesite firebrick and spinel firebricks), used lubrication oil, sludge and waste oil in deoiling tank and domestic garbage. See **Table 8.3-11** for the output and treatment of solid wastes.

Table 8.3-11Treatment of solid wastes of Sinoma Cement

No.	Name	Property	Quantity	Treatment method
1	Waste belt	General industrial solid wastes	20	Sold to the outside
2	Waste iron	General industrial solid wastes	10	Sold to the outside
3	Refractory brick	General industrial solid wastes	120	reclaimed by the plant
4	Domestic garbage	-	500	Disposed by municipal encironmental protection department
5	Domestic sludge	General industrial solid wastes	50	Transportted to the outside
6	Used lubrication oil	Hazardous wastes	2	Incineration in kiln
7	Sludge in deoiling tank	Hazardous wastes	10	
8	Waste oil in deoiling	Hazardous wastes	0.5	

	tank			

(4) Analysis on conformity to *Environmental Protection Technical Specification for Co-processing of Solid Wastes in Cement Kilns* (HJ 662-2013)

According to **Table 8.3-12**, Sinoma Cement is entrusted to dispose organic contaminated soil and it meets the requirements of *Environmental Protection Technical Specification for Co-processing of Solid Wastes in Cement Kilns* (HJ 662-2013) .

Table 8.3-12 Analysis on conformity to *Environmental Protection Technical Specification for Co-processing of Solid Wastes in Cement Kilns* (HJ 662-2013)

Requirements of technical specification		**Project situation**	**Conformity analysis**
Cement kiln meeting the following requirements may be used for co-processing of solid wastes	The kiln type is new-type dry-process cement kiln	The cement clinker kiln used in the company is a new-type double-series dry–process rotary kiln with 5-level suspension preheater and decomposing furnace	Satisfactory
	The design single-line production capacity of clinker is not less than 2000 tons/day.	The design production capacity of clinker is 5000 tons/day.	Satisfactory
	As for cement kiln transforming and utilizing the original facilities for co-processing of solid wastes the original facilities shall meet the requirements of GB4915 for two consecutive years.	Don't utilize the original facilities	Satisfactory
The cement kiln used for co-processing of solid wastes shall have the following functions	Adopt kiln-mill all-in-on-machine mode.	Kiln-mill all-in-on-machine mode	Satisfactory
	Install online monitoring device and ensure the stability of operating condition: including temperature and pressure of flue gas at kiln head; kiln surface temperature; temperature and pressure of flue gas and O2 concentration at kiln tail; temperature, pressure of flue gas and O_2 concentration at the outlet of decomposing furnace or lowest-level cyclone; and temperature, pressure of flue gas and O_2 concentration at the outlet of top-level cyclone	Online monitoring device is installed to monitor temperature and pressure of flue gas at kiln head; kiln surface temperature; temperature and pressure of flue gas and O2 concentration at kiln tail; temperature, pressure of flue gas and O_2 concentration at the outlet of decomposing furnace or lowest-level cyclone; and temperature, pressure of flue gas and O_2 concentration at the outlet of top-level cyclone	Satisfactory
	Cement kiln and kiln tail exhaust heat utilization system adopts high-efficiency bag-type dust collectors, to ensure that PM concentration in flue gas meets the requirements of GB30485. The exhaust funnel of the cement kiln and kiln tail exhaust heat utilization system is equipped with the online monitoring system for dust, NOx and SO2 concentration, and the continuous monitoring device shall meet the requirements of HJ/T76 and be networked with local monitoring center to ensure that the contaminant emission meets the standard.	The head of calcining kiln adopts electrostatic dust collector and other dust discharge points adopt bag-type dust collectors. Cement kiln and kiln tail exhaust heat utilization system is equipped with the online monitoring system for dust, NOx and SO2 concentration. The company is a state-controlled key pollution source, and its online monitoring system is networked with Zhuzhou Monitoring Center. According to the monitoring data of each quarter, the contaminant emission for recent three years meets the standard.	Satisfactory
	Kiln dust backing device shall be installed to send the kiln dust collected by dust collectors back to the raw mill feeding system.	Kiln dust backing device is installed	Satisfactory

Requirements of technical specification		Project situation	Conformity analysis
The locations of production facilities of the cement kiln used for co-processing of solid wastes shall meet the following requirements	Meet the requirements of overall urban development planning and urban industrial development planning.	The location of Sinoma Cement Plant meets the requirements of Zhuzhou overall planning and Zhuzhou industrial development planning	Satisfactory
	There is no threat of flood, tidewater or waterlogging in the region in which the facilities are located. The elevation shall be above the 100-year-return-period food level, and the location shall be outside of the inundated areas and protection areas of existing and planned reservoirs.	The plant is located in Huangtang Village, Xianyu Township, Hetang District, Zhuzhou City, and there is no threat of flood, tidewater or waterlogging.	Satisfactory
	The distance between the facilities used for co-processing of hazardous wastes and the environmental sensitive areas like residential area, commercial area, school and hospital shall meet the requirements of environmental protection with confirmation by the environmental impact assessment approved by local environmental protection administration departments.	According to the Ministry of Environmental Protection HY [2010]143 *Letter on Comments on Environmental Protection Acceptance of Completion of 5000 tons/day Clinker Production Line Project of Sinoma Zhuzhou Cement Co., Ltd.*, the relocation of affected residents within mine blasting safe distance 200m, plant dust prevention distance 500m and 50m on both sides of belt corridor has been completed basically.	Satisfactory
	The transportation routes for facilities used for co-processing of hazardous wastes may not pass by environmental sensitive areas like residential area, commercial area, school and hospital.	The transportation routes will be planned strictly and will not pass by environmental sensitive areas like residential area, commercial area, school and hospital.	Satisfactory

(5) Feasibility of entrusted treatment

According to the abovemetioned analysis, The quantiy of organic contaminated soil in this project accounts for 1.13% of the consumption of raw materials by Sinoma Zhuzhou Cement, which is acceptable to Sinoma Zhuzhou Cement.

According to the regular monitoring of Zhuzhou Environmental Monitoring Center on the company for recent three years 2012-2014, the emission of dust, and sulfur dioxide and nitric oxide by the kilns of Sinoma Cement meets the requirements in Table 1 in *Emission Standard of Air Pollutants for Cement Industry* (GB4915-2004), and has small impact on atmospheric environment.

Production equipment cooling water of Sinoma Cement will be used for water spraying of humidifying tower after deoiling and precipitation; auxiliary production wastewater will be discharged into the collecting tank after neutralization, filtration and precipitation and used for greening and road watering; and domestic sewage will be stored in the collecting tank after two-stage biochemical treatment and used for greening and road watering, not discharged to the outside. According to the regular monitoring of Zhuzhou Environmental Monitoring Center on the rainwater drainage outlets of the company for recent three years 2012-2014, the rainwater drainage concentration meets the requirements. Various solid wastes of Sinoma Cement can be disposed properly.

Sinoma Cement meets th requirements of the requirements of *Environmental Protection Technical Specification for Co-processing of Solid Wastes in Cement Kilns* (HJ 662-2013).

Therefore, it is feasible to entrust Sinoma Cement Co., Ltd. to dispose the organic contaminated soil in the project, and the entrusted treatment has a low environmental impact.

8.3.4 Comparative selection of treatment programs for current ponding water in the landfill site

For the treatment of ammonia nitrogen in the pondig water in the stone pit, the following programs are designed for comparative selection. See **Table 8.3-13** for comparative selection.

(1) Delivery to Qingshuitang Industrial Wastewater Treament and Utilization Plant for mixing treatment with original sewage

The design capacity of Qingshuitang Industrial Wastewater and Utilization Plant is 20 thousand m^3/d. The treatment technology is hydrolytic acidification +AO+MBR denitrification, and the water after treatment reaches higher standard specified in *Municipal Wastewater Treatment Plant Pollutant Discharge Standard*. However, the amount of wastewater that Qingshuitang Industrial Wastewater Treatment and Utilization Plant now can absorb is about 5~10 thousand m^3/d. Moreover, a new sewage pipe shall be built between the stone pit and the existing sewage collecting trunk pipe on Tongxia Road.

(2) Chemical treatment

Checmial treatment is to add chemical agent into the wastewater to make the agent react with ammonia nitrogen and further eliminate it. The common chemical treatment methods include breakpoint chlorination method, ion exchange method, ammonia blowing-stripping method, chemical precipitation and electrochemical treatment technology. At present, the relatively mature methods are breakpoint chlorination method and chemical precipitation method.

Breakpoint chlorination method is a chemical denitrification technology with which chlorine or sodium hypochlorite is bubbled into the wastewater and NH_3-N in the wastewater is oxidized to N_2. When the chlorine inlet exceeds this point, the free chlorine in the water will increase, so this point is called breakpoint, and the chlorination in this state is called breakpoint chlorination. The actual chlorine amount required for the treatment of ammonia nitrogen sewage is depending on temperature, pH and ammonia nitrogen concentration. The oxidation of each gram of ammonia nitrogen requires 9～10mg of chlorine, and the contact time shall be 0.5~2 hours.

$$2NH_4^{+}+3HOCl \rightarrow N_2+HOCl+H^{+}+Cl^{-}$$

With this method, a reaction tank shall be built beside the stone pit, and chemical agent will be added after ponding water is drained. The water will be discharged when the treatment meets the standard.

Table 8.3-13 Comparison of treatment programs for ponding water

No.	Item	Program 1	Program 2
1	Newly-built works	It is needed to build drainage pump station and drainage pipes	It is needed to build drainage pump station and reaction tank
2	Treatment standard	The water discharged shall reach *Municipal Wastewater Treatment Plant Pollutant Discharge Standard*	The water discharged shall meet *Integrated Wastewater Discharge Standard*
3	Cost	High	Low
4	Treatment time	Longer than 300d	Freely adjusted as required

The ponding water in the stone may be discharged when meeting Class-I standard in Table 4 in *Integrated Wastewater Discharge Standard*. If the project investment is fixed, Program 2 is competitive. Besides, Program 1 has limited absorption capacity, and the treatment time is long, with low compatibility the project construction period. According to comprehensive consideration, Program 2 is selected as the treatment method for this project.

8.3.5 Comparative selection of transportation programs for solid wastes in the landfill site

The landfill is a pit landfill. Different from the landfill sites of the same kind, the maximum depth of the reservoir is 60m, far larger than the depth of general pit landfill. In order to ensure the smooth transportation of wastes, three transportation programs are designed for comparative selection.

Program 1: Slideway transportation

Slideway has a wide definition. In terms of logistics and transportation, slideway refers to a kind of facility using natural slope and the own potential energy of the object to complete transportation. At present, there is no engineering project using slideway for transportation of domestic garbage in China. For this project, slideway may adopt zigzag inclined chute and integral chute.

Zigzag inclined chute is composed of multiple independent slide plates, which are fixed on the sidewalls of the reservoir from top to bottom and are arranged in a zigzag pattern. The wastes will drop from one slide plat to the next and finally to the bottom of the reservoir.

Integral chute is arranged along the side slope of the pit and the slid plates are connected with connecting members. The beginning part of the chute is a straight line with a slope of 1:0.7, to ensure the surface contact between wastes and the chute during sliding; the back part of the chute is designed as circular curve, to reduce the vertical velocity of wastes when reaching to the bottom and make the movement of wastes change evenly; in order to ensure the smooth transition of the wastes from the linear part to the curved part, the linear part shall be designed as the tangent line of the curve.

Both two types of sideways adopt PVC, and the fault section adopts semi-circle type with radius of 1500mm. The slideway surface shall be anchored on the walls of the pit by anchor bolts. In order to prevent wastes from scattering during sliding, fiber-glass ceiling shall be installed in parallel with the slideway surface.

Program 2: Tower crane transportation

Tower crane is a kind of hoisting machinery used for construction. According to the characteristics of this project, upper-rotary self-elevating tower crane which is widely used for construction of high-rise buildings is adopted in this project. In order to increase hoisting capacity, anchoring devices are adopted to connect the tower body to the pit walls. This program adopt two sets of QT80A tower cranes and the hoisting moment of single tower crane is 000kN•m, the maximum amplitude is 50m corresponding to hoisting load of 1.5t, and the minimum amplitude is 12.5m corresponding to hoisting load of 8t. The maximum hoisting height is 120m, and the motor power 30kW. The foundation of tower crane adopts steel structure, and one anchoring device will be installed every 16.5m of vertical height, and totally four anchoring devices will be installed for the whole tower body.

Program 3: Road transportation

Based on the low-cost road previously built for quarrying, a new road of 5m wide will be built, and will meet Class-3 standard for surface mine road specified in *Code for Design of Roads in Factories and Mining Areas*, and the pavement structure will adopt concrete surface.

According to comprehensive comparison, the original quarrying road is relatively good, and it is only needed to build the pavement, requiring the lowest investment and providing the largest transportation amount. Therefore, Program 3 is selected.

9 Environment Overview

Zhuzhou City is located in the east of Hunan Province, in the middle and down reaches of Xiang River, at the west foot of Luoxiao Mountain Range, and in the inclined section between Nanling Mountain Range and Jianghan Plain. The city is adjacent to Pingxiang Ciy, Lianhua County, Yongxin Cunty and Jinggangshan City in Jiangxi Province to the east, connectinng to Hengyang City and Chenzhou City in Hunan Province to the south, bordering on Xiangtan City to the west, and neighbouring wih Changsha City to the north.

The city crosses over east longitude 125°57′30″-114°07′15″ and north latitude 26°03′05″-28°01′27″. The south-north length is 219.25km, the east-west width 88.75km, and the total area 11272km^2, accounting for 5.32% of the total area of the province. Now Zhuzhou City governs five cities and counties, including Liling City, Yanling County, Chaling County, You County, four districts including Tianyuan District, Lusong District, Hetang District and Shifeng District, and 113 towns.

The implementation zone of the project is in Zhuzhou Qingshuitang Circular Economy Industrial Zone (Qingshuitang Industrial Zone), which is in Shifeng District in Zhuzhou City. The zone is adjacent to Xiangtian Road to the east, Jingguang High-speed Rail Viaduct to the west, Zhuzhou Smelters Plant to the north and Xiang River to the south. See **Figure9.2-1** for the geographical location.

9.1Natural environment

9.1.1 Climate and weather

The project location has subtropical monsoon climate. According to the data from Zhuzhou Meteorological Observatory, Zhuzhou City belongs to middle subtropical monsoon climate zone, with distinctive four seasons, abundant rainfall, moderate weather and good lighting and heat conditions, which are embodied in that the temperature in spring is variable, the summer is mostly hot, the autumn is invigorating and the winter is less cold. The perennial mean temperature is 17.4 17.4℃, the monthly mean temperature in January is the lowest and in July is the highest, the extreme maximum temperature is 40.2℃ and the extreme minimum temperature is －11.5℃. The mean annual precipitation is 1442.7mm, and the rainfall is distributed between April and August. The annual mean relative humidity is 80%, and the annual mean air pressure is 1007.1hpa. The perennial prevailing wind direction is NW——N, the still wind frequency is 23%, and the annual mean wind speed is 2.0m/s.

Figure9.1-1 Geographical location map

9.1.2 Earth surface and hydrologic regime

The regional surface water in the project location is Xiang River, which is the main river in the project area. As one of major tributaries of Yangtze River, Xiang River originates from Haiyang Mountain in Guangxi Province and flows through Hunan Province from south to north and into Yangtze River, and the total length is 856km. The width of water surface of Zhuzhou section is 500~800m, the depth 2.5～3.5 m, and the hydraulic slope 0.102 ‰. The average annual flow is 1780 m^3/s, the historical maximum flow 20200 m^3/s, and the minimum flow 101 m^3/s. The highest water level is 44.49 m, the lowest water level 27.83m, and the average water level 34m. The annual average flow velocity is 0.25 m/s, and the annual average total flow is 64.4 billion m^3. Xiang River flows through Qingshuitang Industrial Zone from east to west, and the total length in the zone is about 8km, accepting five branches along the way, i.e. Baishi Channel, Xiawangang, Old Xiawangang, Tongtang Channel and Wuya Channel. See **Figure9.1-2** for regional Xiang River system.

Xiawan Chanel originates from a dry pond in the northwest of the urban area, and flows through Qingshuitang District from north to south and into Xiang River, and it is a Class-I branch of Xiang River. The total length is about 6m, and the drainage area is about 11.8 square kilometers. It accepts domestic wastewater from enterprises, factories and public institutions along the way. Large enterprises from the upstream to the downstream include Hunan Zhongcheng Chemicals, Zhicheng Chemicals, Zhuzhou Gas Company, Zhuzhou Insecticide Factory, Zhuzhou Chemical Industry Group, Zhuzhou Smelter Group and Xiawan Sewage Treatment Plant. The terrain in the drainage basin is high in the northeast and low in the southwest. Because of strip and block segmentation by factories and mines, the landform is disordered, and regional vegetation is weak, with vegetation coverage ＜20%.

Old Xiawangang is located in Shifeng District in the northwest of Zhuzhou City. It originates from Xinjichong, is divided into two branches when flowing through flagstone site and finally flows into the planed Qingshui Lake. The whole drainage basin is of dustpan shape, and the terrain is high on three sides and inclines to the west. There are many low hills in the upper and middle reaches; the lower reach belongs to valley plain of Xiang River. The original riverway passed through a large fish pond in Jiangshe Village, and was transformed into branch 1 and branch 2 of the existing Old Xiawangang in the 19602 and 1970s. The total length is about 3km, and the annual average flow is lower than 10000 thousand cubic meters. The enterprises in the drainage basin of Old Xiawangang include Qingshui Smelters, Yongfa

Refinery, Dongfeng Smelters, Flotation Reagents Factory, Yingfeng Comprehensive Welfare Factory and Longzhou Refinery.

See Figure 6.4-1 for locations of Old Xiawangang and Xinqiao low discharge channel.

Xinqiao low discharge channel is located in the middle of Zhuzhou Qingshuitang Industrial Zone. It originates from Datangchong, flows through Xinwuwan and Caomenwuchang, and finally flows into Xiang River. The terrain is high in the west but low in the east, and high in the north but low in the south, and it belongs to valley plain of Xiang River. The total length is about 8.70km, and the landform along the channel is relatively smooth and inclines to the west gradually. The water quality at the upstream and the downstream is relatively good. Because the river section between the tail of Datangchong and the entrance of Xiang River (about 1.50km long) was affected by surrounding small smelting factories in the 1990s, and scattered and remaining waste residues along the long were transferred into the water by rainwater, the sediment at the downstream was contaminated severely by heavy metal, affecting the drinking water safety of Xiang River.

The landform in the region is flat, the hydrogeological conditions are simple, and water retention capacity is low. The groundwater in the middle and upper reaches mainly is pore water in covering layer and mostly supplied by atmospheric precipitation, and the groundwater usually seeps at slope foots or in valleys or is drained in the state of spring. Besides atmospheric precipitation, groundwater also absorbs a great amount of industrial and domestic wastewater, which causes low water quality and high content of heavy metal ion and organic matters, and the water present weak alkalinity.

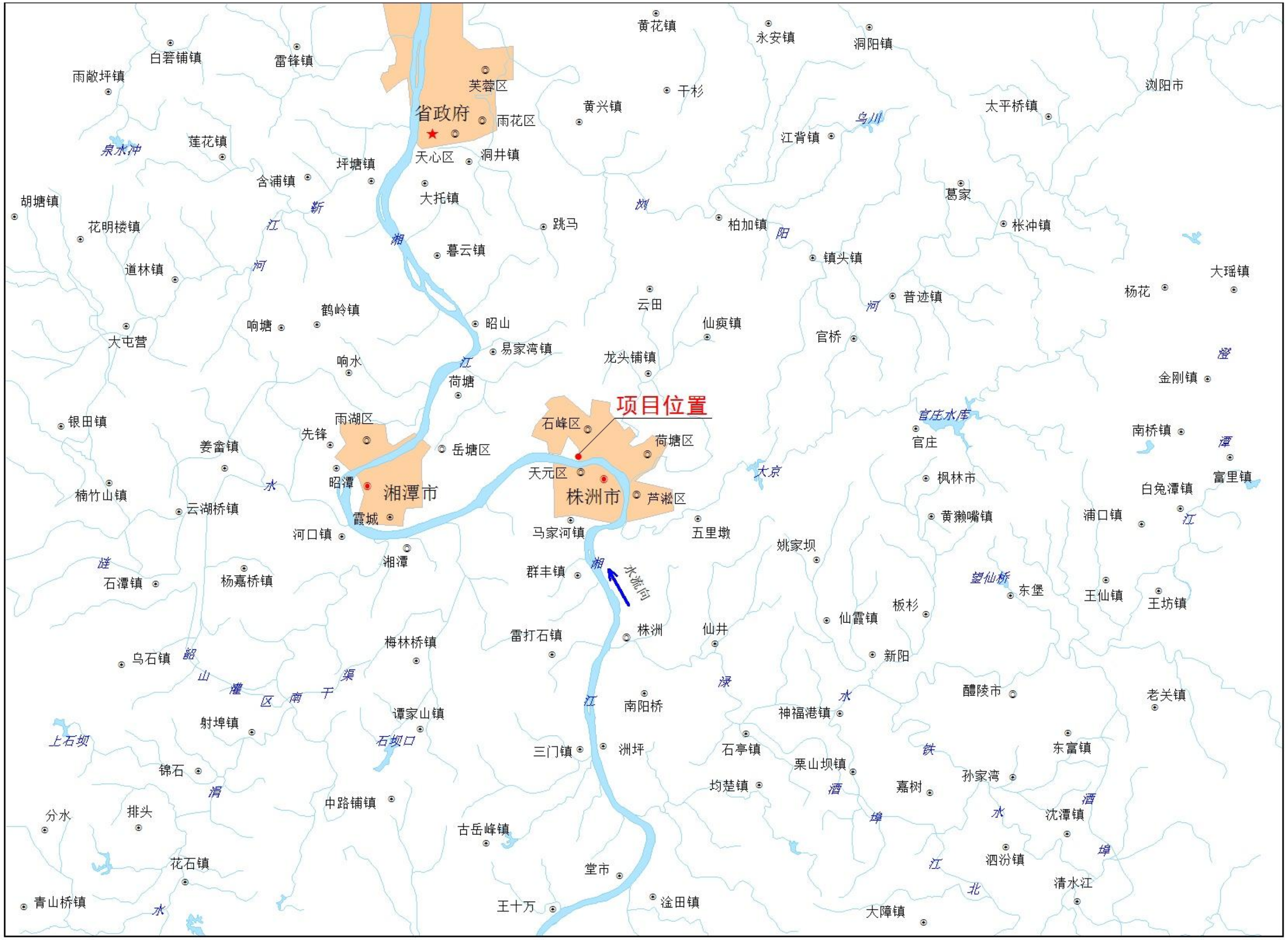


Figure9.1-2 Sketch map of water system in the region

9.1.3 Landform

The water area in Zhuzhou City is 637.27 km^2, accounting for 5.66 of the total city area; the area of plain is 1843.25 km^2, accounting for 16.27%; the area of low downland is 1449.86 km^2, accounting for 12.87%; the area of high downland is 738.74 km^2, accounting for 6.56%; the area of hills is 1916.61 km^2, accounting for 17.02%; and the area of mountainous land is 4676.47 km^2, accounting for 41.52%. The mountainous land is mainly distributed in the southeast of the city area, the downland mainly distributed in the middle north, and the plain mainly distributed on both sides of Xiang River. The city is located at the west foot of Luoxiao Mountain Range, and in the inclined section between Nanling Mountain Range and Jianghan Plain. The overall terrain is high in the southeast but low in the northwest. In the middle north, mountains and valleys are in alternative distribution, and the basin is spreading in the shape of strip. In the southeast is all mountainous land, with overlapping mountains.

Zhuzhou City has tectonic erosional and denudational hilly landform. The city area is high on all sides and low in the middle and presents centripetal valley basin, so Zhuzhou is called Red Basin. The long axis of the basis is in south-north direction, long from south to north and narrow from east to west. The landform is composed of plain, hilly land and downland, belongs to the typical hilly land. Xiang River flows through Zhuzhou City from south to north and forms Hetao Plain in the city area. The width of the river surface is 650¯900m, and the riverbed is sandy. According to the formation causes, the landform can be divided into two categories, i.e. tectonic erosional and denudational landform and erosional accumulation landform, and according to morphological characteristics and material combination, it can be subdivided into six subcategories (**Figure9.1-3**).

The assessment area belongs to tectonic erosional and denudational red rock hilly land and tectonic erosional and denudational sandstone and shale hilly land. It is mainly composed of clastic rocks in Dajiaping Group of cretaceous system and sandstone and shale of devonian system and carboniferous system, and the rocks are soft and have low resistance to weather. The altitude of red rock hilly land is 100-180m, with shallow cutting of 30-60m deep. The composition of gluetenite and conglomerate at the edge of the basin is relatively high, but the sandy mudstones in the center of the basin form isolate round hills with smooth landform and small wave. In the area where the orientation of bedrock is approximately horizontal, the hill top is smoother with slope of 10-25°, and the relative height is 20-00m. in low hilly land connecting to high hilly land, the altitude is 80-100m and the slope is 10-20°. The altitude of sandstone and shale hilly land is 200-350m, and the relative height is 50-100m. The ridge extension is relatively obvious, and the hill top presents coniform shape with slope of 20°-25° in convex or straight line. In the region, denudation-planation surface of 300-350m especially exists stably.

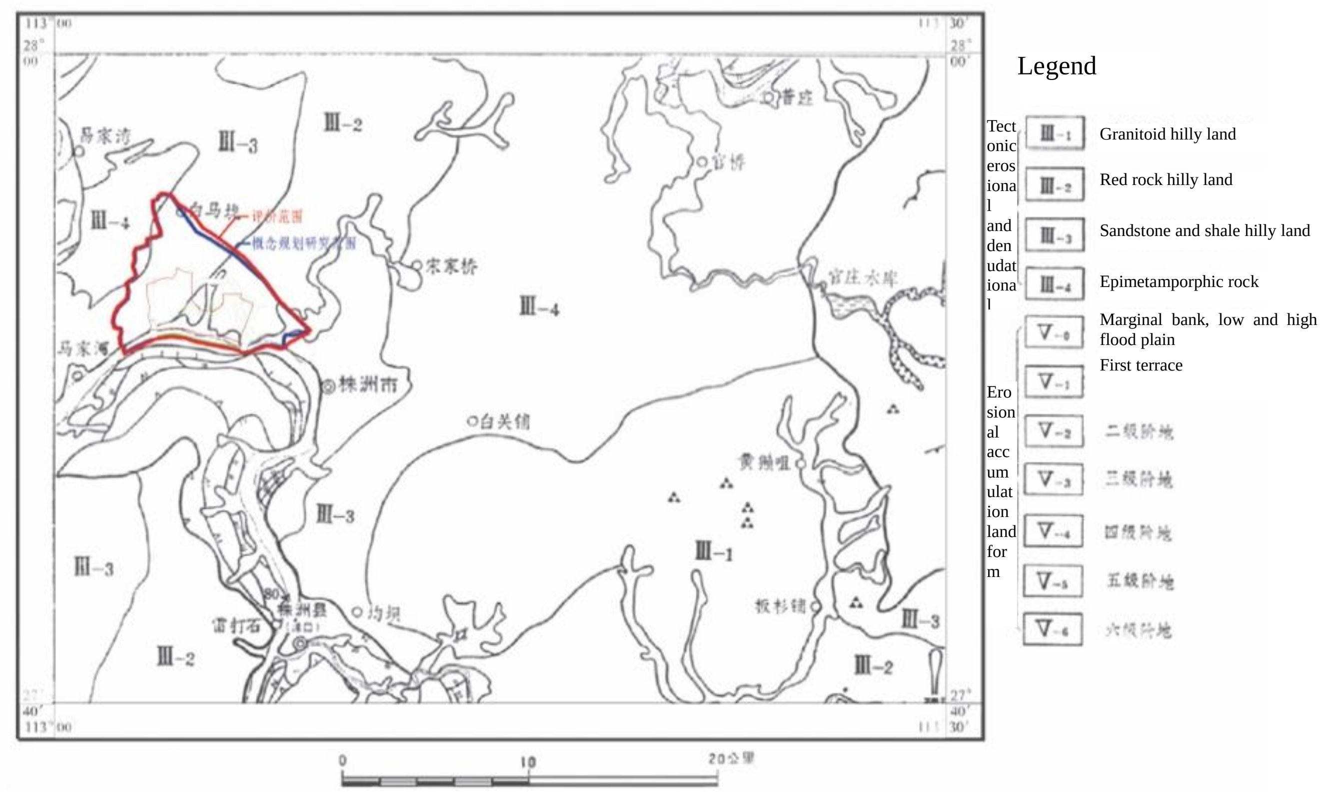


Figure9.1-3Landform map

9.1.4 Geological Overview

I. Formation lithology

Exposure formation lithology in the area includes fuchsia sandstone in cretaceous system, mudstone and sandstone and slate in Lengjiaxi group which are developed, includes quaternary system, cretaceous system, carboniferous system, Devonian system, Lengjiaxi group and Banxi group from the new to the old. The most widely-distribution formations include cretaceous system and Lengjiaxi Group, and Devonian system is next. The distribution situation and lithological characters are described as below from the old to the new:

1. Lengjiaxi Group (P_{tl}^{3})

Interbedding of celadon and greenyellow thick layer – blocky greywacke, fuchsia feldspar quartz siltstone, silty slate and strip slate, and sericite slate. Thickness: 1323m.

2. Banxi Group (P_{tbm}^{1})

Sallow metagreywacke, siltstone, tufaceous conglomerate with sandy slate Thickness: 224m.

3. Devonian system (D)

Tiaomajian group (D_t): upper: grey white and fuchsia silica sand with arenaceous shale, quartz sandstone and siltstone containing gravel, locally containing lenticular hematite layer; lower: purplish-grey and fuchsia siltstone, quartz sandstone, quartz sandstone containing gravel, and conglomerate. Thickness: about 23.4-183.4m.

Shahe group (D_s): grey, grayish yellow and grayish black silty mudstone, carbonaceous mudstone, marlstone and argillaceous limestone, which mostly become foliated after weathering. Thickness: 66.5-71.7m.

Qiziqiao group (D_q) : dark grey dolomite limestone, containing calcite dolomite, dolomite, limestone, and sandy limestone with argillaceous limestone, locally containing chert nodule. Thickness: about 135.1m.

Longkouchong group (Dl): grey white particle limestone, dolomitic silty limestone, argillaceous limestone and argillaceous shale, and limestone usually contains micro-laminated argillaceous strip. Thickness: 467.0m.

Qilijiang group (Ddl): grey white and grey medium –thick layered micrite crystal power limestone with biocalcarenite, and the top is marlstone with biocalcarenite lenticle. Thickness:

77.0m.

4 Carboniferous system (C)

Shangbaochong group (Cs): mainly include arenaceous shale, quartz siltstone and argillaceous limestone and shale. Thickness: 94.6-212.1m.

Zhangshuwan group (C_z): mainly include medium-thick layered quartz sandstone and sarenaceous shale, with siltstone and a small amount of conglomerate. Thickness: 172.5m.

Hutian group (C_{hq}): lower: a set of grey white dolomite and dolomite limestone, thickness: 195-337m; middle and upper: a set of grey white and light grey limestone and dark grey – grayish black dolomite and dolomite limestone, thickness: 180-375m.

5. Cretaceous system (K)

Upper section of Daijiaping group (K_d^1): fuchsia medium –thick silty marlstone with silty mudstone, argillaceous siltstone and fibrous gypsic horizon. Thickness: 1153.2m.

Lower section of Daijiaping group (K_d^2): fuchsia thick massive conglomerate and glutenite with argillaceous siltstone. In the middle is mainly argillaceous siltstone and silty mudstone. Thickness: 1068.5m.

6. Quaternary system (Q)

Mainly distributed in the valleys of Xiang River and its branches, with developed sediment and distinctively graded step terrace.

Holocene series: grey brown sandy clay with sand layer; at the bottom is gravel layer. Thickness: 0-10.2m.

Pleistocene series: the upper is reddish yellow mesh-pattern sandy clay, and the lower is gravel layer and sand layer. Thickness: 0-13.0m.

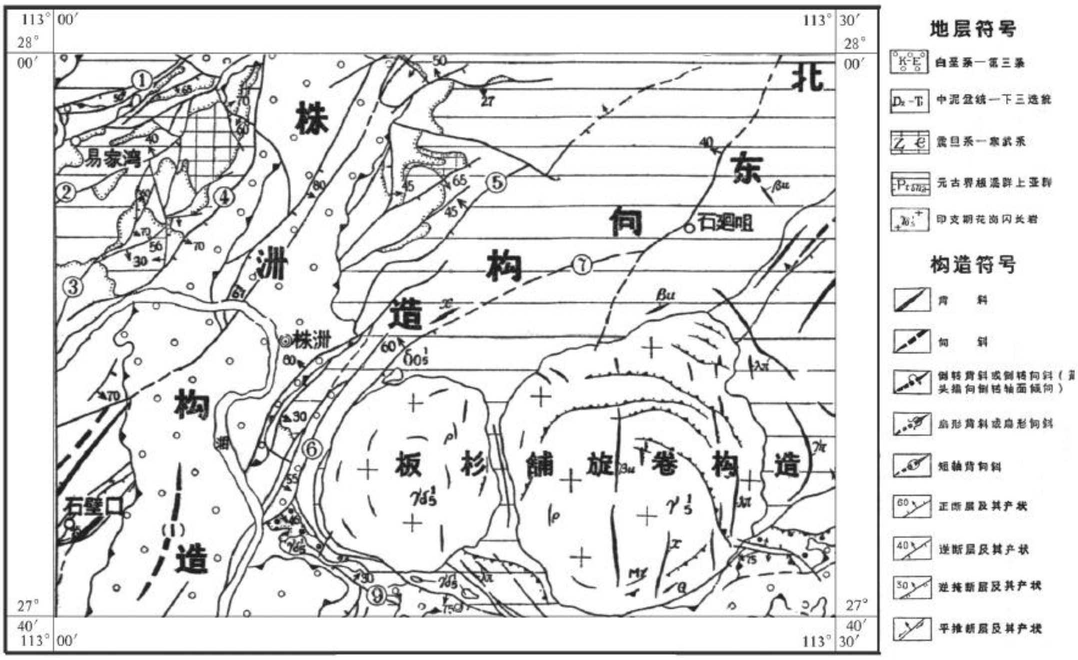
II. Geological structure

The assessment area is located in the middle section of Ping (river) – Heng (yang) Neocathaysian depression belt, and has the structure of depression basin, and it is developed on the basis of Cathaysian structure. The basin is mainly composed of cretaceous system and neogene system, and the angular unconformity is over underlying older stratum. The east-west width of the basin is 10—16km, and south-north long is 66—100km, making it a half-graben dustpan-like basin with west-faulting and east-overlapping.

The structure in the basin is complicated, and is approximately divided into NE-trending structure, Zhuzhou tectonic basin and rotational structures (See **Figure9.1-4** for structure outline map), and the major fold is Umbrella ridge short axial oblique. The main faults include Zhaoshan normal fault, Tanjiaba reverse fault, Shilichong fault, Qingshuitang normal fault, Baixianqiao reverse fault, Wulidun fault, and Shihuizui reverse fault, and most are normal faults, and the fault obliquity is mostly larger than 50°.

1. NE-bending structure

This structure is distributed in the northeast of the map area, and small folds along the stratum are developed, and the axial direction of major folds is 40°-60°, and most are homocline, asymmetric folds and drag folds. The most remarkable faults are Baixianqiao reverse fold e). and Shihuizui fault ⑦ of 40°-60°, and the extension length is about 20km. On the two sides of the faults are usually fault breccias of 1-3m wide, which are intensively silicified and filled with a great quantity of quartz veins. The south-west section of Shihuizui fault is a fracture zone wider than 100m, and the fault surface usually is 320°-340°, with inclination of 40°-70°, and it is a reverse fault.



Fold:(1)Umbrella ridge short axial oblique

Fault :1. Zhaoshan normal fault 2. Tanjiaba reverse fault 3. Shilichong fault 4. Qingshuitang normal fault 5. Baixianqiao reverse fault, 6. Wulidun fault 7. Shihuizui reverse fault

Figure9.1-4 Structure outline map

2. Zhuzhou tectonic basin

This structure is composed of cretaceous system and neogene system, and the angular unconformity is over underlying older stratum. In the map area, the east-west width of the basin is 10-16km, and the south-north length 66km, both extending outside of the map. The folds in the basin all are short axis dorsal oblique, with small range and simple formation, such as umbrella ridge short axis dorsal oblique (1). The faults mostly are normal faults, and the inclination is above 50°. Besides, in the basin, especially in the area in fault contact with the basement, it is usually seen that late-developed tenso-shear fault trails the existing torsional fault surface and yields to the fixed formation of the former for fragment combination, which belongs to succeeding fault activity.

9.1.5 Hydrogeological conditions

I. Classification of groundwater and water yield property of aquifer group

According to the objectives and tasks of the search, and ass per the burying characteristics and medium conditions of groundwater, the groundwater in the assessment are is mainly divided into loose-rock pore water, clastic-rock pore-fissure water, clastic-rock fissure water, epimetamorphic-rock fissure rock and carbonate-rock fissure-karstic water (**Figure9.1-5**). The geological water yield property and the chemical types of the groundwater is described as below:

1. Loose-rock pore water

Aquifer rock group is composed of sand layers of holocene series and pleistocene series and sandy gravel stratum, which is distributed in the terrace on the two sides of Xiang River. The terraces above Grade-III are mostly denuded or become remaining gravels, emergeing from the substrate surface, containing little water or only permeable but not containing water.

Pore water is mostly rich in sand layer or gravel and pebble strata in the middle and lower part of Grade-I and II terraces, and presents the pore-phreatic form, containing little water. The spring flow is 0.02—0.08L/S, and the single-well water yield can only meet the demand of 20-40 persons for domestic water. The buried depth of well water level usually is 1-3m. The survey shows that:

Usually there is no groundwater found at the high point of hilly slope, and the buried depth of groundwater in valley is small and the static water level of groundwater at the lowest point is basically flush with the prothole. The recharge source of groundwater usually is atmospheric precipitation, and in different periods groundwater is in complementary relationship with surface water. Usually groundwater recharges river and there is short-time reverse-recharge in flood period. The runoff slope of groundwater is related to the lithology of aquifer or the fluctuation of bedrock baseboard. The groundwater transfers from the high point to the lower point and emerges in the form of spring in lowland area or gully or is discharged by manual intake. The chemical type mainly is calcium carbonate water (HCO_3-Ca), with PH 7-9, degree of mineralization 0.1—0.5g/L and mean total hardness 2.29mmol/L.

2. Bedrock fissure water

a). Clastic-rock pore-fissure water: aquifer rock group is composed of siltstone in

Daijiaping group of cretaceous system, argillaceous siltstone and conglomerate. In this aquifer group weathering fissure and tectonic fissure are relatively developed and local parts with calcium are corroded causing fissure expanding and forming solution crack, and groundwater moves along the fissure or corrosion belt. The water yield is low, and the spring flow is 0.04—0.0084L/S, remarkably affected by seasons. The buried depth of well water level is about 2.3—6.9m.

b). Clastic-rock fissure water: aquifer stratum is composed of arenaceous shale and shale in carbioniferous system and quartze sand and arenaceous shale in Tiaomajian group of devonian system. The aquifer stratum in Tiaomajian group has medium water content and developed fissure. The monthly spring flow is 4.5L/s and the underground runoff modulus is 143.87 $m^3/d\cdot km^2$; the aquifer stratum in carboniferous system has low water content. The spring flow is 0.05-0.25L/s, remarkably affected by seasons. The buried depth of well water level is about 0.5-6m.

c). Epimetamorphic-rock fissure water: aquifer rock group is composed of slate and sandy slate in Lengjiaxi group. The aquifer rock group has developed tectonic fissure and weathering fissure, and groundwater acts along the concentrated belt of joint fissures. The water content is low, the spring flow usually is 0.039—0.065L/s, and the buried depth of well water level is about 2—8m. The recharge sources include atmospheric precipitation, stagnant water in medium and upper layers of eluvial layer and pore water. Runoff discharge is controlled by fissure development extent and landform. The groundwater in hilly slope land seeps from the high point to the lower point, and part of groundwater seeps out of the ground surface in valley or discharged by manual intake. The hydraulic property usually is phreatic water, and local part has pressure bearing capacity. The chemical type mainly is bicarbonate Calcium magnesium water (HCO_3-Ca·Mg), with PH 6.8—7.3, degree of mineralization 0.1—0.5g/L and mean total hardness 0.8 mmol/L.

3. Carbonatite-rock fissure-cavern water

Covered Carbonatite-rock fissure-cavern water: aquifer group is composed of colomite limestone, delomite, limestone and argillaceous limestone in Qiziqiao group of devonian system, and the covering layer is composed of silty clay with poor water permeability. The water content is medium, the borehole inrush water amount usually is ＞100m^3/d, and spring flow is ＞0.25L/s, remarkably affected by seasons. The buried depth of well water level is about 1.0—5.0m. The groundwater runoff modulus in dry season is 191.55$m^3/d\cdot km^2$. The chemical type mainly is HCO_3-Ca and HCO_3-Ca·Mg is next , with PH 6-7.6, degree of mineralization 0.1-0.3g/L and mean total hardness 1.11 mmol/L.

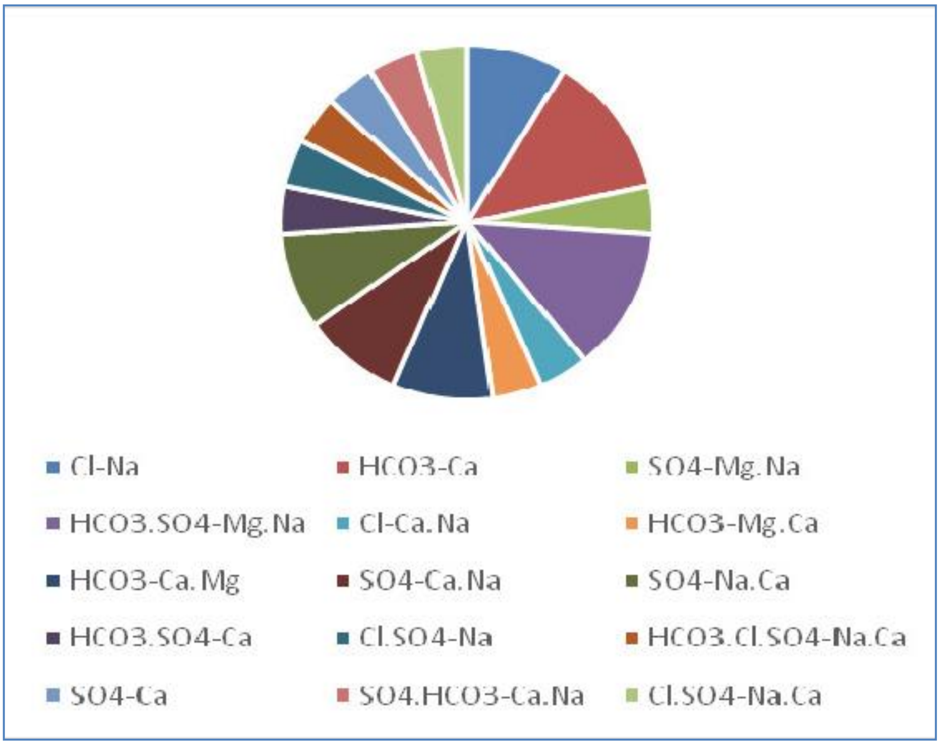


Figure9.1-5 Pie chart for chemical types of groundwater

II. Groundwater recharge, runoff and discharge conditions

Controlled by the landform, the groundwater in the assessment area is mainly recharged by atmospheric precipitation. The groundwater runoff conditions are relatively complicated. Loose-rock pore water and bedrock fissure water usually exist in the form of phreatic water, the processes of recharge, runoff and discharge are not obvious, there is no clear division among them, and the discharge area is controlled by erosion base level.

1. Loose-rock pore water

It is mainly recharged by atmospheric precipitation through direct infiltration of sand layer or gravel layer exposed on the earth surface. The infiltration coefficient usually is below 0.1, and the infiltration volume is different depending on the infiltration capacity of different lithology. The infiltration volume of gravel layer is the largest, because the aquifer usually is phreatic water and the underground runoff area is also a recharge source. The runoff slope of groundwater is related to the lithology of aquifer and the fluctuation of baseboard bedrock of pore aquifer, and the discharge area usually is Xiang River.

2. Bedrock fissure water

a). Clastic-rock pore-fissure water: the recharge source mainly is atmospheric precipitation, and the water in valley is in complementary relationship with Xiang River. In raining season, groundwater is recharged by river water but in dry season groundwater recharges river water. Because the underground flow slope in hilly land is smooth and the runoff conditions are relatively bad; groundwater is mostly discharged in the form of descending spring in gully area; the hydraulic property usually is phreatic water.

2. Clastic-rock fissure water: it is recharged vertically by atmospheric precipitation to different extents. Runoff varies with the development extent of lithological fissure. For stratum in Tiaomajian group with developed fissures and good openness, the groundwater runoff is intensive, but for shale, mudstone and marlstone, the runoff is weak and the groundwater is discharged in the form of spring.

c). Epimetamorphic-rock fissure water: The recharge sources include atmospheric precipitation, stagnant water in medium and upper layers of eluvial layer and pore water. Runoff discharge is controlled by fissure development extent and landform. The groundwater in hilly slope land seeps from the high point to the lower point, and part of groundwater seeps out of the ground surface in valley or discharged by manual intake. The hydraulic property usually is phreatic water, and local part has pressure bearing capacity.

3. Covered carbonatite-rock fissure-cavern water

It is mainly recharged by the groundwater outside of the area, and the recharge source is atmospheric precipitation. Because of long distance to the recharge area of atmospheric area, the change of groundwater far lags behind atmospheric precipitation. The discharge and runoff conditions are controlled by the development extent of tectonic fissure and the landform. In general, the runoff flows from south to north, and is discharged in the form of spring.

III. Dynamic characteristics of groundwater

Because the recharge source of groundwater in the assessment area is mainly atmospheric precipitation, it dynamic state changes periodically with rainfall, the seasonal changes of water level and water volume are remarkable, individual areas slightly lag behind. However, because of the difference in storage condition and recharge, runoff and discharge conditions of groundwater in different zones, the changes of water level and water volume in different aquifers are also different. Water-abundant rock group has high water permeability and its changes don’t lag behind obviously.

According to the long-term data statistics of multiple observation points, the groundwater level in the assessment area changes with season and the annual variation range is 0.5-1m.

IV. Chemical characteristics of groundwater

According to the analysis on sampling and testing of groundwater in 20 borholes in this survey: the sensory properties of about half of groundwater are bad, pH is 5.14-7.6, total hardness 61—869mg/L, and total mineralization 111—10487mg/L, and the water belongs to acid-alkaline low-high-mineralization water.

9.1.6 Ecological environment

The soil type is the project area is mainly quaternary soil, the soil is fertile and the climate is comfortable. 27% of the area is covered with wood land, including commercial tree species like pine, China fir, sassafras, oak, maple and phyllostachys pubescens and a small quantity of economical tree species like camellia oleifera, peach tree, grapefruit tree, persimmon tree and plum tree. Other un-developed area is mainly waste agricultural land, and the core area all is heavy-metal contaminated land, not suitable for crop planting. After regional development, the native vegetation in hilly land, downland and slope land was damaged by land levelling to some extent

The project is close to Xiang River to the south. In the water system of Xiang River, there are 147 species of fish (including subspecies), belonging to 11 orders and 24 families, accounting for 39.7% of total species (370) in the water system of Yangtze River. Cypriniformes is the major fish group in Hunan Province, 102 species, accounting for 69.5% of the total quantity in this area; siluriformes and perciformes are the next, 17 species and 13 species, respectively, accounting for 11.6% and 8.8%; and other orders have 15 species, accounting for 10.2%. cyprinid fish are the richest, 87 species, accounting for 59.% of the total quantity in this area; cobitidae and bagridae are the next, 11 species and 10 species, respectively, accounting for 7.5% and 6.8%; other 21 families have fewer species, totally 39 species, accounting for 26.5%.

As per the ecological habits, the fish resources in Xiang River may be divided into five ecological forms:

a) Brackish-water migratory fish, like Chinese sturgeon, Protosalanx hyalocranius, Anguilla japonica, etc.;

b) River semi-migratory fish, like Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmichthys molitrix, Aristichthys nobilis, Elopichthys bambusa, Ochetobius elongatus Kner, Luciobrama,e tc.;

c) Settled fish: like common carp, crucian, Silurus asotus, Pelteobagrus fulvidraco, Snakehead northerne, etc.;

d) Short-distance migratory fish: like megalobrama amblycephala, triangular bream, mystus, Xenocypris davidi, Erythroculter ilishaeformis, Erythroculter mongolicu, Silurus meridionalis, etc.;

e) Mountain-stream settled fish: like Discogobio tetrabarbatus, Clarias fuscus, Lepturichthys fimbriata, Pseudogastromyzon , etc.

Between 2006 and 2008, the yied of fish catch is 2928t ~ 2976t, and the main species include Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmichthys molitrix, common carp, crucian, Pelteobagrus fulvidraco, Silurus asotus, Squaliobarbus curriculus, siniperce chuatsi and Xenocyprininae. According to the composition of caught fish, the fishery resources at the downstream of Xiang River are mainly settled fish like common carp, crucian, Pelteobagrus fulvidraco and Silurus asotus, which assume absolute superiority and account for more than 50%; the propoportion of river semi-migratory fish like Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmichthys molitrix, Aristichthys nobilis and Elopichthys bambusa is small, reducing to 25% from 40% before the terraced development of Xiang River. According to the age of caught fish, main economic fish have a certain age gradient, but low-age fish are in the majority. Among them, four domestic fishes including Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmichthys molitrix and Aristichthys nobilis are the principal species in the farming of freshwater fishes in China, which are typical river semi-migratory fish. They spawn at the upstream of the river and the germ cells drift about in the water and hatch, and the fish can swim until swimming bladders grow up and are filled with gas.

Current situation of rare fish: there four orders, eleven families and twenty-seven species of protected fish in *the List of Hunan Provincial Key Protected Wildlife*, which are distributed in Xiang River. There is one Class-I species, one Class-2 species, one species listed in IUCN red list (1996), one species listed in CITES Appendix II and six species listed in China Red Data Book of Endangered Animals (1998). According to the investigation, the rare aquatic animals in Chang-Zhu-Tan section of Xiang River mainly include Chinese sturgenon, Myxocyprinus asiaticus, Neophocaena phocaenoides, Tenualosa reevesii and Leptobotia elongate Bleeker. Before the 1970s, the rare migratory fish in Changsha Section of Xiang River like Chinese sturgeon, Tenualosa reevesii and Anguilla japonica all occupy certain proportions in the fishery industry. Along with the terraced development of Xiang River basin, especially the trunk stream, the construction of channels for fish migration is insufficient, as a result the number of migratory fish species sharply decreases and Tenualosa reevesii almost becomes extinct.

9.2 Social environment

Zhuzhou Brownfield Remediation Project is located in the core zone of Qigshuitang Circular Economy Industrial Zone. In 1997 Qingshuitang Region was a office of the North Direct of Zhuzhou City. Since then, the administrative division of Zhuzhou City changed, and four districts are built, i.e. Shifeng District, Hetang District, Lusong District and Tianyuan District, and Qingshuitang is subordinate to Shifeng District. In 2007, Qingshuitang was list in the Second Group National Circualr Economy Development Pilot Park, and Hunan provincial government listed Qingshuitang as one of five demonstration areas which were launched preferentially for comprehensive reforming and experimenting for resource saving and environmental-friendly society construction of Changsha-Zhuzhou-Xiangtan city group. In 2009, Zhuzhou City established Qingshuitang Circular Economic Industrial Zone, which would work in the same office building with Shifeng District and perform the function of municipal economic management.

Qingshuitang Industrial Zone has a long development history, and is the major undertaking area of 156 key projects in the First-Five-Plan period and the Second-Five-Plan period in Zhuzhou City, Hunan Province as well as one of the birthplaces of Zhuzhou industry. At present, nonferrous smelting and heavy chemical industry base has been built, and is the landmark region of industrialization in Hunan Province as well as nationwide famous smelting and chemical industry base. For recent sixty years, the accumulated amount of taxes paid by the industrial zone is more than RMB 48 billion yuan. The planning area of Qingshuitang Circular Economy Industrial Zone is 47 square kilometers, and the core zone is Qingshuitang Industrial Zone, with area of 15.15 square kilometers and population of about 50 thousand.

The range of the World Bank financed heavy-metal contaminated soil remediation project is entirely in Qingshuitang Industrial Zone. Seen from the administrative division, the project site is in the jurisdiction of Tongtangwan Office of Shifeng District. Tongtangwan Street Office governs eight communities including Tongtangwan Community, Zhushan Community, Yingfeng Community, Qingshuitang Community, Xianghe Community, Dingshan Community, Yangmeitang Community and Qingxia Community, and four administrative villages including Qingshui Village, Jianshe Village, Changshi Village and Xiawan New Village. The total area is about 27.95 kilometers, and the registered population is 39 thousand and the permanent population is about 45 thousand.

Table 9.2-1Basic information of Tongtangwan Office

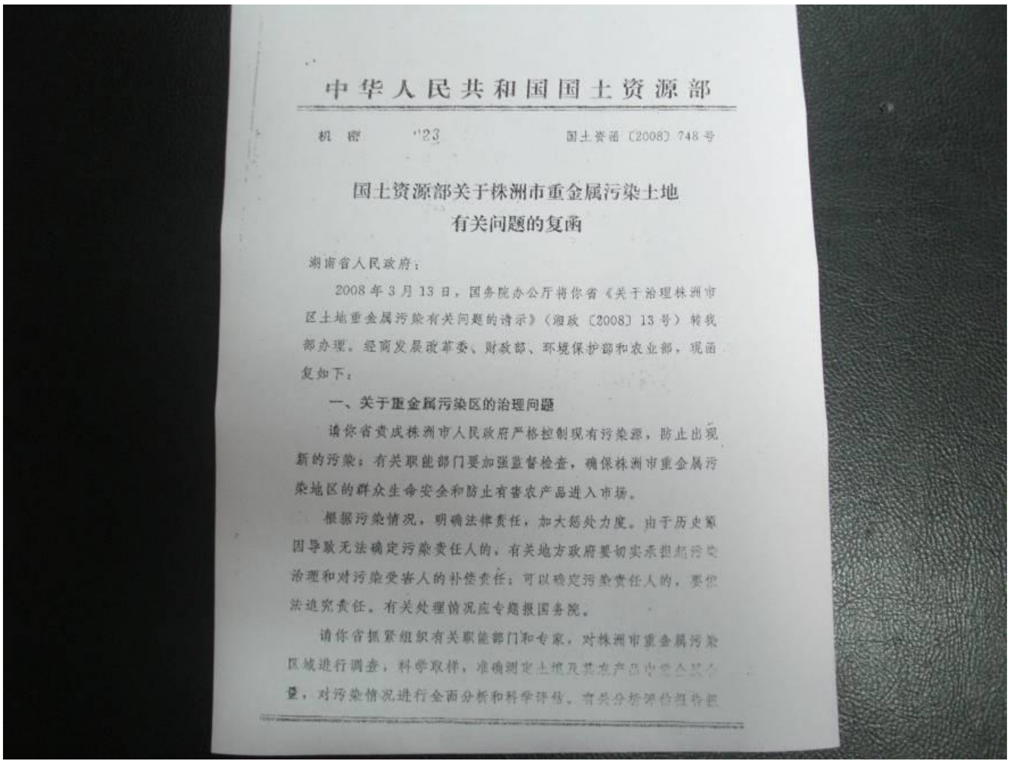
Community (village)	Area (km^2)	Population	Per capita income in 2013 (RMB yuan)
Tongtangwan Community	3.25	7152	9000
Zhushan Community	0.6	1974	20000
Yingfeng Community	4	1980	12000
Qingshuitang Community	2.5	6354	21000
Xianghe Community	0.8	838	10000
Dingshan Community	1.3	5465	10000
Yangmeitang Community	0.6	4732	12000
Qingxia Community	1.5	1680	3570
Qingshui Village	1.5	951	10000
Jianshe Village	1.9	1580	10000
Changshi Village	4	2076	9200
Xiawan New Village	6	4300	9300
Total	27.95	39082	136070

According to the overall planning and administrative division of Qingshuitang Industrial Zone, the project are may be divided into seven regions, i.e. Xiangshiling Region, Qingshi Region, Tongtangwan Region, Tongxia Region, Qingshui Region, Yingfeng Region and Qingshui Lake Region.

Table 9.2-2Basic information of population in different regions within the project scope

No.	Region	Area (km^2)	Population
1	Xiangshiling Region	1.24	1081
2	Qingshi Region	1.21	854
3	Tongtangwan Region	1.23	1185
4	Tongxia Region	1.05	1205
5	Qingshui Region	1.10	504
6	Yingfeng Region	0.97	546
7	Qingshui Lake Region	1.68	862
Total		8.48	6237

Since the 1950s, Qingshuitang area has gradually gathered more than 200 enterprises including Zhuzhou Smelting Group and CNSG Zhuzhou Chemical Industry Group. The long-term emission of industrial waste gas, wastewater and waste residues causes high content of heavy metal in soil, and becomes the key pollution source of heavy metal in Xiang River basin. At present, water bodies and soil in Qingshuitang area have been contaminated by heavy metal to different extent, cadmium, arsenic and lead exceeded standard severely, and the physical and chemical properties of most of soil have changed, affecting the production and life of residents in the area to some extent.



中华人民共和国国土资源部

机 密 "23 国土资函〔2008〕748号

国土资源部关于株洲市重金属污染土地有关问题的复函

湖南省人民政府：

2008年3月13日，国务院办公厅将你省《关于治理株洲市区土地重金属污染有关问题的请示》（湘政〔2008〕13号）转我部办理。经商发展改革委、财政部、环境保护部和农业部，现函复如下：

一、关于重金属污染区的治理问题

请你省责成株洲市人民政府严格控制现有污染源，防止出现新的污染；有关职能部门要加强监督检查，确保株洲市重金属污染地区的群众生命安全和防止有害农产品进入市场。

根据污染情况，明确法律责任，加大惩处力度。由于历史原因导致无法确定污染责任人的，有关地方政府要切实承担起污染治理和对污染受害人的补偿责任；可以确定污染责任人的，要依法追究责任。有关处理情况应专题报国务院。

请你省抓紧组织有关职能部门和专家，对株洲市重金属污染区域进行调查，科学取样，准确测定土壤及其农产品中……量，对污染情况进行全面分析和科学评估。……

Figure9.2-1 Document of the Ministry of Land and Resources on land status change in Qingshuitang area

According to the No.748 Letter sent by the Ministry of Land and Resources in November 2008, the contaminated land in Qingshuitang area is not suitable for crop planting, and it is required to change land classification, and the members in the collective economic organization in the land shall be correspondingly relocated and compensated. According to the document published by the Ministry of Land and Resources in 2009, the agricultural land within the range of 6.7 square kilometers in the core zone of Qingshuitang area shall be transformed into construction land in one time, the residents in the communities and villages governed by Tongtangwan Office shall be changed into urban residents and be brought into the network of urban resident employment and social security, and the land contracted by the original economic organization hasn't been the income source of the residents in the area.

9.3 Overview of Qingshuitang Industrial Zone

9.3.1 Overview

Qingshuitang Industrial Zone borders on Fahua Mountain to the west, Baishi Channel to the east, Zhuzhou North Station to the north and Xiang River to the south and the area of the core zone is about 16 square kilometers. The remediation area is in the core zone.

The core zone is divided into transformed area and expanded area. The existing industrial enterprises in the transformed area mainly include Zhuzhou Smelting Plant, Zhuzhou Chemical Industry Plan and Zhicheng Chemical Industry Plant, and there are also many medium and small-sized chemical industry and smelting plants, and the area of industrial land is 4.2 square kilometers; the expanded area is located to the west of the transformed area, mainly including Jianshe Village, Changshi Village, Xinqiao Village and Yingfeng Neighborhood Committee governed by Togtang Office, and the area is about 8.32 square kilometers.

Environmental Impact Report on the Planning of the Core Zone of Zhuzhou Qingshuitang Circular Economic Industrial Zone obtained the comments of Hunan Department of Environment Protection (XH Letter [2010] No.162) in April 30, 2010.

9.3.2 Current situation of municipal public facilities

(1) Water supply and drainage

1) Water supply y

The water supply sources of the core zone are the second and third water plants located on Yangjiang North Road, which are supplied by Xiang River. Now the water supply scale of the second water plant is 55×10^4 m^3/d, including filtered water of $20\times10^4 m^3/d$ and precipitated water of $35\times10^4 m^3/d$; and the the water supply scale of the third water plant is $50\times10^4 m^3/d$, including filtered water of $240\times10^4 m^3/d$ and precipitated water of $26\times10^4 m^3/d$. The precipitated water of the second and third plants are mainly supplied as industrial water for industrial and mining enterprises like Xiangdan Industry, Zhuzhou Chemicals and Zhuzhou Smelting Group; and the filtered water is used as domestic water and for other purposes. The water supply volume, water pressure and water quality basically meet the current demand of the zone.

2) Water drainage

There is one sewage treatment plant in the core zone, Xiawan Sewage Treatment Plant, which is located in the lower reach of Xiawangang and is responsible for the sewage treatment of Qingshuitang Region and Xiangshilinng Region and the treatment scale of which is 100 thousand m^3/d. The existing drainage pipes in other regions are mainly open drains or concrete pipes distributed along Qingxia Road and Tongxia Road, and the water is finally discharged into Xiang River.

The current drainage mode of the core zone is confluence of rainwater and sewage, and the rainwater is discharged into the surrounding water bodies. In this case, rainstorm may inundate roads or lowland and cause severe pollution to Xiang River and water bodies in the zone.

(2) Power supply

The main power supplies in the core area are Zhuzhou Thermal Power Plant in Qingshuitang Industrial Zone and Yuntian 500KW Substation. The former is located between Hongfu Road and Xiang River, its installed capacity is 850 thousand KW, and the power is tied to the grid in 220KW and plays a role of inner supporting in Zhuzhou urban power grid. The latter is located in Yunlong New City, and the main transformer is 2×1500MVA, and the power is sent to Zhuzhou and Changsha power grid in 220KW and plays a role of outer supporting in Zhuzhou urban power grid.

There are five 220KW substations in Qingshuitang Industrial Zone, i.e. Zhuye 220KW Substation, Baimalong 220KV Substatin, Yezichong 220KW Substation, Zhuhua 220KV Substation, Downtown 220KV Substation (in construction), and ten 110KW substations. The current 220KV high-voltage corridor mainly begins from Baimalong 220KV Substation, passes through Zhuye Substation, Zhuhua Substation and Yezichong Substation, connects to Zhuzhou Power Plant and extends to Yuntian Substation.

(3) Fuel gas supply

At present, liquefied gas is mainly used in Qingshuitang area. The gas supply of large-sized enterprises is mostly depending on pipelines, and the main domestic gas supply is bottled gas, which cannot meet the needs of rapid urban development or bring scale effect and has hidden dangers in production.

9.4Regional environmental quality investigation

9.4.1 Groundwater environment investigation

The hydrogeological investigation of groundwater and the monitoring of current environmental quality situation in the project are quoted from Special Report on Groundwater Environmental Impact Assessment for Zhuzhou Qingshuitang Circular Economy Industrial Zone (Geophysical Survey Party of Hunan Coalfield Geology Bureau, October 2010).

9.4.1.1 Hydrogeological investigation

9.4.1.1.1 Distribution of exploratory points

In the investigation, there are 24 exploratory points (19 new exploratory points plus five applied boreholes, among which, Zk6 is a long-term monitoring well set by Zhuzhou Environmental Monitoring Center), among which, 17 points are distributed in the range of the core zone of 16 square kilometers and the other 7 points are outside of the core zone but in the assessment area (**Figure1.6-3**), meeting the requirements for ascertaining the hydrogeological conditions in the zone. In practical work, due to complicated hydrogeological conditions and intensive distribution of enterprises and ponds, the exploration of Zk24 was not carried out as scheduled, and no water taken at some points (ZK13, ZK 19 and ZK22), therefore the exploration of 20 sampling points were completed.

Five XY-100 drilling machines are used for the investigation. For medium groundwater level, rotary spiral drill is used, and for low groundwater level, slurry-supporting rotatory core-barrel drilling is adopted.

9.4.1.1.2 Formation lithology of the zone

The exposure formation lithology in the core zone is mainly fuchsia sandstone and mudstone in cretaceous system, sandstone and slate in Lengjiaxi group and quaternary system, and limestone and dolomite limestone in Qiziqiao group of devonian system are the next. Among them, cretaceous system is widely distributed in the middle east area of the core zone, and the area is more than 50%; Lengjiaxi group is distributed in the middle west area; and the quaternary system is mainly distributed in the terrace land and gully of Xiang River, and others are distributed sporadically. See Section 9.1.5 for lithological characteristics.

9.4.1.1.3 Geological structure of the zone

The core zone is located in the middle of Zhuzhou tectonic basin, and the major fault is

Qingshuitang fault (F151). This fault (F151) extends along the west edge of Zhuzhou basin, and the direction in Qingshuitang section to the south of Huilongwan is about 40° and that to the noth 5°～10°. It presents an arc protruding to the southeast and is a long-term active fault, and the length is about 20km. As a whole, it is a normal fault, trending to the southeast with inclination of about 70°and locally trending to the northwest. In terms of property, it is a compression – torsion fault. See **Figure9.4-1**.

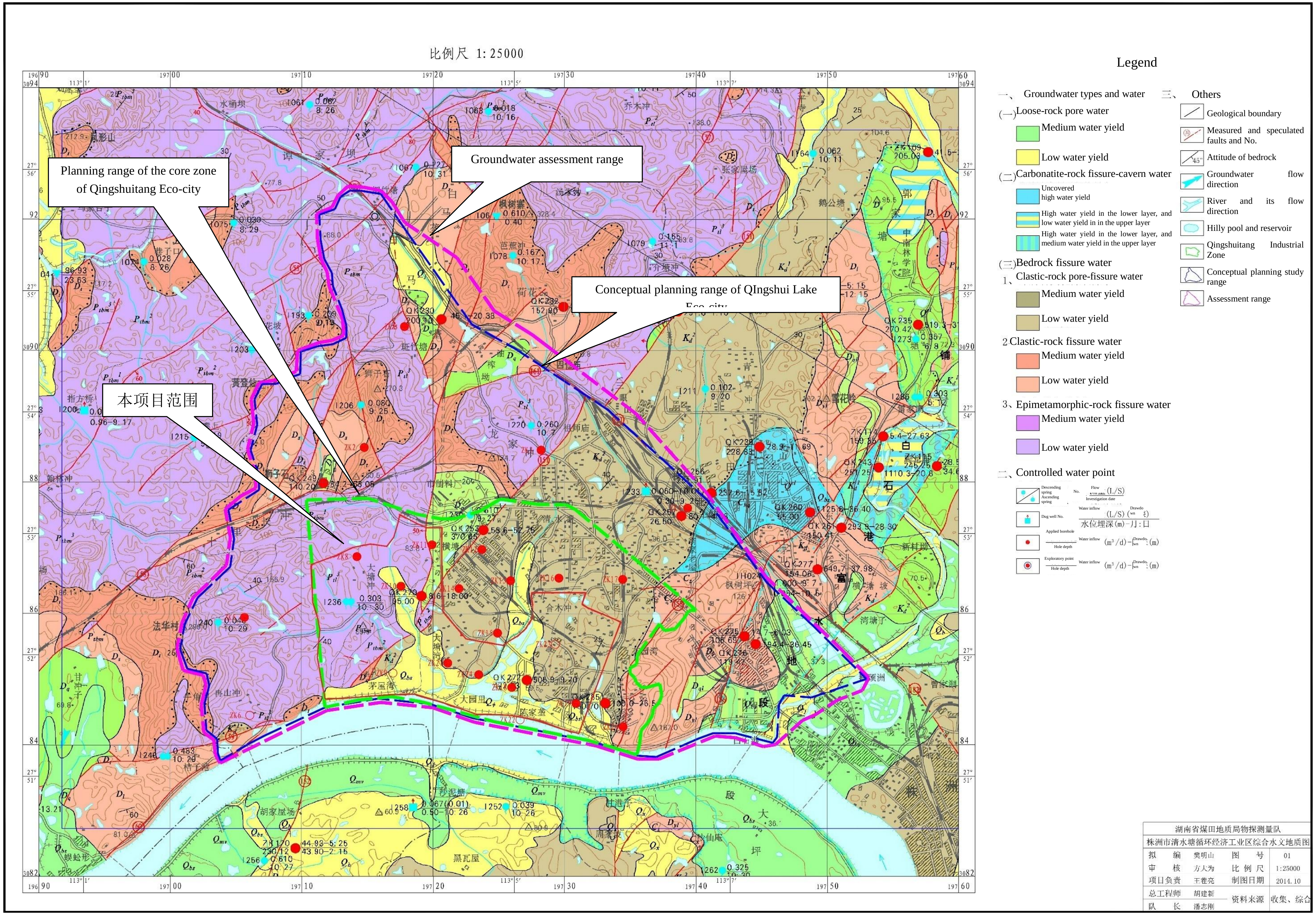


Figure9.4-1 Integrated hydrogeological map

9.4.1.1.4 Hydrogeological characteristics of the zone

1. Characteristics of vadose zone

The lithology of vadose zone in the core zone varies with the underlying bedrock, and may be divided into “red-bed” eluvial layer, epimetamorphic-rock eluvial layer and quaternary-system alluvial and diluvial layer. See **Figure9.4-2** for thickness.

(1) “Red-bed” eluvial layer

This layer is distributed in the clastic rock area of cretaceous system, and the covering area is 7.01 square kilometers, accounting for 43.28% of the total area of the zone. The thickness usually is 5-13.45m. Conglomerate, sandstone, siltstone and mudstone are intensively weathered to eluvial soil. The lithology mainly is clayey soil, sandy soil and pebble sandy soil.

Calyey soil: mainly powder light clay and heavy-clayey loam, part is mesh pattern. The natural water content is 13.67-24.4%. Medium~high liquid limit, plastic. Medium~low compressive soil, quite wet ~ water-saturated, hard ~ rigid plastic, locally swell-shrink characteristic. Sandy soil: mainly medium and fine sand, loose. Pebble sandy soil: mainly arenopelitic gravel and rubble, loose. The natural water content is 14.7-24.2%.

(2) Epimetamorphic-rock eluvial layer

This layer is distributed in the epimetamorphic rock area of Lengjiaxi group and Banxi group and the covering area is 3.79 square kilometers, accounting for 23.38% of the total area of the zone. The thickness usually is 1.05-2.96m, and it is thicker at the foot of slope and at the bottom of valley in normal conditions. The lithology mainly is powder light clay and heavy-clayey loam, and part is loam. The natural water content is 16.8-32.1%.

(3) Quaternary-system alluvial and diluvial layer

The layer is distributed on the north bank of Xiang River in the south of the zone and in the gully, and the covering area is 3.70 square kilometers, accounting for 22.8% of the total area of the zone. The thickness usually is 0.4-6.5m. The lithology mainly is sludge and mucky soil, mostly covered with artificial soil fill. The natural water content is high, usually 24.6-40.19%, and the maximum water content is 96.68%, soft-flow plastic, with high void ratio, and the maximum void ratio reaches 3.05. Moreover, in the middle north part of the core zone, a small amount of marine clastic-rock eluvial clayey soil is distributed, ad the covering area is 0.9 square kilometers, accounting for 5.53% of the total area of the zone. The thickness usually is 2.95-13.30m. The lithology mainly is light clay, heavy-clayey loam and powder light clay containing sandy gravel, and the natural water content is 13.1-26.2%.

2. Hydrological conditions

As per the characteristics of water-bearing media, the groundwater in the zone is divided into loose-rock pore water, clastic-rock pore-fissure water and epimetamorphic-rock fissure water, and locally carbonatite-rock fissure-cavern water. The burying and storage properties and the characteristics of recharge, runoff and discharge of the groundwater are basically consistent with the assessment area, as described in Section 9.1.5. See **Figure9.4-1** for integrated hydrological map and **Figure9.4-3** for groundwater isobath map.

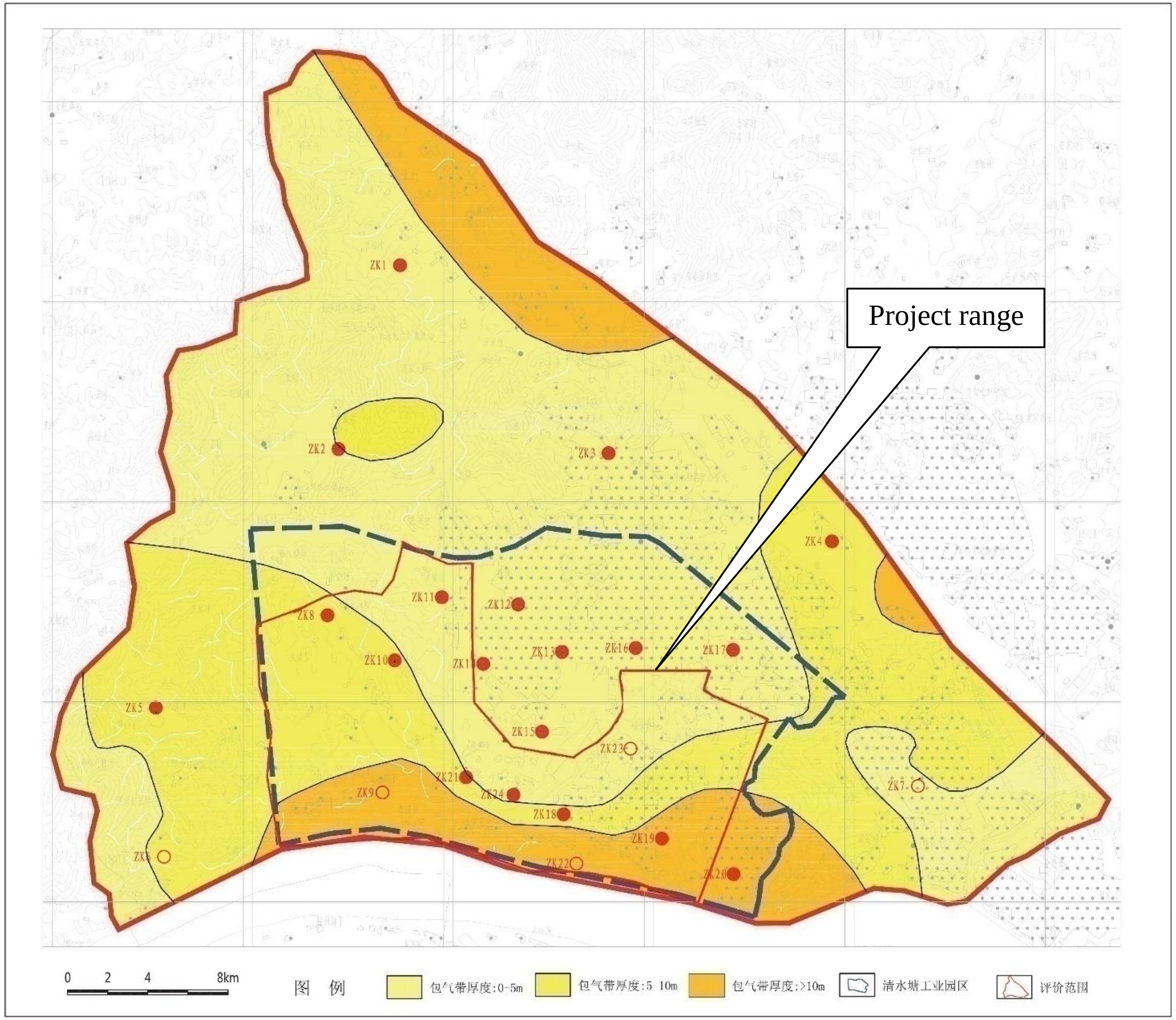


Figure9.4-2 Vadose zone isopach map

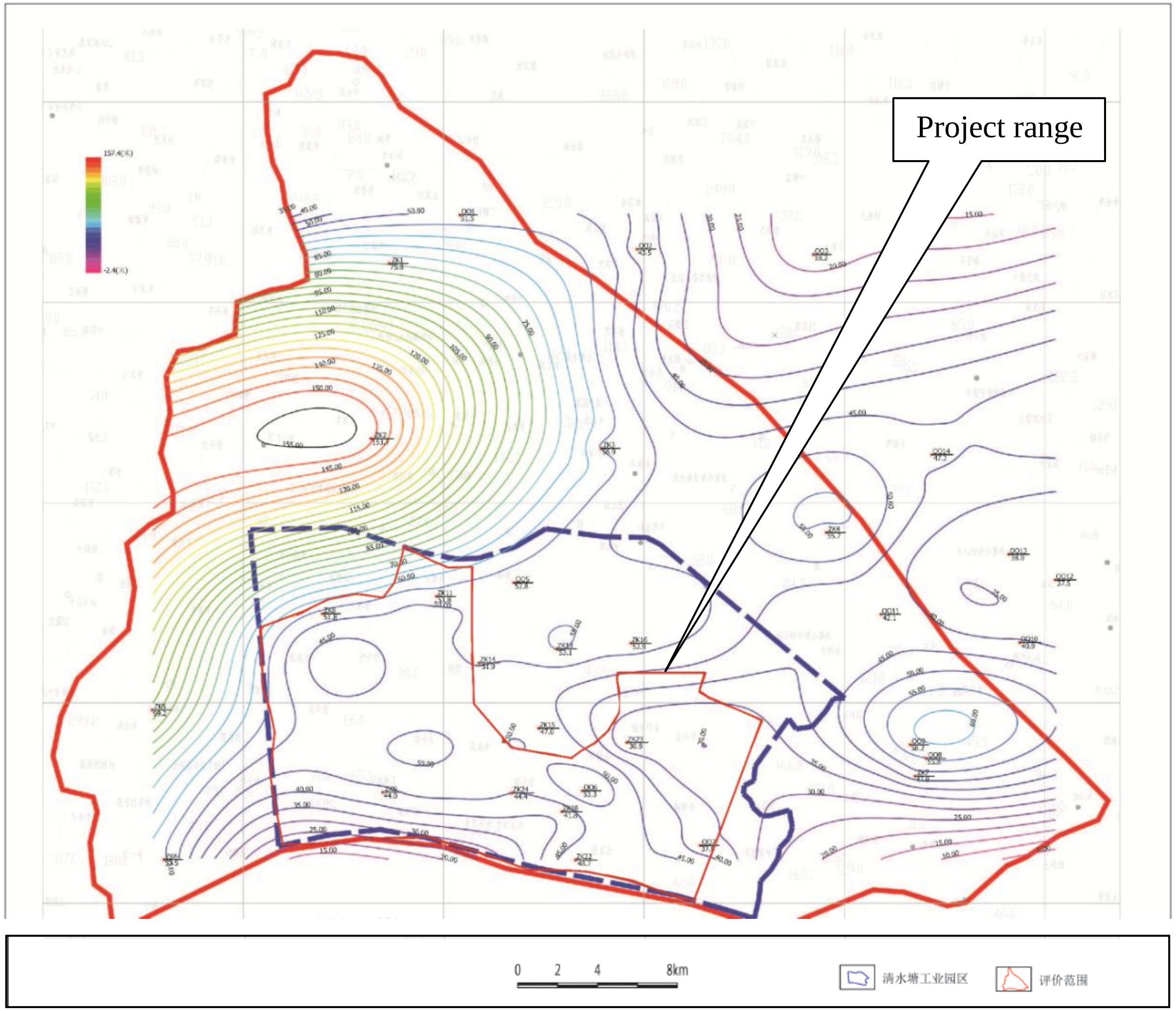


Figure9.4-3Groundwater level isobath map

9.4.1.2 Groundwater environmental quality assessment

9.4.1.2.1 Monitoring factors

The monitoring items for the groundwater in the assessment are include: total dissolved solids, total hardness, pH, ammonia nitrogen, iron, sulfate, chloride, nitrate nitrogen, nitrite nitrogen, Cu, Zn, Pb, Se, Hg, Cd, Cr (hexavalent), As, Mn, Co, Ni, Ba and Be.

9.4.1.2.2 Monitoring analysis methods

The management, analysis tests and quality control of the groundwater quality samples is implemented according to HJ/T164(**Table 9.4-1**).

Table 9.4-1Monitoring items and analysis methods for groundwater quality

No.	Monitoring item	Analysis method	Class-II I standard
1	Total dissolved solids (mg/L)	8.4 IN GB/T 5750.4-2006	1000
2	Total hardness (calculated by $CaCO_3$) (mg/L)	8.4 IN GB/T 5750.4-2006	450
3	pH	8.4 IN GB/T 5750.4-2006	6.5～8.5
4	Ammonia nitrogen (mg/L)	GB/T 5750.5-2006 中 8.4	0.2
5	Iron (mg/L)	GB/T 5750.6-2006 中 8.4	0.3
6	I (mg/L)	GB/T 5750.5-2006 中 3.1	0.2
7	Sulfate (mg/L)	GB/T 5750.5-2006 中 8.4	250
8	Chloride (mg/L)	GB/T 5750.5-2006 中 8.4	250
9	Nitrate nitrogen (by N) (mg/L)	GB/T 5750.5-2006 中 8.4	20
10	Nitrite nitrogen (by N) (mg/L)	GB/T 5750.5-2006 中 8.4	0.02
11	Cu (mg/L)	GB/T 5750.6-2006 中 8.4	1.0
12	Zn (mg/L)	GB/T 5750.6-2006 中 8.4	1.0
13	Pb (mg/L)	GB/T 5750.6-2006 中 8.4	0.05
14	Se (mg/L)	GB/T 5750.6-2006 中 8.4	0.01
15	Hg (mg/L)	GB/T 5750.6-2006 中 8.4	0.001
16	Cd (mg/L)	GB/T 5750.6-2006 中 8.4	0.01
17	Cr (hexavalent) (mg/L)	GB/T 5750.6-2006 中 8.4	0.05
18	As (mg/L)	GB/T 5750.6-2006 中 8.4	0.05
19	Mn (mg/L)	8.4 IN GB/T 5750.4-2006	0.1
20	Co (mg/L)	8.4 IN GB/T 5750.4-2006	0.05
21	Ni (mg/L)	8.4 IN GB/T 5750.4-2006	0.05
22	Ba (mg/L)	8.4 IN GB/T 5750.4-2006	1
23	Be (mg/L)	8.4 IN GB/T 5750.4-2006	0.0002

9.4.1.2.3 Monitoring results

See **Table 9.4-2** for groundwater monitoring results, among which, no water is found in No. 13, 19 and 22 points.

9.4.1.2.4 Analysis of current situation of groundwater environmental quality

Single-factor assessment method is adopted for the groundwater environmental quality assessment.

According to *Technical Guidelines for Environmental Impact Assessment – Groundwater*

Environment (HJ610-2011), the single-factor assessment method is described as below:

(1) As for the water quality factor for which the assessment standard is a fixed value, the formula is:

$$P_i = \frac{C_i}{C_{si}}$$

where, P_i—Standard index of the i-th water quality factor, dimensionless;

C_i—Monitoring concentration value of the i-th water quality factor, mg/L;

C_{si}— Standard concentration value of the i-th water quality factor, mg/L.

(2) As for the water quality factor which the assessment standard is an interval value, the formula is:

$$P_{pH} = \frac{7.0 - pH}{7.0 - pH_{sd}}, \quad pH \le 7$$

$$P_{pH} = \frac{pH - 7.0}{pH_{su} - 7.0}, \quad pH \ge 7$$

where, P_{pH}—Standard index of pH , dimensionless;

pH—Monitoring value of pH ;

pH_{sd} —Low limit value of standard pH;

pH_{su}—Upper limit value of standard pH.

If standard index is >1, it shows that this water quality factor exceeds the specified water quality standard. The larger the designation, the more severely the factor exceeds the standard.

As per the abovementioned method, see **Table 9.4-3** for standard indices of water quality parameters of each monitoring point.

The results show that: at ZK1, ZK8 and ZK11 iron exceeds Class-II I standard; at ZK14, ZK15 and ZK21 sulfate exceeds Class-II I standard; at ZK1、ZK3、ZK71、ZK93、ZK20、ZK23, nitrate nitrogen exceeds Class-II I standard; at ZK2, ZK3, ZK4, ZK7, ZK8, ZK11, ZK15, ZK17, ZK20, ZK21 and ZK23 nitrite nitrogen exceeds Class-II I standard; at ZK14 and ZK21 total dissolved solids exceed Class-II I standard; at ZK4, ZK8,ZK10,ZK15, ZK16, ZK18, ZK20 and ZK21 manganese exceeds Class-II I standard, and at ZK1, ZK3, ZK6-ZK10, ZK12, ZK16-ZK18, ZK20, ZK21 and ZK23 beryllium exceeds Class-II I standard.

According to the monitoring data and analysis results on groundwater quality for which the groundwater was sampled by the Geophysical Survey Party of Hunan Coalfield Geology Bureau in dry season, the main factors exceeding the standard are nitrite nitrogen and beryllium, and nitrite nitrogen exceeds the standard severely and the maximum times of ultra standard is 50; beryllium at 65% of exploratory points exceeds the standard, and the maximum times of ultra standard is 16. The measured values of beryllium at the points in the zone equal to the values of Class-II I standard. Manganese at 38% of exploratory points exceeds the standard, and the times of ultra standard is relatively low except that manganese at ZK21 exceeds the standard by 32.6 times; sulfate, solid dissolved solids and iron at some points exceed the standard, and nitrate nitrogen at individual points exceed the standard; the other factors don't exceed the standard. Seen from the factors exceed the standard, the assessment area mainly involves agricultural and domestic pollution, and beryllium and manganese exceeding the standard show that there is industrial pollution to some extent.

Table 9.4-2Groundwater monitoring results

Assessment factor	**ZK1**	**ZK2**	**ZK3**	**ZK4**	**ZK5**	**ZK6**	**ZK7**	**ZK8**	**ZK9**	**ZK10**
Ammonia nitrogen	0	0	0	0	0.2	0	0	0	0	0
Iron	0.35	0.055	0.018	0.14	0.03	0.0034	0.032	0.53	0.0079	0.15
Chloride	7	0.8	25.4	36.4	9.5	15.7	79.7	7.1	76.2	12.6
Sulfate	111	8.44	91.1	132	164	172	63.8	7.0	126	23.8
Nitrate nitrogen	25.3	0.3	34.6	11.5	1	0.2	92.3	8.9	113	5.6
Nitrite nitrogen	0	0.04	0.03	0.14	0	0	0.17	0.05	0	0
Zn	0.049	0.011	0.044	0.7	0.037	0.0049	0.057	0.0062	0.026	0.011
I	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dissolved solids	274	228	292	366	332	422	415	180	668	263
Cu	0.0013	0.0004	0.0004	0.0008	0.0017	0.0015	0.0007	0.0007	0.0014	0.0005
Pb	0.0006	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Mn	0.013	0.057	0.0072	0.22	0.013	0.0033	0.054	0.1	0.0039	0.66
Co	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ni	0.015	0.0095	0.023	0.0058	0.0098	0.0045	0.0096	0.0095	0.016	0.013
Ba	0	0	0	0	0	0	0	0	0	0
Cr	0.0005	0.0004	0.0004	0.0004	0.0005	0.0005	0.0004	0.0005	0.0004	0.0004
Cd	0.0002	0.0001	0.0001	0.0004	0.0001	0.0001	0.0002	0.0001	0.0002	0.0001
Hg	0.0002	0.0002	0.0006	0.0002	0.0002	0.0004	0.0003	0.0002	0.0002	0.0002
Be	0.0003	0.0002	0.0003	0.0002	0.0002	0.0003	0.0006	0.0003	0.0003	0.0003
Total hardness	61	197	77	135	90	192	152	101	434	200
As	0.0003	0.0004	0.0004	0.0005	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005
pH	6.68	7.49	6.6	6.56	6.855	7.4	6.59	6.97	7.1	6.73

Assessment	**ZK11**	**ZK12**	**ZK13**	**ZK14**	**ZK15**	**ZK16**	**ZK17**	**ZK18**	**ZK20**	**ZK21**	**ZK23**	**ZK29**
Ammonia	0	0		0	0	0	0	0	0	0	0	0
Iron	0.62	0.007		0.001	0.088	0.056	0.17	0.066	0.11	0.043	0.001	0.0002
Chloride	1.6	37.5		64.4	47.8	67.1	22.3	128	29.5	48.4	37.6	14.1
Sulfate	4.7	149		1030	380	101	23.8	188	122	864	219	144
Nitrate	1.6	14.3		0.4	15	19.2	14.9	4.3	83.1	3.1	49.5	3.6
Nitrite	0.02	0		0	0.03	0	0.05	0	0.06	1.02	0.07	0
Zn	0.0096	0.16		0.075	0.048	0.11	0.0021	0.0085	0.069	0.13	0.0072	0.0017
I	0.001	0.001		0.011	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	0.00	0.00		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	181	378		1750	943	299	202	625	403	1345	574	402
Cu	0.0002	0.0011		0.0069	0.003	0.001	0.0007	0.0038	0.0012	0.0037	0.0014	0.0012
Pb	0.0001	0.0006	No water	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Mn	0.021	0.0098		0.023	0.19	0.36	0.034	0.11	0.63	3.36	0.02	0.0021
Co	0.00	0.00		0	0.00	0.02	0.00	0.00	0.02	0.03	0.00	0.00
Ni	0.0038	0.0073		0.035	0.017	0.029	0.0057	0.014	0.015	0.049	0.01	0.0052
Ba	0	0		0	0	0	0	0	0	0	0	0
Cr	0.0004	0.0004		0.0006	0.0005	0.0005	0.0004	0.0005	0.0005	0.0005	0.0005	0.0004
Cd	0.0001	0.0008		0.0008	0.0008	0.001	0.0001	0.0013	0.0013	0.0086	0.0005	0.0002
Hg	0.0002	0.0002		0.0002	0.0005	0.0003	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002
Be	0.0002	0.0003		0.0002	0.0002	0.0034	0.0003	0.0003	0.0007	0.0004	0.0003	0.0003
Total	111	121		957	580	69	129	359	111	869	273	167
As	0.0005	0.0003		0.0005	0.0005	0.0004	0.0004	0.0004	0.0003	0.0004	0.0005	0.0005
pH	7.1	6.51		7.7	7.13	5.14	7.36	7.165	6.55	6.58	7.12	7.17

Table 9.4-3 Calculation results of standard indicators of water quality parameters

Assessment factor	ZK1	ZK2	ZK3	ZK4	ZK5	ZK6	ZK7	ZK8	ZK9	ZK10
Ammonia nitrogen	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Iron	1.17	0.18	0.06	0.47	0.10	0.01	0.11	1.77	0.03	0.50
Chloride	0.03	0.00	0.10	0.15	0.04	0.06	0.32	0.03	0.30	0.05
Sulfate	0.44	0.03	0.36	0.53	0.66	0.69	0.26	0.03	0.50	0.10
Nitrate nitrogen	1.27	0.02	1.73	0.58	0.05	0.01	4.62	0.45	5.65	0.28
Nitrite nitrogen	0.00	2.00	1.50	7.00	0.00	0.00	8.50	2.50	0.00	0.00
Zn	0.05	0.01	0.04	0.70	0.04	0.00	0.06	0.01	0.03	0.01
I	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Se	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dissolved solids	0.27	0.23	0.29	0.37	0.33	0.42	0.42	0.18	0.67	0.26
Cu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pb	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.13	0.57	0.07	2.20	0.13	0.03	0.54	1.00	0.04	6.60
Co	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ni	0.30	0.19	0.46	0.12	0.20	0.09	0.19	0.19	0.32	0.26
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cr	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cd	0.02	0.01	0.01	0.04	0.01	0.01	0.02	0.01	0.02	0.01
Hg	0.20	0.20	0.60	0.20	0.20	0.40	0.30	0.20	0.20	0.20
Be	1.50	1.00	1.50	1.00	1.00	1.50	3.00	1.50	1.50	1.50
Total hardness	0.14	0.44	0.17	0.30	0.20	0.43	0.34	0.22	0.96	0.44
As	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Assessment factor	**ZK11**	**ZK12**	**ZK14**	**ZK15**	**ZK16**	**ZK17**	ZK18	ZK20	ZK21	ZK23	ZK29
Ammonia nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0. 00	0. 00	0. 00	0. 00	0. 00
Iron	2.07	0.02	0.00	0.29	0.19	0.57	0. 22	0. 37	0. 14	0. 00	0. 00
Chloride	0.01	0.15	0.26	0.19	0.27	0.09	0. 51	0. 12	0. 19	0. 15	0. 06
Sulfate	0.02	0.60	4.12	1.52	0.40	0.10	0. 75	0. 49	3. 46	0. 88	0. 58
Nitrate nitrogen	0.08	0.72	0.02	0.75	0.96	0.75	0. 22	4. 16	0. 16	2. 48	0. 18
Nitrite nitrogen	1.00	0.00	0.00	1.50	0.00	2.50	0. 00	3. 00	51. 00	3. 50	0. 00
Zn	0.01	0.16	0.08	0.05	0.11	0.00	0. 01	0. 07	0. 13	0. 01	0. 00
I	0.01	0.01	0.06	0.01	0.01	0.01	0. 01	0. 01	0. 01	0. 01	0. 01
Se	0.00	0.00	1.00	0.00	0.00	0.00	0. 00	0. 00	0. 00	0. 00	0. 00
Total dissolved solids	0.18	0.38	1.75	0.94	0.30	0.20	0. 63	0. 40	1. 35	0. 57	0. 40
Cu	0.00	0.00	0.01	0.00	0.00	0.00	0. 00	0. 00	0. 00	0. 00	0. 00
Pb	0.00	0.01	0.00	0.00	0.00	0.00	0. 00	0. 00	0. 00	0. 00	0. 00
Mn	0.21	0.10	0.23	1.90	3.60	0.34	1. 10	6. 30	33. 60	0. 20	0. 02
Co	0.00	0.00	0.00	0.00	0.40	0.00	0. 00	0. 40	0. 60	0. 00	0. 00
Ni	0.08	0.15	0.70	0.34	0.58	0.11	0. 28	0. 30	0. 98	0. 20	0. 10
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0. 00	0. 00	0. 00	0. 00	0. 00
Cr	0.01	0.01	0.01	0.01	0.01	0.01	0. 01	0. 01	0. 01	0. 01	0. 01
Cd	0.01	0.08	0.08	0.08	0.10	0.01	0. 13	0. 13	0. 86	0. 05	0. 02
Hg	0.20	0.20	0.20	0.50	0.30	0.10	0. 20	0. 20	0. 20	0. 20	0. 20
Be	1.00	1.50	1.00	1.00	17.00	1.50	1. 50	3. 50	2. 00	1. 50	1. 50
Total hardness	0.25	0.27	2.13	1.29	0.15	0.29	0. 80	0. 25	1. 93	0. 61	0. 37
As	0.01	0.01	0.01	0.01	0.01	0.01	0. 01	0. 01	0. 01	0. 01	0. 01

Table 9.4-4 2009 – 2014 Groundwater monitoring statistics of Xiawan well

(Unit: mg/kg, ecxcept pH)

Meauring point	Monitoring time	Chroma (times)	pH	Total hardness (Germany)	Dissolved solids	Sulfate	Chloride	Fe	Mn	Cu	Zn	Volatile phenol	Anionic surfactant	Permanganate index	Nitrate nitrogen	Nitrite nitrogen	Ammonia nitrogen	Fluoride	Cyanide	Hg	As	Cd	Cr^{6+}	Pb	Ni	fecal coliform (no./l)	Se
Xiawan measuring well	2009.5	10	7.03	11.39	581	215.0	40.2	0.047	0.049	0.00118	0.209	0.002L	0.05L	2.45	13.8	0.375	0.240	0.336	0.002L	0.00005L	0.0119	0.00254	0.004L	0.00127	0.016L	5400	0.0004
	2009.11	5	7.50	11.22	543	37.6	10.2	0.010	0.008	0.001L	0.003L	0.002L	0.05L	0.42	13.6	0.085	0.170	0.226	0.002L	0.00005L	0.0043	0.00151	0.004L	0.00009	0.016L	260	0.0003
	2010.5	20	6.65	22.16	515	48.7	47.5	0.013	0.056	0.00773	0.111	0.002L	0.05L	1.77	99.2	0.002L	0.360	0.284	0.002L	0.00005L	0.0084	0.00020	0.004L	0.00001	0.016L	260	0.0005
	2010.11	10	7.45	13.91	500	37.4	15.3	0.036	0.005	0.00029	0.010	0.002L	0.05L	0.84	16.2	0.002L	0.05	0.179	0.002L	0.00002L	0.0188	0.00005	0.004L	0.00005	0.021	270	0.0003
	2011.5	10	6.47	13.13	481	20.9	84.7	0.014	0.008	0.00144	0.224	0.002L	0.05L	1.10	12.1	0.002L	0.17	0.872	0.002L	0.00002L	0.0017	0.00360	0.004L	0.00120	0.016L	18000	0.0015
	2011.11	15	6.84	9.19	510	130.0	77.2	0.047	0.061	0.001L	0.093	0.002L	0.05L	1.42	0.5	0.003L	0.17	0.976	0.002L	0.00002L	0.0041	0.00039	0.004L	0.00008	0.016L	4900	0.0002
Class-II I standard		15	6.5-8.5	450	1000	250	250	0.3	0.1	1.0	1.0	0.002	0.3	3.0	20	0.02	0.2	1.0	0.05	0.001	0.05	0.01	0.05	0.05	0.05		0.01

Meauring point	Monitoring time	Chroma (times)	pH	Total hardness (Germany)	Dissolved solids	Sulfate	Chloride	Fe	Mn	Cu	Zn	Volatile penol	Anionic surfactant	Permanganate index	Ordor and taste	Nitrate nitrogen	Nitrite nitrogen	Ammonia nitrogen	Fuoride	Cyanide	Hg	As	Cd	Cr^{6+}	Pb	Ni	fecal coliform (no./l)	Se	Total number of bacteria
Xiawan measuring well	2012.5	20	6.69	11.42	469	307.0	39.0	0.042	0.012	0.00340	0.202	0.002L	0.05L	1.56	Weak	42.1	0.080	1.03	0.831	0.002L	0.00005	0.00166	0.00170	0.004L	0.00052	0.016L	24000	0.0011	1720
	2012.11	15	6.85	16.69	397	194.0	61.4	0.034	0.005L	0.00087	0.127	0.002L	0.05L	2.48	Weak	1.6	0.003L	0.65	0.864	0.002L	0.00002L	0.00488	0.00064	0.004L	0.00018	0.016L	9200	0.0029	200
	2013.5	10	6.79	13.89	349	206.0	34.2	0.010L	0.010	0.00187	0.085	0.002L	0.05L	1.22	Weak	27.7	0.003L	0.26	0.940	0.002L	0.00002L	0.00327	0.00028	0.004L	0.00030	0.016L	24000	0.0008	540
	2013.11	5	6.96	12.09	367	97.4	33.8	0.028	0.073	0.00366	0.003L	0.0008	0.05L	1.34	Weak	1.2	0.002L	0.171	0.936	0.002L	0.00002	0.00189	0.00011	0.004L	0.05100	0.016L	24000	0.000587	10
	2014.6	5	7.28	8.74	407	136.0	22.0	0.037	0.115	0.00147	0.024	0.0009	0.05L	1.06	Weak	4.1	0.002L	0.215	0.99	0.002L	0.00002	0.00062	0.00027	0.004L	0.00022	0.016L	13000	0.000719	/
Class-II I standard		15	6.5-8.5	25	1000	250	250	0.3	0.1	1.0	1.0	0.002	0.3	3.0	/	20	0.02	0.2	1.0	0.05	0.001	0.05	0.01	0.05	0.05	0.05	/	0.01	100

9.4.1.3 Historical groundwater environmental quality

9.4.1.3.1 Historical monitoring data of Xiawan well

According to the historical monitoring data of Xiawan well between 2009 and 2014 provided by Zhuzhou Environmental Monitoring Center, see **Table 9.4-4** for the statistical results.

According to the monitoring data , in 2013 lead exceeded the standard by 0.02 times in 2014 manganese exceeded the standard by 0.15 times; in the other years, chroma, nitrite, nitrate nitrogen, ammonia nitrogen, sulfate and fluoride exceeded the standard.

9.4.1.3.2 Historical groundwater investigation data of Qingfeng Region, Qingshui Lake Zone I and Qingshui Lake Zone II

The Contaminated Site Investigation, Evaluation and Remediation Center of Nanjing Institute of Environmental Science of the Ministry of Environmental Protection carried out soil contamination investigation in Yingfeng Region, Qingshui Lake Zone I and Qingshui Lake Zone 2 between March 28 and April 2 in 2012 (normal flow period), six groundwater samples were taken, and testing was performed for 26 indicators, including pH, Cr^{6+}, fluoride, Chloride, bromide, sulfate, nitrate, nitrite, phosphate, Ag, As, Be, Cd, Cr, Cu, Ni, Pb, Ab, Se, Ti, Zn, Mn, Hg, Na, K and Ca. See **Table 9.4-5** for testing results. The screening of groundwater contaminants in three regions were carried out as per Class-II I standard in *Groundwater Quality Standard*.

Table 9.4-5Contents of contaminants in groundwater samples in Yingfeng Region and Qingshui Lake Zones (mg/L)

Analysis indicator	**Detection limit**	**Class-III standard value**	**Yingfeng Region**		**Qingshui Lake Zone I**			**Qingshui Lake Zone II**
			SJ11	**SJ56**	**SJ71**	**SJ124**	**SJ172**	**SJ269**
pH	-	6.5-8.5	7.9	7.1	7.4	7.8	7.2	7.2
$Cr6^+$	0.004 mg/L	0.05 mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fluoride	0.02 mg/L	1.0 mg/L	0.31	0.34	0.26	0.26	0.23	0.28
Chloride	0.02 mg/L	250 mg/L	11.4	17.7	13.9	6.79	28.5	12.6
Bromide	0.05 mg/L	-	<0.05	<0.05	<0.05	0.10	1.10	<0.05
Sulfate	0.1 mg/L	250 mg/L	36.3	65.4	33.4	64.6	**478**	58.1
Nitrate	0.05 mg/L	20 mg/L	2.48	18.5	**42.0**	1.84	1.06	**28.9**
Nitrite	0.05 mg/L	0.02 mg/L	**0.10**	**1.70**	**0.11**	<0.05	<0.05	<0.05
Phosphate	0.1 mg/L	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Metal								
Ag	1ìg/L	-	<1	<1	<1	<1	<1	<1
As	5ìg/L	50ìg/L	28	7	7	6	<5	<5
Be	1ìg/L	0.2ìg/L	<1	<1	<1	<1	<1	<1
Cd	0.1ìg/L	10ìg/L	0.1	1.4	0.5	0.2	0.4	0.5
Cr	1ìg/L	50ìg/L	4	<1	2	**95**	3	<1
Cu	1ìg/L	1.0ìg/L	**3**	**4**	**3**	**16**	**2**	**4**
Ni	1ìg/L	50ìg/L	4	19	5	27	9	4
Pb	1ìg/L	50ìg/L	6	<1	<1	16	4	<1
Sb	1ìg/L	-	4	3	<1	<1	<1	1
Se	5ìg/L	10ìg/L	<5	<5	<5	<5	<5	<5
Ti	1ìg/L	-	<1	<1	<1	<1	<1	<1
Zn	5ìg/L	1000ìg/L	<5	186	38	45	13	43
Mn	1ìg/L	100ìg/L	**379**	**135**	<1	**228**	**3.26×10^3**	2
Hg	0.1ìg/L	1ìg/L	<0.1	<0.1	<0.1	**2.9**	<0.1	<0.1
Na	0.1 mg/L	-	10.4	18.0	11.3	26.8	14.5	8.9
K	0.1 mg/L	-	2.4	14.6	3.4	4.1	2.5	12.1
Ca	0.01 mg/L	-	43.8	31.1	27.8	32.7	131	40.7
Mg	0.02 mg/L	-	11.2	9.81	11.7	15.2	66.2	**12.1**

According to the groundwater monitoring data and analysis, the contents of nitrite and manganese in two groundwater samples taken in Yingfeng Region are relatively high, and the measuring values for both two sampling point exceed the standard. The content of manganese at SJ11 sample point is relatively high, reaching 79ìg/L. Except manganese and copper, the groundwater is basically not contaminated by heavy metal. Therefore, the contaminants needing attention in the region are nitrite, copper and manganese.

Among the three groundwater samples taken in Qingshui Lake Zone 1, the content of nitrate at SJ71 point is the highest, 42.0mg/L, exceeding the standard value 20mg/L. Nitrite is only found at SJ71 point, and the content is 0.11 mg/L, exceeding the standard value 0.02 mg/L. The high contents of nitrate and nitrite may be related to the application of fertilizers. The content of manganese at SJ172 and SJ124 points is relatively high, 3260ìg/L and 228ìg/L respectively, exceeding the standard value 100ìg/L; the content of mercury at SJ124 point is 2.9ìg/L, exceeding the standard value 1ìg/L; the contents of other heavy metal elements are low. Except manganese and mercury, the groundwater in the region is not contaminated by heavy metal. Therefore, the contaminants needing attention in the region are nitrate, nitrite, manganese and mercury.

One groundwater sample was taken in Qingshui Lake Zone II. The content of nitrate is 28.9mg/kg, exceeding the standard value 20mg/L, and the content of copper is 4228ìg/L, exceeding the standard value 1ìg/L; the contents of other heavy metal elements are low. Therefore, the contaminants needing attention are nitrate and copper.

Brief summary

The Contaminated Site Investigation, Evaluation and Remediation Center of Nanjing Institute of Environmental Science of the Ministry of Environmental Protection carried out soil contamination investigation in Yingfeng Region, Qingshui Lake Zone I and Qingshui Lake Zone 2 between March 28 and April 2 in 2012 (normal flow period), and in the investigation the number of groundwater samples is small, only six, among which, two in Yingfeng Region, three in Qingshui Lake Zone 1 and one in Qingshui Lake Zone II. According to the results of screening and testing of groundwater contaminants in three regions which was carried out as per Class-II I standard in *Groundwater Quality Standard* (GB/T 14848—9), the groundwater contaminants needing attention in Qingfeng Region are nitrite, copper and manganese, the groundwater contaminants needing attention in Qingshui Lake Zone I are nitrate, nitrite, manganese and mercury, and the groundwater contaminants needing attention in Qingshui Lake Zone II are nitrate and copper.

9.4.1.3.3 Historical groundwater investigation data of Qingshi Region, Tongtangwan Region and Xiangshiling Region

According to the environmental survey report of the Technical Research and Development Center for Contaminated Site Ecological Remediation under Nanjing Institute of Soil Science of the Ministry of Environmental Protection on Qingshi Region, Tongtangwan Region and Xiangshiling Region, forty sampling points are arranged. Seen from region distribution, ten sampling points are distributed in Tongtangwan Region, among which, four points have deep and shallow wells, one for each; fifteen sampling points are distributed in Qingshi Region, among which two points have deep and shallow wells, one for each; fifteen sampling points are distributed in Xiangshiling Region, among which four points have deep and shallow wells, one for each. Among the sixteen sampling points, eight points are arranged in chemical industry additives factory (Tiancheng Chemicals), three points are arranged in the waste residue staging site, and one point is arranged in Tongda Smelting site. In the investigation, the contents of metal components in 44 (including parallel samples) shallow groundwater samples, the concentration of semi-volatile organic contaminants (SVOCs) in 31 shallow groundwater samples, the concentration of volatile organic contaminants (VOCs) in 21 shallow groundwater samples, and the concentration of main anion concentration in 8 shallow groundwater samples were analyzed. The sampling period is from November 23, 2011 to December 2, 2011 (dry season).

The analysis indicators for metal components include the total contents of 12 kinds of metal, i.e. Ag, Cu, Pb, Zn, Cd, As, Hg, Ni, Be, Se and Ti, and the content of Cr VI. The analysis indicators for semi-volatile contaminant include the concentration of 16 kinds of phenolic contaminants, 18 kinds of PAH contaminants, 6 kinds of PAE contaminants, 9 kinds of nitrosamine contaminants, 16 kinds of Nitro-Aromatic and cyclic ketone contaminants, 5 kinds of halogenether contaminants, 13 kinds of chlorinated hydrocarbon and aniline contaminants and 8 kinds of benzidine contaminants. The analysis indicators for organo-chlorine pesticide include the concentration of 25 kinds of pesticides like α-HCH, β-HCH, γ-HCH, δ-HCH, o, p'-DDE, p, p'-DDE, o, p'-DDD, p, p'-DDD, o, p'-DDT, p, p'-DDT, heptachlor, aldrin, heptachlor epoxide andγ-chlordan as well as the concentration of the series. The analysis indicators for volatile organic compound include the concentration of 14 kinds of mononuclear aromatics, 5 kinds of fumigation agents, 26 kinds of halogenated hydrocarbons, 9 kinds of aryl halide and 4 kinds of trihalomethane and naphthalene. The analysis indicators for main ions include the concentration of fluorinion, chloridion, sulfate radical, nitrate, Na^{+}, K^{+}, Ca^{2+} and Mg^{2+}.

As fore the shallow groundwater environmental quality and health assessment in the three regions, the maximum concentration limit (MCL) of Zhuzhou water environmental protection specified in the regional screening value report of Qingshuitang Industrial Zone and the groundwater screening values based on human health protection are used as the assessment standards respectively.

The maximum concentration limit of Zhuzhou protection water environmental protection mainly refers to Class-II I standard in *Groundwater Quality Standard* (for approval), *Hygienic Standard for Drinking Water* (GB 5749-2006) and *Environmental Quality Standard for Surface Water* (GB 3838-2002) in China as well as EU and WHO drinking water standards. When determining the maximum concentration limit of Zhuzhou water environmental protection, no standards related to 2-methylnaphthalene, 3&4- methylphenol and 2- methylphenol were found, and the related assessment will not be performed.

The groundwater screening value based on human health protection is obtained through calculation with using the risk assessment software HERA developed by Nanjing Institute of Soil Science of China Academy of Sciences according to the relevant calculation principles specified in Technical Guidelines for Risk Assessment of Contaminated Soil (HJ 25.3 -2014).

In order to unify the assessment standards, the results of groundwater quality tested by Nanjing Institute of Soil Science of China Academy of Sciences will be reanalyzed according to Class-II I standard in *Groundwater Environmental Quality Standard* (GB/T 14848—9).

I. The maximum concentration limit (MCL) of Zhuzhou water environmental protection and the groundwater screening value based on human health protection are used as assessment standards.

As for the area planned as residential land, the risks and hazards of groundwater caused to sensitive receivers (human body and water environment) as pollution source shall be taken into consideration. When groundwater becomes pollution source for protecting human health, children and adults are sensitive receivers, which inhale the vapor when contaminated groundwater volatilizes indoors and outdoors. When groundwater becomes pollution source for protecting water environment, water environment is sensitive receiver. The maximum concentration limit (MCL) is concluded through referring to water body standards of different countries, so as to evaluate the extent to which the groundwater is affected.

1. Heavy metal contamination assessment

1) The maximum concentration limit (MCL) of Zhuzhou water environmental protection is used as assessment standard

In the investigation, the contents of 13 kinds of metal in 25 shallow groundwater samples are analyzed, among which, ten samples are perched water and the other 15 are confined water. See **Table 9.4-6** for the analysis results. The metal contaminants in perched water exceeding the standard include Cd, Ni and Se, and the over-standard rates are 60%, 10% and 10%, respectively; the metal contaminants in confined water exceeding the standard include As, Cd, Ni, Zn, Be, Pb, Sb and Se, and the over-standard rates are 40％, 40％, 20％, 20％, 13.3%, 6.67%, 6.67% and 6.67%. The contents and the contamination situation of 13 kinds of metal components in groundwater are described as below:

As: among 25 shallow groundwater sample, the content of As in one confined water sample (collected from GWQ17S close to the Dahu in Qingshi Region) is 25μg/L, exceeding the assessment standard (10 μg/L), 2.5 times of MCL, which may be related to the water supply of the lake.

Be: among 15 confined water samples, the content of Be in three samples (collected from GWQ08 and GWQ11S in Qingshi Region and GWQ03 in Xiangshiling Region) exceeds the assessment standard (1μg/L) and MCL (2μg/L). The contents are 8μg/L, 15μg/L and 7μg/L, exceeding the standard by 2.5－6.5 times. Seen from the geographical locations, these three boreholes are close to each other, Be in the groundwater may come from the same pollution source.

Cd: Cd is found in all 25 shallow groundwater samples, and the content of Cd in 60% of perched water samples and 40% of confined water samples exceed MCL (5μg/L), showing that Cd contamination in the shallow groundwater in the area is severe. The maximum contents of Cd in perched water and confined water are 72.1μg/L and 64.5μg/L, respectively, 14.2 times and 12.9 times of MCL, and the samples are collected from GWQ19 in Tongtangwan Region and GWQ07 close to Dongtai Industry in Qingshi Region. The lithological analysis results show that the content of Cd in surface miscellaneous fill soil of GWQ19 is 68.2mg/L but that in silty clay about 3m below the ground reaches 212 mg/L, showing that the Cd contamination in the perched water may be related to the Cd contamination in miscellaneous fill soil and silty clay.

Ni: among 25 shallow groundwater samples, the content of Ni in one perched water sample (collected from GWQ26 in Tongtangwan Region) and six confined water samples (collected from GWQ08, GWQ11, GWQ11S, GWQ17Sand GWQ24 in Qingshi Region and GWQ03 in Xiangshiling Region) exceeds MCL (20μg/L), and the content of Ni in shallow water sample collected from GWQ08 in Qingshi Region is 4.3 times of the assessment standard.

Pb: among 25 shallow water sample, the content of Pb in three confined water samples (collected from GWQ07, GWQ11S and GWQ17S in Qingshi Region) exceeds or equals to MCL (10μg/L), and the contents are 17μg/L, 10μg/L and 36μg/L, 1.7 times, 1 time and 3.6 times of MCL, respectively.

Sb: among 15 confined water samples, the content of Sb in one confined water sample collected from GWQ24 in Qingshi Region equals to MCL (5μg/L).

Se: among 10 perched water samples, the content of Se in one sample (collected from GWQ26 in Tongtangwan Region) exceeds the assessment standard (5 μg/L) and MCL (10μg/L), reaching 30μg/L; among 15 confined water samples, the content of Se in one sample (collected from GWQ17S in Qingshi Region) exceeds MCL and reaches 21μg/L, 2.1 times of the assessment standard.

Zn: among 15 confined water samples, the content of Zn in two samples (collected from GWQ24 in Qingshi Region and GWQ36 in Xiangshiling Region) reaches 2100 μg/L and 2140 μg/L respectively, 2.1 times and 2.14 times of MCL.

In conclusion, in terms of water environmental protection, the contaminants needing attention in the area are As, Cd, Ni, Zn, Be, Pb, Sb and Se.

2) The groundwater screening value based on human health protection is used as assessment standard

No contaminant exceeds the standard, and there is no potential risk.

Table 9.4-6Comparison between contents of metal components (μg/L) in shallow groundwater of Qingshi District, Tongtangwan District and Xiangshiling District and the MCL

Borehole No.	Ag	As	Be	Cd	Cu	Ni	Pb	Sb	Se	Tl	Zn	Hg	Cr^{6+}	Groundwater type
GWQ04	<1	<5	<1	**8.0**	1	11	5	<1	<5	<1	489	<0.1	<4	Perched water
GWQ05	<1	<5	<1	**6.9**	<1	3.5	<1	<1	<5	<1	417	<0.1	<4	Perched water
GWQ17	<1	<5	<1	**6.1**	<1	6	<1	1	<5	<1	634	<0.1	<4	Perched water
GWQ18	<1	<5	<1	**9.3**	<1	7	<1	<1	<5	<1	394	<0.1	<4	Perched water
GWQ19	<1	<5	<1	**72.1**	19	7	5	3	<5	<1	740	<0.1	<4	Perched water
GWQ20	<1	<5	<1	1.3	<1	3	<1	<1	<5	<1	377	<0.1	<4	Perched water
GWQ23	<1	<5	<1	**12.0**	2	4	<1	<1	<5	<1	374	<0.1	<4	Perched water
GWQ25	<1	<5	<1	3.5	2	5	<1	<1	<5	<1	581	<0.1	<4	Perched water
GWQ26	<1	<5	<1	0.3	42	**25**	1	<1	**30**	<1	38	<0.1	<4	Perched water
GWQ27	<1	<5	<1	3	<1	7	<1	<1	<5	<1	575	<0.1	<4	Perched water
GWQ03	<1	<5	**8**	2.3	12	**64**	<1	<1	<5	<1	116	<0.1	<4	Confined water
GWQ07	<1	<5	<1	**64.5**	2	19	**17**	2	9	<1	429	<0.1	<4	Confined water
GWQ08	<1	<5	**15**	**5.1**	7	**86**	<1	<1	<5	<1	212	<0.1	<4	Confined water
GWQ09	<1	<5	<1	0.7	3	7	<1	1	<5	<1	216	<0.1	<4	Confined water
GWQ10	<1	<5	<1	0.1	<1	4	<1	<1	<5	<1	<5	<0.1	<4	Confined water
GWQ11	<1	<5	<1	**31.0**	<1	**21**	<1	<1	<5	<1	411	<0.1	<4	Confined water
GWQ11S	<1	<5	7	**13.8**	4	**41**	10	<1	<5	<1	263	<0.1	<4	Confined water
GWQ17S	<1	25	<1	**0.6**	51	**36**	36	<1	21	<1	30	<0.1	<4	Confined water
GWQ18S	<1	<5	<1	**2.3**	<1	**5**	<1	<1	<5	<1	513	<0.1	<4	Confined water
GWQ20S	<1	<5	<1	**1.6**	<1	**7**	<1	<1	<5	<1	321	<0.1	<4	Confined water
GWQ21	<1	<5	<1	**1.7**	<1	**7**	<1	<1	<5	<1	328	<0.1	<4	Confined water
GWQ23S	<1	<5	<1	**15.8**	1	**4**	1	<1	<5	<1	432	<0.1	<4	Confined water
GWQ24	<1	<5	<1	**6.0**	1	**49**	2	5	6	<1	2100	<0.1	<4	Confined water
GWQ25S	<1	<5	<1	**0.1**	1	**4**	<1	<1	<5	<1	8	<0.1	<4	Confined water
GWQ36	<1	<5	<1	**3.2**	3	**8**	<1	<1	<5	<1	2140	<0.1	<4	Confined water
MCL	50	10	2	**5**	1000	**20**	10	5	10	0.1	1000	1	50	All
Detection rate(%)	0	0	0	**100**	50	**100**	30	20	10	0	100	0	0	Perched water
Over-standard rate (%)	0	0	0	**60**	0	**10**	0	0	10	/	0	0	0	Perched water
Detection rate(%)	0	6.67	20	**100**	66.7	**100**	33.3	20	20	0	93.3	0	0	Confined water
Over-standard rate (%)	0	6.67	20	**40**	0	**40**	20	6.67	6.67	/	13.3	0	0	Confined water

2. Volatile and semi-volatile organic contaminants pollution assessment

In the assessment, the concentration of 91 kinds of semi-volatile organic contaminants (16 kinds of phenolic contaminants, 18 kinds of PAH contaminants, 6 kinds of PAE contaminants, 9 kinds of nitrosamine contaminants, 16 kinds of Nitro-Aromatic and cyclic ketone contaminants, 5 kinds of halogenether contaminants, 13 kinds of chlorinated hydrocarbon and aniline contaminants and 8 kinds of benzidine contaminants) in 12 shallow groundwater samples are analyzed, among which, 5 samples are perched water and the other 7 are confined water. The concentration of 59 kinds of volatile organic contaminants (14 kinds of mononuclear aromatics, 5 kinds of fumigation agents, 26 kinds of halogenated hydrocarbons, 9 kinds of aryl halide and 4 kinds of trihalomethane and naphthalene) in 3 shallow water samples are analyzed, among which 2 samples are perched water and the other one is confined water).

1) The maximum concentration limit (MCL) of Zhuzhou water environmental protection) is used as assessment standard

Seen from **Table 9.4-7** and **Table 9.4-8** (the indicator with detection rate of 0 is not listed), among the shallow groundwater samples, the majority of volatile and semi-volatile organic compounds are not found, and at individual exploratory points, the concentration of semi-volatile organic contaminants like acenaphthylene, acenaphthene, fluorene, phenanthrene, pyrene, phenol and 2,6- dichlorophenol and the concentraion of volatile organic compound like 1,2- dichloroethane exceed the maximum concentration limit based on water environmenal protection.

2) The groundwater screening value based on human health protection is used as assessment standard

Seen from **Table 9.4-9** and **Table 9.4-10** (the indicator with detection rate of 0 is not listed), among 12 shallow groundwater samples, the concentration of semi-volatile organic contaminants are far lower than the groundwater screening value based on human health protection, and none exceeds the standard; among 3 shallow groundwater samples, the concentration of volatile organic contaminants are far lower than the groundwater screening value based on human health protection, and none exceeds the standard.

Table 9.4-7Comparison between the concentration of semi-volatile organic contaminants (μg/L) in the shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and the MCL based on water environmental protection

No.	Ground water type	Naphthaline	2-methylnaphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	pyrene	Benzo (b) &(k) fluoranthene	1, 2, 4-trichlorobenzene	Aniline	Dibenzofuran	carbazole	phenol	3&4-methylphenol	2, 6-Dichlorophenol	DMP	diphenylamine &nitrosodiphenylamine	acetophenone
GWQ 04	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.0	<0.5	<0.5
GWQ 05	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 26	Perched water	1.8	1.7	<0.2	<0.2	**0.4**	**0.6**	<0.2	<0.2	<0.2	<0.05	1.7	<2.5	<0.5	<0.5	**2.7**	<0.5	**0.6**	<0.5	<0.5	<0.5
GWQ 27	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 18	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 18S	Confined water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 03	Confined water	0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 08	Confined water	0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 09	Confined water	0.3	<0.5	<0.2	**0.3**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 17S	Confined water	6.1	1.2	**0.2**	<0.2	**0.3**	**0.35**	<0.2	<0.2	<0.2	<0.05	<0.5	23.1	<0.5	0.8	**53.6**	6.6	<0.5	<0.5	4.0	1.1
GWQ 24	Confined water	2.1	<0.5	<0.2	<0.2	**1.5**	**1.7**	0.3	1.0	**0.4**	0.12	<0.5	<2.5	1.1	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ 36	Confined water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
MCL		**100**	**-**	**0.1**	**0.1**	**0.1**	**0.1**	**300**	**400**	**0.1**	**0.3**	**20**	**100**	**3.7**	**7.5**	**0.5**	**—**	**0.2**	**8**	**207**	**700**
Detection rate(%)		50.0	16.7	8.33	8.33	25.0	25.0	8.33	8.33	8.33	8.33	8.33	8.33	8.33	16.7	16.7	8.33	8.33	8.33	8.33	8.33
Over-standard rate (%)		0	-	/	/	/	/	0	0	/	0	0	0	0	0	16.7	—	/	0	0	0

Table 9.4-8Comparison between the concentration of semi-volatile organic contaminants (μg/L) in the shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and the MCL based on water environmental protection

No.	Groundwater type	Benzene	Methylbenzene	Styrene	1, 1-Dichloroethane	1, 2-Dichloroethane	Naphthaline
GWQ05	Perched water	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
GWQ17	Perched water	1.5	0.6	0.7	<0.5	<0.5	2.0
GWQ24	Confined water	1.4	0.7	<0.5	0.8	**60.8**	2.1
MCL		**10**	**700**	**20**	**30**	**30**	**100**
Detection rate(%)		66.7	66.7	33.3	33.3	33.3	100
Over-standard rate (%)		0	0	0	0	33.3	0

Table 9.4-9Comparison between the concentration of semi-volatile organic contaminants (μg/L) in the shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and the MCL based on human health protection

No.	Ground water type	Naphthaline	2-methylnaphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	pyrene	Benzo (b) &(k) fluoranthene	1, 2, 4-trichloro benzene	Aniline	Dibenzo furan	carbazole	phenol	3&4-methyl phenol	2, 6-Dichloro phenol	DMP	diphenylamine &nitrosodiphenylamine	acetophenone
GWQ04 (Residential)	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.0	<0.5	<0.5
GWQ05(Residential)	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ26 (Residential)	Perched water	1.8	1.7	<0.2	<0.2	0.4	0.6	<0.2	<0.2	<0.2	<0.05	1.7	<2.5	<0.5	<0.5	2.7	<0.5	0.6	<0.5	<0.5	<0.5
GWQ27 (Park)	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ18 (Park)	Perched water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ18S (Park)	Confined water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ03(Residential)	Confined water	0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ08(Residential)	Confined water	0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ09(Residential)	Confined water	0.3	<0.5	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ17S (Commercial)	Confined water	6.1	1.2	0.2	<0.2	0.3	0.35	<0.2	<0.2	<0.2	<0.05	<0.5	23.1	<0.5	0.8	53.6	6.6	<0.5	<0.5	4.0	1.1
GWQ24 (Park)	Confined water	2.1	<0.5	<0.2	<0.2	1.5	1.7	0.3	1.0	0.4	0.12	<0.5	<2.5	1.1	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GWQ36 (Commercial	Confined water	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.5	<2.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Groundwater screening value based on human health protection	Residential land	**299**	**—**	**607000**	**469000**	**855000**	**348000**	**4166000**	**6681000**	**4704000**	**457000**	**81000**	**123000**	**29000**	**2360**	**4055000**	**—**	**7428000**	**1576000**	**451000**	**1044000**
	Commercial land	**1500**	**—**	**3042000**	**2351000**	**4280000**	**1745000**	**20856000**	**33383000**	**23505000**	**2190000**	**409000**	**617000**	**147000**	**11000**	**20256000**	**—**	**37103000**	**7870000**	**2252000**	**5220000**
	Park land	**473000**	**—**	**162523000**	**133826000**	**182486000**	**87527000**	**984062000**	**1196239000**	**840278000**	**78881000**	**56294000**	**21537000**	**2252000**	**554000**	**703685000**	**—**	**1285791000**	**273386000**	**80889000**	**191272000**
Over-standard rate (%)		0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	0	0	0

Table 9.4-10 Comparison between the concentration of semi-volatile organic contaminants (μg/L) in the shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and the MCL based on human health protection

No.	Groundwater type	Benzene	Methylbenzene	Styrene	1, 1-Dichloroethane	1, 2-Dichloroethane	Naphthaline
GWQ05 (Resident land)	Perched water	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
GWQ17 (commercial land)	Perched water	1.5	0.6	0.7	<0.5	<0.5	2.0
GWQ24(park land)	Confined water	1.4	0.7	<0.5	0.8	60.8	2.1
Groundwater screening value based on human health protection	Residential land	299	271000	127000	26000	18.4	1740
	Commercial land	1500	1364000	617000	132000	88.9	8770
	Park land	473000	451724000	21537000	40202000	20000	1020000
Over-standard rate (%)		0	0	0	0	33.3	0

3. Comprehensive assessment

1) Qingshi Region

According to the results of shallow groundwater environmental quality assessment, in seven shallow groundwater samples, the heavy metal contaminants exceeding the maximum concentration limit based in human health protection include As, Be, Cd, Ni, Pb, Sb, Se and Zn, and the over-standard rates are 14.3％, 28.6％, 85.7％, 71.4％, 42.9％, 14.3％, 14.3% and 14.3%, respectively. Because the detection limit of Ti is higher than the maximum concentration limit based on water environmental protection, it is difficult to exactly judge whether the result of the sample in which Ti is not detected exceeds the standard. In three shallow groundwater samples, the semi-volatile organic contaminants exceeding the maximum concentration limit based on water environmental protection include acenaphthylene, fluorene, phenanthrene, pyrene, dibenzofuran and phenol, and the over-standard rates all exceed or equal to 33.3%; in two shallow groundwater samples, the volatile organic contaminant exceeding the maximum concentration limit based on water environmental protection is 1,2- dichloroethane, and the over-standard rate is 50%. The results of preliminary assessment on shallow groundwater health risks in Qingshi Region show that the volatile and semi-volatile organic contaminants in the shallow groundwater in Qingshi Region don’t exceed the standard.

2) Tongtangwan Region

There is only one exploratory point (GWQ26) in the residential land in Tongtangwan Region, and the concentration of Se in the perched water sample exceeds the detection limit (5 μg/L) and the MCL (0 μg/L), reaching 30 μg/L; the concentration of fluorene in the perched water sample is 0.4 μg/L, exceeding the assessment standard (0.1 μg/L); the concentration of phenol in the perched water sample exceeds the detection limit (0.5 μg/L) and is 5.5 times of the assessment standard (0.5 μg/L); the concentration of 2,6-dichlorophenol exceeds the detection limit (0.5 μg/L), and reaches 0.6 μg/L, 3 times of the assessment standard (0.2 μg/L). Other items don’t exceed the standard.

There are two exploratory points (GWQ20 and GWQ25) in the industrial and commcercial land in Tongtangwan Region, and none of testing items in the two samples exceed the standard.

In the four groundwater samples (GWQ18, GWQ19, GWQ21 and GWQ23) collected in the park land in Tongtangwan Region, the analysis results of heavy metal contaminants show that the detection rates of Cd, Ni and Zn are 100%, but the over-standard rate of Cd is 75% and the others don't exceed the standard. The testing results of organic-chlorine pesticides show that the testing items in these four exploratory points don't exceed the standard.

From the point of water environmental protection, the groundwater contaminants needing attention in Tongtangwan Region include Se, Cd, fluorene, phenol and 2,6-dichlorophenol; from the point of human health protection, the volatile and xemi-volatile organic contaminants in the shallow groundwater don't exceed the standard.

3) Xiangshiling Region

As per the maximum concentration limit (MCL) based on water environmental protection, the assessment results of the groundwater samples in six exploratory points in Xiangshiling Region show that: the metal components in the shallow groundwater samples exceeding the standard include Cd, Pb, Zn, As, Be, Ni, Sb, Se and Cr^{6+}; the semi-volatile organic contaminants in the shallow groundwater samples exceeding the standard include PAH contaminants like acenaphthene, fluorene, phenanthrene and pyrene, N-Nitrosomorpholine and dibenzofuran. As per the groundwater screening value based on human health protection, the assessment results show that when the shallow groundwater in the region and in the site is the pollution source of volatile and semi-volatile organic contaminants, its risks and hazards on sensitive receivers are acceptable.

II. Class-II I standard of groundwater quality is used as assessment standard

According to the results of comparison between the monitoring results of shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and Class-II I standard value of groundwater quality, among the five groundwater samples in Xiangshiling Region, the content of Zn at GWQ36 is 2140μg/L, exceeding the standard value 1000μg/L, and the testing results for other points are lower than Class-II I standard value; among the seven groudwater samples in Tongtangwan Region, the contents of Cd at GWQ19 and Se at GWQ26 exceed the standard by 6.21 times and 2 times respectively, and the testing results for other points don't exceed the standard; among the eight groundwater samples in Qingshi Region, the content of Cd at GWQ07 exceeds the standard by 5.45 times, the content of Be at GWQ08 exceeds the standard more severely, by 74 times and the content of Ni at the same point exceeds the standard by 0.72 times; the content of Cd at GWQ11 exceeds the standards by 0.38 times; the contents of Se at GWQ17S exceed the standard by 0.11 times, and the content of Zn at GWQ24 by 0.11 times. The testing results for the other points don't exceed the standard.

Table 9.4-11Comparison between the detection indices (μg/L) of shallow groundwater in Qingshi Region, Tongtangwan Region and Xiangshiling Region and Class-II I standard of groundwater quality

Borehole No.		Concentration of heavy metal (													Groundwater type
		Ag	**As**	**Be**	**Cd**	**Cu**	**Ni**	**Pb**	**Sb**	**Se**	**Ti**	**Zn**	**Hg**	**Cr^{6+}**	
Class-II I standard value		**—**	**50**	**0.2**	**10**	**1000**	**50**	**50**	**—**	**10**	**0.1**	**1000**	**1**	**50**	
Xiangshiling Region	GWQ04	<1	<5	<1	8	1	11	5	<1	<5	<1	489	<0.1	<4	Perched water
	GWQ05	<1	<5	<1	6.9	<1	3.5	<1	<1	<5	<1	417	<0.1	<4	Perched water
	GWQ09	<1	<5	<1	0.7	3	7	<1	1	<5	<1	216	<0.1	<4	Confined water
	GWQ10	<1	<5	<1	0.1	<1	4	<1	<1	<5	<1	<5	<0.1	<4	Confined water
	GWQ36	<1	<5	<1	3.2	3	8	<1	<1	<5	<1	**2140**	<0.1	<4	Confined water
Tongtangwan Region	GWQ18	<1	<5	<1	9.3	<1	7	<1	<1	<5	<1	394	<0.1	<4	Perched water
	GWQ19	<1	<5	<1	**72.1**	19	7	5	3	<5	<1	740	<0.1	<4	Perched water
	GWQ20	<1	<5	<1	1.3	<1	3	<1	<1	<5	<1	377	<0.1	<4	Perched water
	GWQ21	<1	<5	<1	1.7	<1	7	<1	<1	<5	<1	328	<0.1	<4	Confined water
	GWQ23	<1	<5	<1	12	2	4	<1	<1	<5	<1	374	<0.1	<4	Perched water
	GWQ25	<1	<5	<1	3.5	2	5	<1	<1	<5	<1	581	<0.1	<4	Perched water
	GWQ26	<1	<5	<1	0.3	42	25	1	<1	**30**	<1	38	<0.1	<4	Perched water
Qingshi Region	GWQ07	<1	<5	<1	**64.5**	2	19	17	2	9	<1	429	<0.1	<4	Confined water
	GWQ08	<1	<5	**15**	5.1	7	**86**	<1	<1	<5	<1	212	<0.1	<4	Confined water
	GWQ11	<1	<5	<1	31	<1	21	<1	<1	<5	<1	411	<0.1	<4	Confined water
	GWQ11S	<1	<5	**7**	**13.8**	4	41	10	<1	<5	<1	263	<0.1	<4	Confined water
	GWQ17	<1	<5	<1	6.1	<1	6	<1	1	<5	<1	634	<0.1	<4	Perched water
	GWQ17S	<1	25	<1	0.6	51	36	36	<1	**21**	<1	30	<0.1	<4	Confined water
	GWQ24	<1	<5	<1	6	1	49	2	5	6	<1	**2100**	<0.1	<4	Confined water

III. Brief summary

In the environmental investigation implemented by the Technical Research and Development Center for Contaminated Site Ecological Remediation under Nanjing Institute of Soil Science of the Ministry of Environmental Protection for Qingshi Region, Tongtangwan Region and Xiangshiling Region from November 23, 2011 to December 2, 2011 (dry season), the contents of metal components in 44 (including parallel samples) shallow groundwater samples, the concentration of semi-volatile organic contaminants (SVOCs) in 31 shallow groundwater samples, the concentration of volatile organic contaminants (VOCs) in 21 shallow groundwater samples, and the concentration of main anion concentration in 8 shallow groundwater samples were analyzed. The screening of groundwater contaminants in these three regions were carried out based on the maximum limit (MCL) based on Zhuzhou water environmental protection and the groundwater screening value based on human health protection, and the screening results show that:

1) With the maximum concentration limit (MCL) based on Zhuzhou water environmental protection as assessment standard, among the 25 shallow groundwater samples (19 samples are perched water and the other 15 are confined water): the metal contaminants in perched water exceeding the standard include Cd, Ni and Se, and the over-standard rates are 60%, 10% and 10%, respectively; the metal contaminants in confined water exceeding the standard include As, Cd, Ni, Zn, Be, Pb, Sb and Se, and the over-standard rates are 40％, 40％, 20％, 20％, 13.3%, 6.67%, 6.67% and 6.67%. From the point of water environmental protection, the contaminants needing attention in the area are As, Cd, Ni, Zn, Be, Pb, Sb and Se.

Among the shallow groundwater samples, the majority of volatile and semi-volatile organic compounds are not found, and at individual exploratory points, the concentration of semi-volatile organic contaminants like acenaphthylene, acenaphthene, fluorene, phenanthrene, pyrene, phenol and 2,6- dichlorophenol and the concentraion of volatile organic compound like 1,2- dichloroethane exceed the maximum concentration limit.

2) With the groundwater screening value based on human health protection as assessment standard, among 12 shallow groundwater samples, the concentration of semi-volatile organic contaminants are far lower than the groundwater screening value based on human health protection, and none exceeds the standard; among 3 shallow groundwater samples, the concentration of volatile organic contaminants are far lower than the groundwater screening value based on human health protection, and none exceeds the standard.

3) With Class-II I standard value of groundwater quality as assessment standard, among the five groundwater samples in Xiangshiling Region, the content of Zn at GWQ36 is 2140μg/L, exceeding the standard value 1000μg/L, and the testing results for other points are lower than Class-II I standard value; among the seven groundwater samples in Tongtangwan Region, the contents of Cd at GWQ19 and Se at GWQ26 exceed the standard by 6.21 times and 2 times respectively, and the testing results for other points don't exceed the standard; among the eight groundwater samples in Qingshi Region, the content of Cd at GWQ07 exceeds the standard by 5.45 times, the content of Be at GWQ08 exceeds the standard more severely, by 74 times, and the content of Ni at the same point exceeds the standard by 0.72 times; the content of Cd at GWQ11 exceeds the standards by 0.38 times; the contents of Se at GWQ17S exceed the standard by 0.11 times, and the content of Zn at GWQ24 by 0.11 times. The testing results for the other points don't exceed the standard.

9.4.1.4 Overall assessment of regional groundwater environmental quality

Nanjing Institute of Environmental Science of the Ministry of Environmental Protection, Nanjing Institute of Soil Science of Chinese Academy of Sciences and the Geophysical Survey Party of Hunan Coalfield Geology Bureau carried out investigation and research on groundwater environmental quality in the regions respectively.

According to the search results, the period of investigation and sampling by Nanjing Institute of Environmental Science under the Ministry of Environmental Protection is March 2012 (normal flow period), during which six groundwater samples were collected in Yingfeng Region and Qingshui Lake Region and the testing factors mainly included inorganic compound and heavy metal and didn't involve organic compound. The assessment standard is Class-II I standard value specified in *Groundwater Quality Standard*.

The period of investigation and research by Nanjing Institute of Soil Science of Chinese Academy of Sciences is November 2011 (dry season), during which, forty exploratory points were arranged in Qingshi Region, Tongtangwan Region and Xiangshiling Region, and the number of groundwater sampling points was relatively large, but the testing factors mainly included heavy metal and organic compound and didn't involve inorganic compound. The assessment standards include the maximum concentration limit (MCL) of Zhuzhou water environmental protection specified in the *Regional Screening Value Report of Qingshuitang Industrial Zone in Zhuzhou City* and the groundwater screening value based on human health protection.

In October 2014 (dry season), the Geophysical Survey Party of Hunan Coalfield Geology Bureau arranged 24 sampling points in the groundwater assessment range of the project, among which, 17 points are in the research range of this project, and the testing factors mainly included heavy metal and inorganic salt. The assessment standard is Class-II I standard value specified in Groundwater Quality Standard.

Therefore, the time of site investigation in different regions has a certain limitation and the investigation area is a local area. The assessment standards used in different investigation are inconsistent, and the assessment factors and contents in different reports are not all-inclusive. Now, the Class-II I standard value specified in *Groundwater Quality Standard* is used as the assessment standard to reanalyze and reassess the investigation results of different organizations in an unified way, and the assessment results show that:

From the point of region, the groundwater contaminants needing attention in Yingfeng Region include nitrite, Cu and Mn; those in Qingshu Lake Zone I include nitrate, nitrite, Mn and Ag; those in Qingshu Lake Zone II include nitrate and Cu; those in Xiangshiling Region include Zn; those in Tongtangwan Region include Cd and Se; and those in Qingshi Region include Cd, Bd, Ni, Se and Zn.

From the point of contaminant types, the phenomenon of nitrite and nitrate exceeding the standard is the most widespread in the regions; although there are phenomena of heavy metal contaminants exceeding the standard in all monitoring, except that Be element in the monitoring data of groundwater quality collected by the Geophysical Survey Party of Hunan Coalfield Geology Bureau has an impact in the whole region, the other contaminants only exceed the standard in a small quantity of exploratory points and there is no regional phenomenon of other contaminants exceeding the standard.

From the point of hydrogeological conditions, the groundwater in the assessment area is divided into loose-rock pore water, clastic-rock pore-fissure water, clastic-rock fissure water, epimetamorphic-rock fissure water and carbonatite-rock fissure-cavern water. Controlled by vadose zone permeability, fissure development extent and landform, except that the water content of the aquifer of covered carbonatite-rock fissure-cavern water in local regions is medium, the water content in other aquifers is low. The groundwater usually exist in the form of phreatic water and is mainly recharged by atmospheric precipitation, and the recharge, runoff and discharge process are not obvious. The groundwater flow slope is relatively smooth and the runoff conditions are relatively bad, so the hydrgeological conditions are not suitable for migration and spreading of contaminants. From the point of the current situation of groundwater contamination, it is mainly agricultural contamination, and there is industrial contamination to some extent, with controllable risks to human health. From the point of the current situation of groundwater research, the research work has a limitation and no groundwater investigation has been implemented in an all-round way.

The groundwater is hidden and complicated systematically. According to international practices, contaminated groundwater remediation is a huge project with long process, enormous investment and great difficulty. The remediation of groundwater shall be based on the comprehensive and systematic investigation on the groundwater.

Considering that the groundwater in the regions are not used as drinking water source and is based on human health protection, the contaminants don’t exceed the groundwater risk control value.

From the point of dynamic change characteristics of groundwater level, the groundwater aquifers usually have low content of water, and are mainly recharged by atmospheric precipitation. The groundwater level varies periodically with rainfall, and the annual amplitude of variation is only 0.5-1m. Compared with dry season, the groundwater level in wet season rises slightly. According to the situation disclosed with the existing boreholes provided by the Geophysical Survey Party of Hunan Coalfield Geology Bureau, the buried depth of groundwater level in dry season in the remediation area is 2.3-17.2m, and the buried depth of groundwater level in wet season is 1.1-15.2m; the minimum buried depth of groundwater levels in dry season and wet season is larger than the soil remediation depth 60cm. Therefore, the change of groundwater level in the remediation area has a quite small impact on the remedied soil within the depth range of 60m below the earth surface.

In conclusion, the remediation of groundwater will not be included in the project temporarily, but long-term comprehensive monitoring and research will be carried out for the groundwater. Meanwhile, corresponding management measures shall be taken to strictly control the groundwater pollution sources to prevent pollution for spreading. The groundwater in the region is forbidden to be used as drinking water. Besides, the nation has issued relevant documents prohibiting the local residents or enterprises from using the groundwater as drinking water and irrigation water.The corresponding remediation will be implemented when the long-term conditions are complete

9.4.2 Current situation of surface water environmental quality

9.4.2.1 Monitoring of current situation

9.4.2.1.1 Monitoring section

The assessment range is a range of about 7.0 km from 1000m at the upstream of the outlet of Xiawangang to Majia River at the downstream (boundary between Zhuzhou and Xiangtan).

Monitoring point: seven monitoring sections are arranged. See **Figure1.6-2** and **Table 9.4-12**.

Table 9.4-12Monitoring sections of current situation of water environmental quality

No.	Monitoring section No.	Water area	Monitoring point
1	W1	Xiang River	Section of The Third Water Plant intake
2	W2	Xinqiao low discharge channel	Section of outfall of Xinqiao low discharge channel flowing into Xiang River
3	W3	Xiang River	Section of Xiang River where the west boundry of the project is located
4	W4	Xiang River	Section of outfall of Majia River flowing into Xiang River at the boundary between Zhuzhou and Xiangtan
5	W5	New Xiawangang	Section of New Xiawangang flowing into the project area
6	W6	New Xiawangang	Section of New Xiawangang flowing into the project area
7	W7	Old Xiawangang	Section of Old Xiawangang flowing into the project area

9.4.2.1.2 Monitoring factors

pH, COD, SS, cyanide, ammonia nitrogen, TP, volatile phenol, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+} and Cu.

9.4.2.1.3 Monitoring requirements

The settling of sampling vertical lines and sampling points shall refer to the Class-II I standard in *Technical Guidelines for Environmental Impact Assessment – Surface Water Environment* and relevant technical specification.

9.4.2.1.4 Monitoring institute, monitoring time interval, frequency, sampling and analysis methods

Changsha Environmental Protection Vocational College carried out continuous monitoring for three days from December 8, 2014 to December 10, 2014, once evey days. Sampling and analysis shall conform to *Technical Specification for Environmental Monitoring* (groundwater environment part) published by the Ministry of Environmental Protection and relevant technical specification.

9.4.2.1.5 Monitoring results

See **Table 9.4-13** for monitoring results. The assessment results show that:

In all monitoring sections, the monitoring values of pH, SS, cyanide, volatile phenol, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+} and Cu meet the water quality standard specified in *Surface Environmental Quality Standard* (GB3838—2002); the monitoring value of total phosphorus at W1 section cannot meet the requirements of Class-II water in *Surface Environmental Quality Standard* (GB3838—2002), and the maximum times of ultra standard is 020; the monitoring value of COD at W2 section cannot meet the requirements of Class-V water in *Surface Environmental Quality Standard* (GB3838—2002), and the maximum times of ultra standard is 037; the monitoring values of ammonia nitrogen and total phosphorus at W5, W6 and W7 cannot meet the requirements of Class-V water in *Surface Environmental Quality Standard* (GB3838—2002), the maximum times of ultra-standard of ammonia nitrogen is 0.25, 1.04 and 0.56 respectively, and that of total phosphorus is 0.55, 0.77 and 0.51, respectively.

Table 9.4-13Monitoring results of current situation of surface water environmental quality (Unit: mg/L)

Monitoring point	Monitoring time	Monitoring value (mg/L)														
		pH(dimensionless)	SS	Chemical oxygen demand	Ammonia nitrogen	TP	Volatile phenol	Cyanide	Cu	Zn	Pb	Cd	Ni	Cr^{6+}	As	Hg
W1	2014.12.8	6.75	10	6.5	0.277	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.9	6.8	10	6.8	0.323	0.1	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.10	7.04	8	8.5	0.224	0.1	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Min. value	6.75	8	6.5	0.224	0.1	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	7.04	10	8.5	0.323	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value	-	9	7.3	0.275	0.11	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	0	0	0.20	0	0	0	0	0	0	0	0	0	0
	Standard value (Class-II)	6～9	25	15	0.5	0.1	0.002	0.05	1	1	0.01	0.005	0.02	0.05	0.05	0.00005
	Standard index	-	0.37	0.48	0.55	1.07	1.00	0.08	0.01	0.05	1.00	1.00	0.50	0.08	0.00	1.00
	Whether up to standard	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W2	2014.12.8	6.72	8	51.4	1.963	0.21	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.9	7.05	9	48.9	1.454	0.21	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.10	6.85	12	54.6	1.602	0.17	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L

Monitoring point	Monitoring time	Monitoring value (mg/L)														
		pH(dimensionless)	**SS**	**Chemical oxygen demand**	**Ammonia nitrogen**	**TP**	**Volatile phenol**	**Cyanide**	**Cu**	**Zn**	**Pb**	**Cd**	**Ni**	**Cr^{6+}**	**As**	**Hg**
	Min. value	6.72	8	48.9	1.454	0.17	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	7.05	12	54.6	1.963	0.21	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value		10	51.6	1.673	0.20	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	0.37	0	0	0	0	0	0	0	0	0	0	0	0
	Standard value (class-V)	6～9	150	40	2	0.4	0.1	0.2	1	2	0.1	0.01	0.02	0.1	0.1	0.001
	Standard index	-	0.06	1.29	0.84	0.49	0.02	0.02	0.01	0.03	0.10	0.50	0.50	0.04	0.00	0.05
	Whether up to standard	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W3	2014.12.8	7.03	11	9.7	0.237	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005	0.01L	0.004L	0.0001L	0.00005L
	2014.12.9	6.7	8	8.2	0.251	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.007	0.01L	0.004L	0.0001L	0.00005L
	2014.12.10	7.01	10	9.8	0.227	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Min. value	6.7	8	8.2	0.227	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	7.03	11	9.8	0.251	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value		10	9.2	0.238	0.11	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max.		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Monitoring point	Monitoring time	Monitoring value (mg/L)														
		pH(dimensionless)	SS	Chemical oxygen demand	Ammonia nitrogen	TP	Volatile phenol	Cyanide	Cu	Zn	Pb	Cd	Ni	Cr^{6+}	As	Hg
	times of ultra standard															
	Standard value (Class-III)	6～9	30	20	1	0.2	0.005	0.2	1	1	0.05	0.005	0.02	0.05	0.05	0.0001
	Standard index		0.32	0.46	0.24	0.57	0.40	0.02	0.01	0.05	0.20	1.00	0.50	0.08	0.002	0.50
	Whether up to standard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W4	2014.12.8	7	10	11.6	0.353	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.9	6.79	18	12.6	0.33	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.10	6.78	10	11.3	0.225	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Min. value	6.78	10	11.3	0.225	0.11	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	7	18	12.6	0.353	0.12	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value		13	11.8	0.303	0.11	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Standard value (class-V)	6～9	30	20	1	0.2	0.005	0.2	1	1	0.05	0.005	0.02	0.05	0.05	0.0001

Monitoring point	Monitoring time	Monitoring value (mg/L)														
		pH(dimensionless)	**SS**	**Chemical oxygen demand**	**Ammonia nitrogen**	**TP**	**Volatile phenol**	**Cyanide**	**Cu**	**Zn**	**Pb**	**Cd**	**Ni**	**Cr^{6+}**	**As**	**Hg**
	Standard index		0.42	0.59	0.30	0.57	0.40	0.02	0.01	0.05	0.20	1.00	0.50	0.08	0.002	0.50
	Whether up to standard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W5	2014.12.8	6.88	12	49.9	3.091	0.22	0.004	0.01	0.11	0.17	0.06	0.009	0.01L	0.004L	0.0002	0.00005
	2014.12.9	6.9	18	37.5	2.574	0.25	0.002L	0.008	0.14	0.19	0.06	0.007	0.01L	0.004L	0.0006	0.00009
	2014.12.10	7.05	14	42.1	2.821	0.27	0.004	0.011	0.12	0.13	0.09	0.009	0.01L	0.004L	0.0005	0.00008
	Min. value	6.88	12	37.5	2.574	0.22	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	7.05	18	49.9	3.091	0.27	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value		15	43.2	2.829	0.25	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	0.25	0.55				0	0	0	0	0	0	0	0
	Standard value (class-V)	6～9	150	40	2	0.4	0.1	0.2	1	2	0.1	0.01	0.02	0.1	0.1	0.001
	Standard index		0.10	1.08	1.41	0.62	0.02	0.02	0.01	0.03	0.10	0.50	0.50	0.04	0.001	0.05
	Whether up to standard	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W6	2014.12.8	6.83	24	81.7	3.53	0.36	0.002	0.008	0.2	0.21	0.14	0.03	0.01L	0.004L	0.0006	0.00008

Monitoring point	Monitoring time	Monitoring value (mg/L)														
		pH(dimensionless)	**SS**	**Chemical oxygen demand**	**Ammonia nitrogen**	**TP**	**Volatile phenol**	**Cyanide**	**Cu**	**Zn**	**Pb**	**Cd**	**Ni**	**Cr^{6+}**	**As**	**Hg**
	2014.12.9	6.99	37	74.7	2.88	0.29	0.004	0.014	0.21	0.17	0.11	0.017	0.01L	0.004L	0.0005	0.00008
	2014.12.10	6.72	32	70.6	2.951	0.27	0.004	0.012	0.26	0.23	0.16	0.021	0.01L	0.004L	0.0006	0.0001
	Min. value	6.72	24	70.6	2.88	0.27	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max. value	6.99	37	81.7	3.53	0.36	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Avg. value		31	75.7	3.120	0.31	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	1.04	0.77	0	0	0	0	0	0	0	0	0	0	0
	Standard value (class-V)	6～9	150	40	2	0.4	0.1	0.2	1	2	0.1	0.01	0.02	0.1	0.1	0.001
	Standard index		0.21	1.89	1.56	0.77	0.02	0.020	0.01	0.03	0.10	0.50	0.50	0.04	0.001	0.05
	Whether up to standard	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W7	2014.12.8	7.02	36	56.9	3.025	0.18	0.005	0.011	0.01L	0.09	0.01L	0.001L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.9	7.05	34	62.4	2.877	0.18	0.002	0.015	0.01L	0.09	0.01L	0.001L	0.01L	0.004L	0.0001L	0.00005L
	2014.12.10	6.95	30	57.9	2.797	0.16	0.006	0.017	0.01L	0.11	0.01L	0.001L	0.01L	0.004L	0.0001L	0.00005L
	Min. value	6.95	30	56.9	2.797	0.16	0.002L	0.004L	0.01L	0.05L	0.01L	0.005L	0.01L	0.004L	0.0001L	0.00005L
	Max.	7.05	36	62.4	3.025	0.1	0.002	0.004L	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005

Monitoring point	**Monitoring time**	**Monitoring value (mg/L)**														
		pH(dimensionless)	**SS**	**Chemical oxygen demand**	**Ammonia nitrogen**	**TP**	**Volatile phenol**	**Cyanide**	**Cu**	**Zn**	**Pb**	**Cd**	**Ni**	**Cr^{6+}**	**As**	**Hg**
	value					8	L		L	L	L	L	L	L	L	L
	Avg. value		33	59.1	2.900	0.17	0.002	0.004	0.01	0.05	0.01	0.005	0.01	0.004	0.0001	0.00005
	Max. times of ultra standard	0	0	0.56	0.51	0	0	0	0	0	0	0	0	0	0	0
	Standard value (class-V)	6～9	150	40	2	0.4	0.1	0.2	1	2	0.1	0.01	0.02	0.1	0.1	0.001
	Standard index		0.22	1.48	1.45	0.43	0.02	0.020	0.01	0.03	0.10	0.50	0.50	0.04	0.001	0.05
	Whether up to standard	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

9.4.2.2 Historical monitoring of water environmental quality

9.4.2.2.1 Water quality of source of the Third Water Plant drinking water

Three monitoring sections are arranged 100m at the upstream of the water intakes of the First Water Plant, the Second and Third Water Plant and the Fourth Water Plant in Zhuzhou, and the water intake of the Third Water Plant is set about 800m at the upstream on the east of the project.

According to the monitoring data on surface water source quality of Zhuzhou City between 2012 and 2014 (Zhuzhou Environmental Monitoring Center Station), and the water quality monitoring results of the sewage outlet of the Third Water Plant, between 2012 and 2014, except total nitrogen, all the other monitoring factors of the monitoring section of the Third Water Plant meet the requirements of Class-II I water quality standard specified in *Environmental Quality Standards for Surface Water* (GB3838-2002); the over-standard rates of total nitrogen in 2012, 2013 and 2014 are all 100%, the annual average value is 3.318, 3.036 and 3.411mg/L, respectively, and the maximum times of ultra standard of monthly average value is 3.15, 3.903 and 3.84. See **Table 9.4-14~Table 9.4-16** for monitoring results.

Table 9.4-14Monitoring results of drinking water source of the Third Water Plant in 2014

Unit: (except pH and indicated unit)

Section name	Item	pH (dimensionless)	DO	Permanganate index	Chemical oxygen demand (COD)	Ammonia nitrogen (NH3-N)	TP (calculated by P)	TN (calculated by N for lake and reservoir)	Cu	Zn	Fluoride (calculated by F-)	Se
Water intake at the upstream of the Third Water Plant	Annual average value	7.3	7.4	1.83	14.3	0.283	0.062	3.411	0.00426	0.0102	0.325	0.00105
	Max. monthly average value	7.5	8.9	2.43	17.4	0.934	0.130	4.840	0.01224	0.0327	0.434	0.00562
	Min. monthly average value	7.0	5.9	1.38	10.6	0.033	0.027	2.640	0.00081	0.003L	0.255	0.00021
	Over-standard rate of monthly average value %							100%				
	Max. times of ultra-standar							3.84				

	d of monthly average value											
	GB3838-2002(III)	6-9	≥5	6	20	1	0.2	1.0	1.0	1.0	1.0	0.01
	Item	**As**	**Hg**	**Cd**	**Cr^{6+}**	**Pb**	**Cyanide**	**Volatile phenol**	**Petroleum**	**Anionic surfactant**	**Sulfide**	**Fecal coliform(No.、L)**
	Annual average value	0.00849	0.00002L	0.00046	0.004L	0.00051	0.002L	0.002L	0.022	0.05L	0.02L	5379
	Max. monthly average value	0.01830	0.00004	0.00115	0.004L	0.00223	0.002L	0.002L	0.047	0.05L	0.02L	9400
	Min. monthly average value	0.00030	0.00002L	0.00012	0.004L	0.00014	0.002L	0.002L	0.002	0.05L	0.02L	2666
	Over-standard rate of monthly average value %											
	Max. times											

	of ultra-standard of monthly average value											
	GB3838-2002(III)	0.05	0.0001	0.005	0.0001	0.05	0.2	0.005	0.05	0.2	0.2	10000
	Item	**Sulfate (calculated by SO42-)**	**chloride (calculated by Cl-)**	**Nitrate (calculated by N)**	**Fe**	**Mn**						
	Annual average value	24.10	11.91	2.29	0.129	0.019						
	Max. monthly average value	34.53	22.63	4.29	0.244	0.049						
	Min. monthly average value	14.70	6.63	1.72	0.037	0.005						
	Over-standard rate of monthly average value											

	%												
	Max. times of ultra-standard of monthly average value												

Table 9.4-15 Monitoring results of drinking water source of the Third Water Plant in 2013

Unit: (except pH and indicated unit)

Section name	Item	pH (dimensionless)	DO	Permanganate index	COD	NH3-N	TP	TN	Cu	Zn	Fluoride (calculated by F-)	Se
Water intake at the upstream of the Third Water Plant	Annual average value	7.4	7.0	1.74	13.3	0.251	0.061	3.036	0.00453	0.010	0.315	0.00045
	Max. monthly average value	7.8	9.7	2.23	17.0	0.896	0.100	4.903	0.01483	0.028	0.461	0.00073
	Min. monthly average value	7.1	5.9	1.33	9.9	0.035	0.013	1.917	0.00153	0.002	0.239	0.00025
	Over-standard rate of monthly average value %							100%				
	Max. times of ultra-standard of monthly average value							3.903				
	GB3838-2002(III)	6-9	≥5	6	20	1	0.2	1.0	1.0	1.0	1.0	0.01
	Item	**As**	**Hg**	**Cd**	**Cr^{6+}**	**Pb**	**Cyanide**	**Volatile phenol**	**Petroleum**	**Anionic surfactant**	**Sulfide**	**Fecal coliform(No.、L)**
	Annual average value	0.00574	0.00002	0.00044	0.002	0.00049	0.001	0.001	0.028	0.025	0.010	7983
	Max. monthly average value	0.00965	0.00004	0.00102	0.002	0.00212	0.001	0.002	0.045	0.025	0.010	9400
	Min. monthly average value	0.00213	0.00001	0.00001	0.002	0.00010	0.001	0.001	0.002	0.025	0.010	3300
	Over-standard rate of monthly average value %											
	Max. times of ultra-standard of											

	monthly average value											
	GB3838-2002(III)	0.05	0.0001	0.005	0.0001	0.05	0.2	0.005	0.05	0.2	0.2	10000
	Item	**SO_4^{2-}**	**Cl-**	**Nitrate (calculated by N)**	**Fe**	**Mn**						
	Annual average value	24.88	11.95	2.31	0.133	0.015						
	Max. monthly average value	39.53	23.33	3.63	0.246	0.059						
	Min. monthly average value	15.23	5.76	1.64	0.044	0.003						
	Over-standard rate of monthly average value %											
	Max. times of ultra-standard of monthly average value											
	GB3838-2002(III)	250	250	10	0.3	0.1						

Table 9.4-16Monitoring results of drinking water source of the Third Water Plant in 2012

Unit: (except pH and indicated unit)

Section name	Item	pH (dimensionless)	DO	Permanganate index	COD	NH3-N	TP	TN	Cu	Zn	Fluoride (calculated by F-)	Se
Water intake at the upstream of the Third Water Plant	Annual average value	7.3	7.4	1.97	13.9	0.448	0.058	3.318	0.00223	0.0180	0.385	0.00055
	Max. monthly average value	7.7	9.5	2.37	17.6	0.990	0.166	4.150	0.00524	0.0420	0.470	0.00108
	Min. monthly average value	6.8	5.6	1.47	10.6	0.080	0.030	2.680	0.00005	0.0030	0.300	0.00033
	Over-standard rate of monthly average value %							100%				
	Max. times of ultra-standard of monthly average value							3.15				
	GB3838-2002(III)	6-9	≥5	6	20	1	0.2	1.0	1.0	1.0	1.0	0.01
	Item	**As**	**Hg**	**Cd**	**Cr^{6+}**	**Pb**	**Cyanide**	**Volatile phenol**	**Petroleum**	**Anionic surfactant**	**Sulfide**	**Fecal coliform(No.、L)**
	Annual average value	0.00936	0.00002	0.00083	0.002	0.00051	0.001	0.001	0.025	0.030	0.010	6050
	Max. monthly average value	0.04038	0.00006	0.00218	0.002	0.00338	0.003	0.001	0.042	0.030	0.010	8600
	Min. monthly average value	0.00361	0.00001	0.00007	0.002	0.00003	0.001	0.001	0.002	0.030	0.010	3267
	Over-standard rate of monthly average value %											
	Max. times of ultra-standard of monthly average value											

	GB3838-2002(III)	0.05	0.0001	0.005	0.0001	0.05	0.2	0.005	0.05	0.2	0.2	10000
	Item	**SO_4^{2-}**	**Cl^-**	**Nitrate (calculated by N)**	**Fe**	**Mn**						
	Annual average value	28.49	15.88	2.51	0.118	0.024						
	Max. monthly average value	46.60	21.20	3.59	0.280	0.086						
	Min. monthly average value	21.20	12.30	1.52	0.010	0.003						
	Over-standard rate of monthly average value %											
	Max. times of ultra-standard of monthly average value											
	GB3838-2002(III)	250	250	10	0.3	0.1						

9.4.2.2.2 Water quality monitoring of Zhuzhou section of Xiang River

According to *2010 Annual Report on Water Quality Monitoring of Zhuzhou Section of Xiang River, 2011 Annual Report on Water Quality Monitoring of Zhuzhou Section of Xiang River,, 2012 Annual Report on Water Quality Monitoring of Zhuzhou Section of Xiang River, and 2013 Annual Report on Water Quality Monitoring of Zhuzhou Section of Xiang River* provided by Zhuzhou Environmental Monitoring Center Station, the statistical results of water quality change of Xiawan (control section) of Zhuzhou Section of Xiang River are detailed in **Table 9.4-17**.

According to the statistical results, , the maximum value of ammonia nitrogen at Xiawan Section in 2012 exceeds the standard, the over-standard rate is 8.3%, the maximum times of ultra-standard is 1.3, but the annual value is 0.623mg/L and doesn’t exceed the standard; the monitoring results of fecal coliform in 2011 and 2012 exceed the standard; the monitoring results of total nitrogen in 2010, 2011, 2012 and 2013 all exceed the standard and the over-standard rates are 100%, the annual average values is 2.908, 3.64, 3.2 and 3.47mg/L, respectively, and the maximum times of ultra standard is 3, 3.92, 3.84 and 4.74, respectively.

Table 9.4-17Monitoring results of water quality of Xiawan (control section) between 2010 and 2013

Year	Item	Water temperature(℃)	pH	DO	COD_{Mn}	BOD_5	Ammonia nitrogen	TP	Cu	Zn	Fluoride	Se	As
2010	Annual average value	19.9	7.64	7.5	1.67	1.37	0.623	0.080	0.00406	0.019	0.40	0.00058	0.0078
	Max. value	33.7	7.92	8.4	2.36	3.30	2.300	0.170	0.02638	0.065	0.84	0.00100	0.0154
	Min. value	8.1	7.40	6.5	1.19	0.20	0.090	0.030	0.00020	0.002	0.22	0.00009	0.0013
	Over-standard rate %						8.3						
	Max. times of ultra standard						1.30						
2011	Annual average value	20.2	7.35	7.2	1.90	2.1	0.47	0.05	0.0028	0.020	0.39	0.00057	0.00569
	Max. value	32.0	7.76	9.2	2.41	6.8	0.99	0.07	0.0083	0.040	0.48	0.00121	0.01059
	Min. value	7.9	6.71	5.2	1.52	0.4	0.07	0.03	0.0001	0.002	0.28	0.00009	0.00279
	Over-standard rate %												
	Max. times of ultra standard												
2012	Annual average value	19.0	7.46	6.9	1.79	1.93	0.272	0.06	0.00612	0.0103	0.335	0.00052	0.00630
	Max. value	30.8	7.82	9.8	2.31	3.90	0.972	0.10	0.01680	0.0810	0.560	0.00146	0.01723
	Min. value	7.0	7.09	5.9	1.26	0.60	0.013	0.01	0.00160	0.0015	0.210	0.00012	0.00119
	Over-standard rate %												
	Max. times of ultra standard												
2013	Annual average value	20.0	7.28	7.25	1.78	1.9	0.235	0.06	0.00571	0.008	0.321	0.000957	0.007253
	Max. value	29.4	7.58	8.7	2.26	4.0	0.956	0.13	0.02359	0.027	0.431	0.004445	0.015237
	Min. value	5.7	6.97	5.8	1.38	0.5	0.013	0.01	0.00132	0.002	0.249	0.000115	0.000265
	Over-standard rate %												
	Max. times of ultra standard												
GB3838-2002(III)			6-9	≥5	6	4	1	0.2	1	1	1	0.01	0.05

Year	Item	Hg	Cd	Cr6+	Pb	Total cyanide	Volatile phenol	Petroleum	Anionic detergent	Sulfide	Fecal coliform (No./L)	COD	TN
2010	Annual average value	0.000019	0.00089	0.002	0.00038	0.001	0.001	0.014	0.023	0.01	29972	12.81	2.908
	Max. value	0.000040	0.00314	0.002	0.00128	0.001	0.001	0.047	0.025	0.01	160000	18.40	4.000
	Min. value	0.000010	0.00008	0.002	0.00003	0.001	0.001	0.002	0.003	0.01	5400	8.20	1.78
	Over-standard rate %										25.0		100
	Max. times of ultra standard										15.0		3
2011	Annual average value	0.00001	0.00110	0.002	0.00065	0.001	0.001	0.024	0.03	0.01	15421	14.2	3.64
	Max. value	0.00004	0.00390	0.002	0.00292	0.003	0.001	0.049	0.03	0.01	92000	18.6	4.92
	Min. value	0.00001	0.00007	0.002	0.00004	0.001	0.001	0.002	0.03	0.01	2400	8.2	2.56
	Over-standard rate %										25		100
	Max. times of ultra standard										8.2		3.92
2012	Annual average value	0.00002	0.000805	0.002	0.0007	0.001	0.001	0.032	0.028	0.01	6567	13.72	3.20
	Max. value	0.00006	0.002800	0.002	0.00262	0.001	0.003	0.049	0.030	0.01	9400	18.80	4.84
	Min. value	0.00001	0.000010	0.002	8.1E-05	0.001	0.001	0.002	0.025	0.01	2200	9.90	2.28
	Over-standard rate %												100
	Max. times of ultra standard												3.84
2013	Annual average value	0.00001	0.000612	0.002	0.001003	0.001	0.0009	0.027	0.025	0.01	9400	14.8	3.47
	Max. value	0.00003	0.00189	0.002	0.004899	0.001	0.0011	0.046	0.025	0.01	1700	18.3	5.74
	Min. value	0.00001	0.000063	0.002	0.000127	0.001	0.0006	0.002	0.025	0.01	5744	12.0	2.35
	Over-standard rate %												100
	Max. times of ultra standard												4.74
GB3838-2002(Ⅲ)		0.0001	0.01	0.05	0.05	0.2	0.01	0.05	0.2	0.2	10000	20	1.0

9.4.2.2.3 Majia River section

The monitoring data of Majia River section is 2012 and 2013 is detailed in **Table 9.4-18**. Seen from the table, except ammonia nitrogen, all the other monitoring factors reach Class-III water quality standard specified in *Environmental Quality Standards for Surface Water* (GB3838-2002).

9.4.2.3 Overall assessment of water environmental quality

In conclusion, according to the monitoring results of current situation of water environmental quality and in combination with the historical monitoring data on water environmental quality, the contaminants exceeding the standard mainly are ammonia nitrogen and total phosphorus, and the content of heavy metal in the water body doesn’t the corresponding standard.

Table 9.4-18Monitoring results of Majia River between 2012 and 2013

Majia River	**2013**					**2012**				
Monitoring factor	Avg. value	Max. value	Min. value	Over-standard rate (%)	Max. times of ultra standard	Avg. value	Max. value	Min. value	Over-standard rate (%)	Max. times of ultra standard
pH	7.58	7.83	7.11			7.67	7.98	7.32		
DO content	6.7	12.0	5.1			7.47	11.1	5		
COD_{Mn}	2.6	4.3	1.2			2.35	3.2	1.5		
COD_{Cr} *	9.0	16.0	5.0			8.31	13	5		
BOD5	1.7	3.0	1.0			1.29	2	1		
Ammonia nitrogen	0.402	1.070	0.042	8.70	0.07	0.486	2.18	0.156	8.33	1.18
TP	0.077	0.18	0.01			0.081	0.12	0.03		
Cu	0.0081	0.0842	0.0020			0.0051	0.0212	0.0002		
Zn	0.013	0.103	0.001			0.0251	0.11	0.001		
Fluoride *	0.249	0.370	0.130			0.339	0.73	0.1		
Se	0.00028	0.001	0.00005			0.000644	0.0019	0.0001		
As	0.0086	0.0384	0.0014			0.008496	0.0173	0.0003		
Total Hg	0.000025	0.000090	0.000010			0.000014	0.00004	0.00001		
Cd	0.00078	0.00274	0.00005			0.001301	0.00414	0.00035		
Cr^{6+}	0.002	0.002	0.002			0.0023	0.004	0.002		
Pb	0.00122	0.00660	0.00015			0.000852	0.0049	0.00015		
Cyanide	0.002	0.002	0.002			0.0023	0.004	0.002		
Volatile phenol	0.0008	0.002	0.0002			0.0016	0.0035	0.0002		
Petroleum	0.0050	0.005	0.005			0.00611	0.02	0.003		
Anionic detergent *	0.03	0.05	0.02			0.0308	0.05	0.02		
Sulfide *	0.010	0.010	0.010			0.012	0.02	0.01		

9.4.3 Current situation of ambient air quality

9.4.3.1 Monitoring of current situation

9.4.3.1.1 Monitoring points and items

Table 9.4-19Monitoring points and items for air environmental quality

No.	Monitoring point	Location of monitoring point	Distance to the boundary of project (km)	Monitoring items
G1	Yixin Garden	N	1.7	TSP, PM_{10}, SO_2, NO_2, fluoride, Hg, Pb and its compounds, arsenide, Cr^{6+}, Mn and its compounds, TVOC, phenol, and ammonia
G2	Gangchang Jianshe Village	In the area		
G3	Lijiawuchang	In the area	-	
G4	Yingfeng Community	In the area	-	
G5	Fengjia Ancestral Hall	In the area	-	
G6	Xiangwan Community	S	1.6	

See**Figure1.6-1** for monitoring points

9.4.3.1.2 Monitoring institution and monitoring time & frequency

Monitoring institution: Changsha Environmental Protection Vocational College

Hourly values of SO_2, NO_2, fluoride, $Cr^{6+,}$ phenol and ammonia: from December 5, 2014 to December 11, 2014; continuous monitoring for seven days; four times every day (time；2:00, 8:00, 14:00 and 20:00); 45 minutes every hour.

Daily average values of SO_2, NO_2, TSP, PM_{10}, Hg, Pb and its compounds, arsenide, Mn and its compounds and TVOC: continuous monitoring for more than 18 hours every day(12 hours fro PM_{10}); from December 5, 2014 to December 11, 2014; continuous monitoring seven days; once every day.

9.4.3.1.3 Monitoring results

See **Table 9.4-20** and **Table 9.4-21** for monitoring results.

The monitoring results show that: the 1-hour and 24-hour average values of TSP, SO_2 and NO_2 at all monitoring points meet the requirements of Class-II standard specified in *Ambient Air Quality Standard* (GB3095-2012); PM_{10} at G2, G3, G5 and G6 cannot meet the requirements for Class-II standard specified in *Ambient Air Quality Standard* (GB3095-2012);; the 8-hour average values of TVOC at all monitoring points can meet the requirements of Indoor Air Quality Standard (GB/T18883-2002); fluoride, Hg, Pb and its compounds, arsenide, Cr^{6+}, Mn and its compounds, phenol and ammonia at all monitoring points meet the requirements of *Sanitary Standard for Industrial Enterprise Design* (TJ36-79).

Table 9.4-20Monitoring of current atmosphere situation

Monitoring item	Monitoring point	Value type	Concentration range (mg/m^3)		Proportion of Max. Concentration in the standard value (%)	Standard	Over-standar rate (%)	Whether up to standard
			Min. value	Max. value		(mg/m^3)		
SO_2	G1	1-hour AVG	0.022	0.022	4.40%	0.5	0	Up to standard
		24-hour AVG	0.034	0.034	22.67%	0.15	0	Up to standard
	G2	1-hour AVG	0.021	0.021	4.20%	0.5	0	Up to standard
		24-hour AVG	0.033	0.033	22.00%	0.15	0	Up to standard
	G3	1-hour AVG	0.022	0.022	4.40%	0.5	0	Up to standard
		24-hour AVG	0.032	0.032	21.33%	0.15	0	Up to standard
	G4	1-hour AVG	0.025	0.025	5.00%	0.5	0	Up to standard
		24-hour AVG	0.03	0.03	20.00%	0.15	0	Up to standard
	G5	1-hour AVG	0.022	0.022	4.40%	0.5	0	Up to standard
		24-hour AVG	0.031	0.031	20.67%	0.15	0	Up to standard
	G6	1-hour AVG	0.021	0.021	4.20%	0.5	0	Up to standard
		24-hour AVG	0.032	0.032	21.33%	0.15	0	Up to standard
NO_2	G1	1-hour AVG	0.038	0.038	19.00%	0.2	0	Up to standard
		24-hour AVG	0.042	0.042	52.50%	0.08	0	Up to standard
	G2	1-hour	0.039	0.039	19.50%	0.2	0	Up to standard

		AVG						
		24-hour AVG	0.043	0.043	53.75%	0.08	0	Up to standard
	G3	1-hour AVG	0.039	0.039	19.50%	0.2	0	Up to standard
		24-hour AVG	0.046	0.046	57.50%	0.08	0	Up to standard
	G4	1-hour AVG	0.038	0.038	19.00%	0.2	0	Up to standard
		24-hour AVG	0.045	0.045	56.25%	0.08	0	Up to standard
	G5	1-hour AVG	0.038	0.038	19.00%	0.2	0	Up to standard
		24-hour AVG	0.044	0.044	55.00%	0.08	0	Up to standard
	G6	1-hour AVG	0.04	0.04	20.00%	0.2	0	Up to standard
		24-hour AVG	0.042	0.042	52.50%	0.08	0	Up to standard
TSP	G1	24-hour AVG	0.169	0.169	56.33%	0.3	0	Up to standard
	G2	24-hour AVG	0.137	0.236	78.67%	0.3	0	Up to standard
	G3	24-hour AVG	0.15	0.27	90.00%	0.3	0	Up to standard
	G4	24-hour AVG	0.168	0.261	87.00%	0.3	0	Up to standard
	G5	24-hour AVG	0.154	0.22	73.33%	0.3	0	Up to standard
	G6	24-hour AVG	0.159	0.26	86.67%	0.3	0	Up to standard
PM10	G1	24-hour AVG	0.095	0.095	63.33%	0.15	0	Up to standard
	G2	24-	0.09	0.15	100.00%	0.15	83.33%	Exceeding

		hour AVG							standard
	G3	24-hour AVG	0.089	0.162	108.00%	0.15	33.33%		Exceeding standard
	G4	24-hour AVG	0.089	0.146	97.33%	0.15	0		Up to standard
	G5	24-hour AVG	0.096	0.15	100.00%	0.15	16.67%		Exceeding standard
	G6	24-hour AVG	0.108	0.157	104.67%	0.15	33.33%		Exceeding standard
Fluoride	G1	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
	G2	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
	G3	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
	G4	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
	G5	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
	G6	One-off value	0.0005L	0.0005L	2.50%	0.02	0		Up to standard
Ammonia	G1	One-off value	0.01	0.03	15.00%	0.2	0		Up to standard
	G2	One-off value	0.01	0.03	15.00%	0.2	0		Up to standard
	G3	One-off value	0.01	0.02	10.00%	0.2	0		Up to standard
	G4	One-off value	0.01	0.03	15.00%	0.2	0		Up to standard
	G5	One-off value	0.01	0.02	10.00%	0.2	0		Up to standard
	G6	One-off value	0.01	0.03	15.00%	0.2	0		Up to standard

Phenol	G1	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
	G2	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
	G3	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
	G4	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
	G5	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
	G6	One-off value	0.01L	0.01L	50.00%	0.02	0	Up to standard
TVOC	G1	8-hour AVG	0.005	0.012	2.00%	0.6	0	Up to standard
	G2	8-hour AVG	0.007	0.015	2.50%	0.6	0	Up to standard
	G3	8-hour AVG	0.006	0.011	1.83%	0.6	0	Up to standard
	G4	8-hour AVG	0.005	0.012	2.00%	0.6	0	Up to standard
	G5	8-hour AVG	0.006	0.01	1.67%	0.6	0	Up to standard
	G6	8-hour AVG	0.007	0.016	2.67%	0.6	0	Up to standard

Table 9.4-21Monitoring of current atmosphere situation

Monitoring item	Monitoring point	Value type	Concentration range (μg/m^3)		Proportion of Max. Concentration in the standard value (%)	Standard	Over-standard rate (%)	Whether up to standard
			Min. value	Max. value		(μg/m^3)		
Cr^{6+}	G1	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
	G2	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
	G3	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
	G4	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
	G5	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
	G6	One-off value	0.01L	0.01L	0.67%	1.5	0	Up to standard
Mn	G1	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
	G2	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
	G3	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
	G4	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
	G5	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
	G6	Daily average value	0.2L	0.2L	2.00%	10	0	Up to standard
Pb and its compounds	G1	Daily average value	0.05L	0.09	12.86%	0.7	0	Up to standard
	G2	Daily average value	0.05L	0.08	11.43%	0.7	0	Up to standard
	G3	Daily average value	0.05L	0.09	12.86%	0.7	0	Up to standard
	G4	Daily average value	0.05	0.07	10.00%	0.7	0	Up to standard
	G5	Daily average value	0.05L	0.08	11.43%	0.7	0	Up to standard
	G6	Daily average value	0.05L	0.08	11.43%	0.7	0	Up to standard
As	G1	Daily average value	0.002L	0.003	0.10%	3	0	Up to standard
	G2	Daily average value	0.002L	0.003	0.10%	3	0	Up to standard
	G3	Daily average value	0.002L	0.003	0.10%	3	0	Up to standard
	G4	Daily average value	0.002L	0.003	0.10%	3	0	Up to standard
	G5	Daily average value	0.002L	0.003	0.10%	3	0	Up to standard
	G6	Daily average	0.002	0.003	0.10%	3	0	Up to

		value	L					standard
Hg	G1	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard
	G2	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard
	G3	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard
	G4	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard
	G5	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard
	G6	Daily average value	0.001 L	0.001 L	0.33%	0.3	0	Up to standard

9.4.3.2 Historical monitoring data of ambient air

According to *2011 Annual Report on Ambient Air Quality Monitoring of the Downtown of Zhuzhou City, 2012 Annual Report on Ambient Air Quality Monitoring of the Downtown of Zhuzhou City, 2013 Annual Report on Ambient Air Quality Monitoring of the Downtown of Zhuzhou City, and 2014 Annual Report on Ambient Air Quality Monitoring of the Downtown of Zhuzhou City* provided by Zhuzhou Environmental Monitoring Center Station, the statistical results of ambient air quality change of the downtown of Zhuzhou city are detailed in **Table 9.4-22**.

Table 9.4-22 2011-2014 Monitoring annual reports of routine monitoring points in Zhuzhou City

Year	**Item**	**Statistical item**	**Monitoring point**						**Standard**
			Monitoring station of the city	**Zhuye Hospital**	**Railway station**	**Tiantai Villa**	**Fourth Middle School of the city**	**Whole city**	
2014	SO_2	Annual average value	0.047	0.039	0.037	0.045	0.025	0.036	0.06
	NO_2	Annual average value	0.048	0.048	0.041	0.040	0.031	0.040	0.04
	PM_{10}	Annual average value	0.1	0.108	0.098	0.109	0.103	0.102	0.07
	CO	Max.daily average value	3.3	3.4	3.2	2.8	2.6	3.4	4
2013	SO_2	Annual average value	0.055	0.063	0.045	0.055	0.039	0.048	0.06
	NO_2	Annual average value	0.053	0.055	0.038	0.038	0.027	0.04	0.04

	PM_{10}	Annual average value	0.111	0.094	0.082	0.112	0.091	0.108	0.07
	CO	Max.daily average value	3.7	5.6	4.0	6.8	3.0	6.8	4
2012	SO_2	Annual average value	0.049	0.052	0.041	0.031	0.037	0.042	0.06
	NO_2	Annual average value	0.039	0.04	0.039	0.022	0.028	0.034	0.04
	PM_{10}	Annual average value	0.08	0.084	0.063	0.095	0.075	0.08	0.07
	CO	Max.daily average value	1.50	2.13	1.88	1.63	1.75	2.13	4
2011	SO_2	Annual average value	0.048	0.087	0.042	0.047	0.038	0.052	0.06
	NO_2	Annual average value	0.05	0.046	0.038	0.036	0.036	0.041	0.04
	PM_{10}	Annual average value	0.083	0.106	0.064	0.098	0.082	0.087	0.10
	CO	Max.daily average value	2.63	2.5	2.63	2.25	2.5	2.63	4

Note: the monitoring in 2011 referred to Class-II standard limit specified in *Ambient Air Quality Standard* (GB3095-1996), and the monitoring from 2012 to 2014 referred to *Ambient Air Quality Standard* (GB3095-2012).

9.4.3.3 Overall assessment of ambient air quality

In conclusion, according to the monitoring results of current situation of ambient air quality and in combination with the historical monitoring data of ambient air quality, the contaminants in the air exceeding Class-II standard mainly include CO, NO_2 and PM_{10}; the ambient air quality between 2011 and 2012 is better that that in 2011-2012; the number of contaminant factors at the point of Zhuye Hospital exceeding the standard is larger than that at other points, showing that the ambient air quality in the project area is worse than other areas. However, in the project area, fluoride, Hg, Pb and its compounds, arsenide, Cr^{6+}, Mn and its compounds, phenol and ammonia all meet the requirements of *Sanitary Standard for Industrial Enterprise Design* (TJ36-79).

9.4.4 Current situation of sound environmental quality

9.4.4.1 Monitoring point

Sixteen monitoring points are set along regional boundary, residential areas and roads for monitoring of current situation of sound environmental quality. See **Figure9.4-4**.

Table 9.4-23Noise monitoring points

Point	Position name	Point	Position name
Z1	Huoshaowuchang	Z9	On the south side of Xiawan Sewage Treatment Plant
Z2	Changshi Village	Z10	Jianshe Village
Z3	Longjiazhai	Z11	On the north side of the mixing site of China railway 16th Bureau Group
Z4	At the gate of Municipal Casting Plant (adjacent to Tongxia Road)	Z12	Xinqiao Primary School
Z5	On the north side of Longke Fertilizer Industry Co., Ltd.	Z13	Tongtangwan Community
Z6	On the north side of Dingshan Community	Z14	Yingfeng Community
Z7	Dawangshan Community	Z15	Fengjia Ancestral Hall
Z8	Yingfeng Commuity	Z16	Jianshe Village

9.4.4.2 Monitoring time and frequency

Changsha Environmental Protection Vocational College performed continuous monitoring for two days between December 8, 2014 and December 9, 2014, twice every day(daytime 06:00~22:00, nighttime 22:00~06:00).

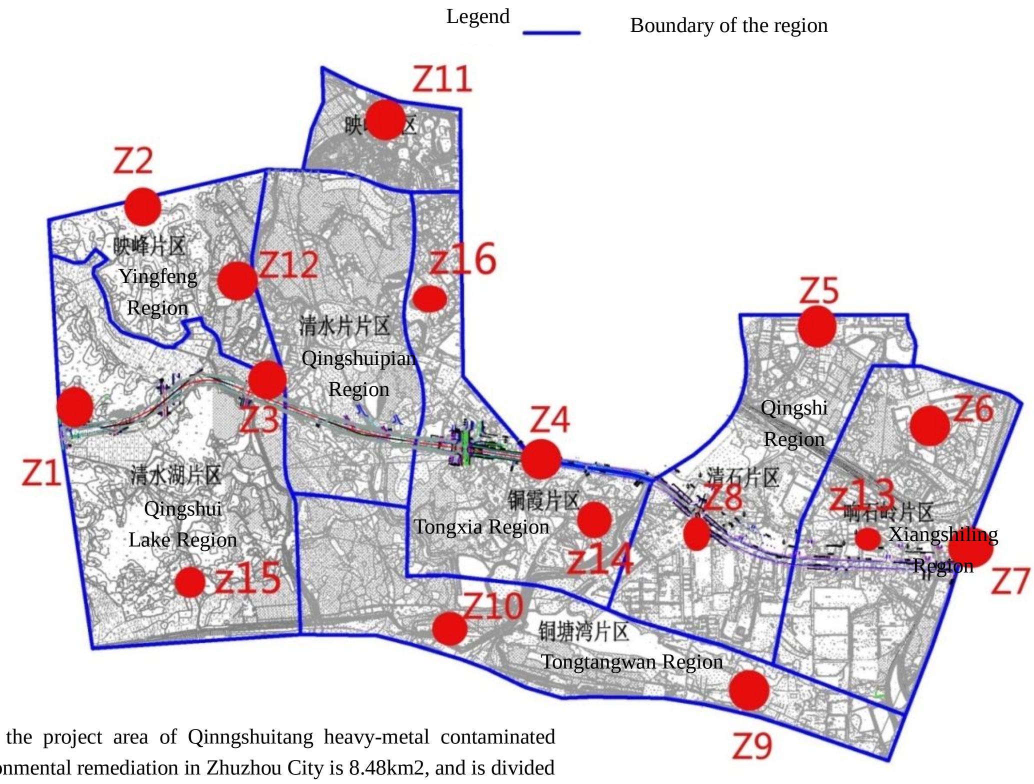
9.4.4.3 Monitoring results

See **Table 9.4-24**for monitoring results.

Table 9.4-24Monitoring statistics of current situation of sound environment

Monitoring point	**Monitoring time**	**Monitoring result (dB(A))**		**Whether up to standard**	**Monitoring point**	**Monitoring time**	**Monitoring result (dB(A))**		**Whether up to standard**
		L_d	**L_n**				**L_d**	**L_n**	
Z1	December 8, 2014	62.7	51.0	**Yes**	Z9	December 8, 2014	56.3	49.1	**Yes**
	December 9, 2014	61.9	54.6	**Yes**		December 9, 2014	49.8	47.5	**Yes**
Z2	December 8, 2014	52.5	39.4	**Yes**	Z10	December 8, 2014	57.5	49.9	**Yes**
	December 9, 2014	54.9	47.3	**Yes**		December 9, 2014	58.4	41.7	**Yes**
Z3	December 8, 2014	60.1	49.2	**Yes**	Z11	December 8, 2014	58.4	44.6	**Yes**
	December 9, 2014	60.9	47.8	**Yes**		December 9, 2014	53.1	42.1	**Yes**
Z4	December 8, 2014	61.0	53.2	**Yes**	Z12	December 8, 2014	58.4	38.1	**Yes**
	December 9, 2014	61.9	50.8	**Yes**		December 9, 2014	50.5	39.0	**Yes**
Z5	December 8, 2014	54.1	41.7	**Yes**	Z13	December 8, 2014	58.5	47	**Yes**
	December 9, 2014	54.9	44.4	**Yes**		December 9, 2014	57.0	49.5	**Yes**
Z6	December 8, 2014	59.2	47.8	**Yes**	Z14	December 8, 2014	54.2	46.0	**Yes**
	December 9, 2014	51.7	41.2	**Yes**		December 9, 2014	58.4	42.3	**Yes**
Z7	December 8, 2014	58.5	42.0	**Yes**	Z15	December 8, 2014	51.5	45.4	**Yes**
	December 9, 2014	58.2	42.5	**Yes**		December 9, 2014	47.7	40.3	**Yes**
Z8	December 8, 2014	57.2	39.3	**Yes**	Z16	December 8, 2014	54.5	48.5	**Yes**
	December 9, 2014	59.2	44.5	**Yes**		December 9, 2014	53.2	42.1	**Yes**

The monitoring results show that all noise monitoring points meet the standard and the sound environment in the project area is good.



Note: the project area of Qinngshuitang heavy-metal contaminated environmental remediation in Zhuzhou City is 8.48km2, and is divided

Figure9.4-4 Location map for noise monitoring points

9.4.5 Current situation of sediment environmental quality

According to 2010 Annual Report of Water Quality Monitoring of Zhuzhou Section of Xiang River, 2011 Annual Report of Water Quality Monitoring of Zhuzhou Section of Xiang River, 2012 Annual Report of Water Quality Monitoring of Zhuzhou Section of Xiang River and 2013 Annual Report of Water Quality Monitoring of Zhuzhou Section of Xiang River provided by Zhuzhou Environmental Monitoring Center Station, the changes of sediment contaminants at Xiawan section of Zhuzhou section of Xiang River are taken into the statistics and the results are detailed in **Table 9.4-25**.

According to the statistical results, the contents of total arsenic, total mercury, total copper, total lead, total cadmium and total zinc in the sediment at Xiawan section in 2011 decrease to a large extent compared with 2010, but the content of total chromium increases. A a whole, the heavy metal contamination in the sediment at this section is improved significantly.

Table 9.4-25 2010-2011 Sediment monitoring of Xiawan section

(Unit: mg/kg, except pH)

Year	Month	pH	Total As	Total Hg	Total Cu	Total Pb	Total Cd	Total Zn	Total Cr
2010	Sep.	7.15	918.26	10.361	597.99	1841.45	63.092	5300.8	55.008
	Nov.	7.02	149.92	9.24	69.81	207.16	17.744	654.1	47.089
Comparison between 2010 and 2009		0.09	-357.59	-8.75	-7.03	200.51	-47.566	-580.35	-13.053
2011	Sep.	6.61	38.422	0.13	35.463	82.819	9.031	581.14	118.64
Comparison between 2011 and 2010		-0.48	-495.67	-9.67	-298.44	-941.49	-31.39	-2396.31	67.59
Class-II standard		6.5-7.5	25	0.5	100	300	0.3	250	300

9.5 Conservation area and cultural relics

According to Zhuhzou Cultural Relics Bureau, there is no protected cultural relic in the project area.

According to the field investigation, the tangible cultural resources in the project area mainly include Wuniang Temple, graveyard and Dawang Temple. See **Table 9.5-1** and **Figure9.5-1** and **Figure9.5-2** for locations and situations. The graveyard and Dawang Temple are on the hills. The construction of the project will not involve the land of these tangible cultural resources.

Table 9.5-1List of tangible cultural resources in the project area

No.	Name	Location	Quanity (scale)
1	Dawang Temple	At the peak of Nanbazi Mountain in Yingfeng Region	About 15m^2
2	Graveyard	Congshutang Group, Jianshe Village	About 800
3	Graveyard	On the hill close to Xiawan New Village	About 1500
4	Wuniang Temple	Wuniang Temple	About 100 m^2

Figure9.5-1 Location map for tangible cultural resoucrs in the project area

	
Dawang Temple	
	
Dawang Temple	**Graveyard**

Figure9.5-2Pictures of tangible cultural resources in the project area

10 Investigation of the Existing Industrial Pollution Sources and Contaminant Emission

10.1Information of major enterprises in the project area

Within the range of 47km^2 of the conceptual planning of Qingshui Lake Eco-city, there are more than 110 enterprises. Within the range of 15.17km^2 of the planning of Qingshuitang Eco-city, there are more than 80 enterprises, including Zhuzhou Smelter Industry Group, Zhuzhou Chemical Industry Plant Zhongcheng Chemicals, CNSG Hunan Zhuzhou Chemical Industry Group, Liuhua Guicheng Chemicals, Xiang River Nitrogen Fertilizer Plant; and there are 45 enterprises within the range of 8.48km^2 of this project.

The leading industries in the project are nonferrous smelting and chemical industry with high energy consumption and serious pollution, and the majority of large and medium-sized enterprises were built in the First-Five-Plan period and the Second-Five-Plan period, and the area is an old industrial base. Zhuzhou Smelter Industry Group is the largest production base of lead, zinc and copper in China, Zhuzhou Chemical Industry Goup is the largest production base of chemical raw materials in Hunan Province, Zhongcheng Chemicals is the largest production base of sodium hydrosulfite in the world, and all of them are the key pollution sources. In the project area, there are a great number of chimneys and overhead pollution sources, and the amount of orderly and disorded emission of industrial waste gas is large, a large quantity of heavy metal and other contaminants in the waste gas are discharged into the environment, the emission of wastewater is still staying at a high level, and the industrial structural pollution is quite severe.

In the project area, there are 45 in-production enterprises, among which six enterprises have closed. See **Table 10.1-1** for the list of in-production and closed enterprises. See **Table 10.1-2** for the list of major in-production and closed enterprises in the assessment area but outside of the project area. See **Figure10.1-1** for the location map for enterprises in the project area, and see **Figure10.1-2** for the distribution of enterprises outside of the project area.

Table 10.1-1 Situation of major in-production enterprises in the project area

No.	Operation status	Enterprise name	Main products
1	In-production	Hunan Xiangdan Industry Co., Ltd.	Hydrogen peroxide, synthesis ammonia, sodium carbonate, urea, building materials and thermal power
2		Hunan Longke Fertilizer Industry Co., Ltd.	Research, production and sales of composite and mixed fertilizers, and sales of fertilizers
3		Hunan Haohua Chemical Industry Co., Ltd.	Pesticides and chemical products
4		Hunan Xiangzhu Chemical Industry Stock Co., Ltd.	Phosphatic fertilizer and composite fertilizer
5		Zhuzhou Water Supply Company	Office working
6		Zhuzhou Special Welding Electrodes Co., Ltd.	Welding electrode, welding wire and capacitor
7		Zhuzhou Shifeng District State-owned Property Investment Management Co., Ltd.	
8		Hunan Petroleum Subsidiary of Sinopec Assets Management Co., Ltd.	New technology development and technical consulting of petroleum and chemical industry
9		Hunan Changsha-Zhuzhou-Xiangtan International Logistics Co., Ltd.	Management and logistics value-added services
10		Hunan Dongzheng Traffic Facilities Co., Ltd.	Separation fence, railing, mesh, traffic guidance device, traffic safety sign and galvanized pipe
11		Zhuzhou Pinhe Zinc Material Co., Ltd.	Zinc ingot, zinc plate and lead slag
12		Hunan Zhuzhou Electric Power Bureau	
13		Zhuzhou Tongda Smelting Industry Co., Ltd.	Chemical products and reagent
14		Zhuzhou Xinyu Industry Co., Ltd.	Oil-tea tree planting, processing and sales
15		Hunan Yuanzheng Investment Co., Ltd.	Transportation, auto trade, tourism services, development of tourism area, real estate investment and development, financial investment and wine industry investment and development
16		Hunan Sales Subsidiary of China National Petroleum Corporation	
17		Zhuzhou Fangyuan Assessment Management Co., Ltd.	Development, construction, leasing and sales of standard industrial workshops, and routine management of stock assets authorized by government and related institutions
18		Hunan Zhuzhou Iron & Steel Co., Ltd.	Building steels
19		Zhuzhou Qibin Group Stock Co., Ltd.	Production of glass sheets and deep processing of glass
20		Zhuzhou Changsheng Industry Co, Ltd.	Wholesale and retail and warehouse leasing
21		Zhuzhou Xinzheng Nonferrous Metals Co., Ltd.	

22		Zhuzhou Xindu Industry Co., Ltd.	Dining and housing
23		Zhuzhou Yunlong Industry Co., Ltd.	Glass products
24		Zhuzhou Xiawan Sewage Treatment Plant	Wastewater treatment
25		Xiawan Building Materials Co., Ltd.	Autoclaved aerated concrete blocks
26		The 23th Metallurgical Construction Corporation of China Nonferrous Metal Industry	Nonferrous metals, mine quarrying, heavy metal, and engineering construction
27		Tiehong Workshop of Dongtai Industry Co., Ltd.	Reduced titanium
28		Zhuzhou Haili Fine Chemicals Co., Ltd.	Pesticide emulsifier and intermediate, o-sec-butylphenol and benzofuranol
29		Qingshuitang Industrial Wastewater Treatment and Utilization Plant	Wastewater treatment
30		Zhuzhou Huanmei Waste and Old Materials Recycling Co., Ltd.	Reclaiming and wholesales of recycled materials
31		Sanxing Fluorine Plastics Plant	Plastic products, daily plastics and sundry goods
32		Original Mixing Station of China Railway 16th Bureau	
33		Zhuzhou Tongtangwan Channel Jianxia Operation Zone Project	
34		Huarui Industry Co., Ltd.	Resource utilization of volatile kiln slag produced by Zhuzhou Smelter
35		Hongyun Sand Field	River sand
36		Zhuzhou Tongda Cement Pipes Co., Ltd.	Cement, concrete and asphalt
37		Shifeng District Jianshe Precast Yard	
38		Dayu Co., Ltd.	
39		Libo Chemical Fibers	
40	Closed	Kangli Smelting Plant	Blister copper
41		Zhuzhou Brothers Industry Co., Ltd.	Protofilament
42		Zhuzhou Hongji Zinc Indsutry Co., Ltd. (Yongfa Refinery Plant)	Secondary zinc oxide, zinc sulfate and crude indium, zinc oxide and crude cadmium
43		Zhuzhou Xinda Smelting Co., Ltd.	Zinc oxide
44		Zhuzhou Tiancheng Chemical Co., Ltd.	Ruber accelerator and nickel alloy
45		Zhuzhou Hehua Cement Plant	Cement, lime and gysum

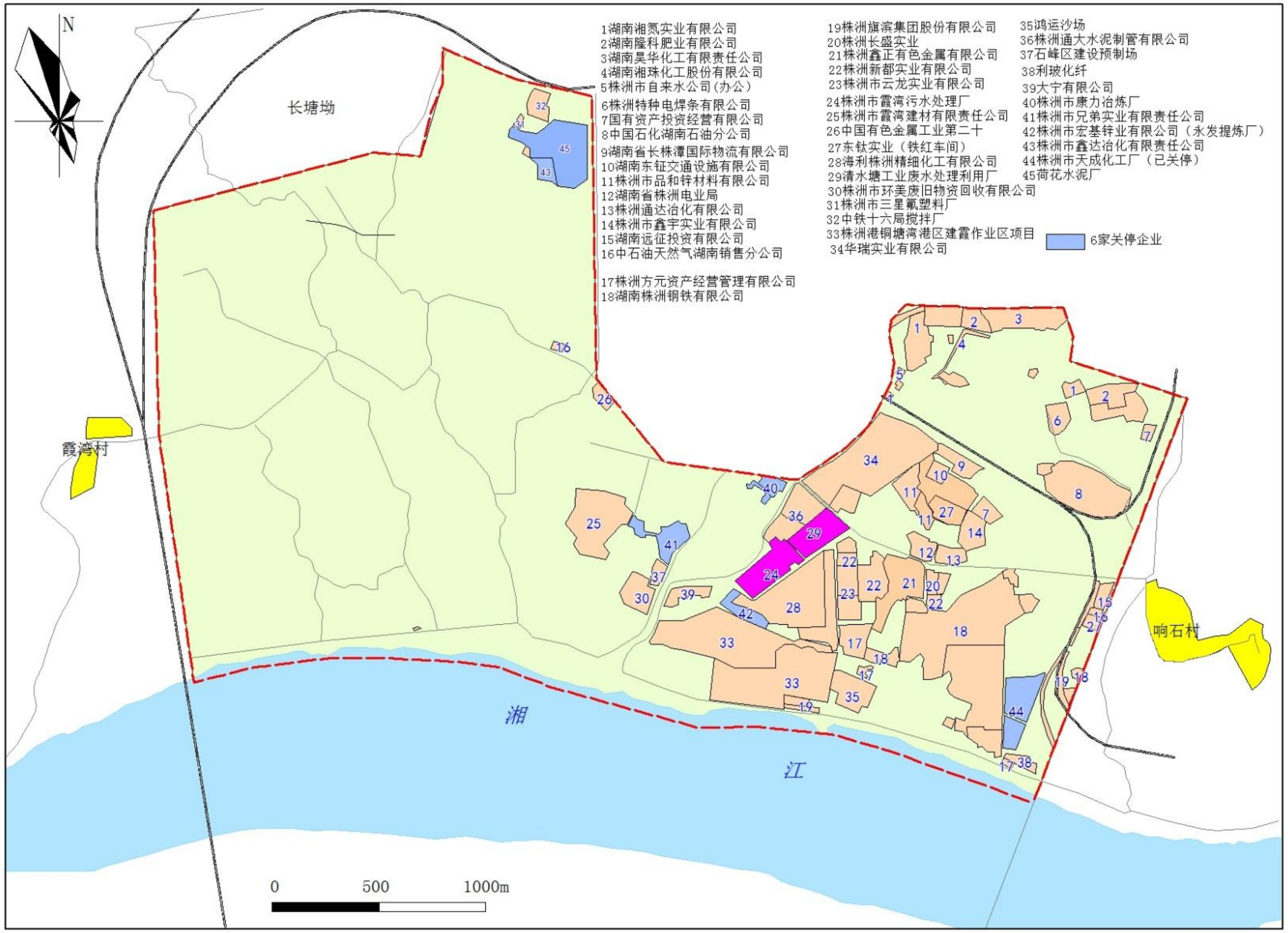


Figure10.1-1Location map for in-production and closed enterprises in the project area

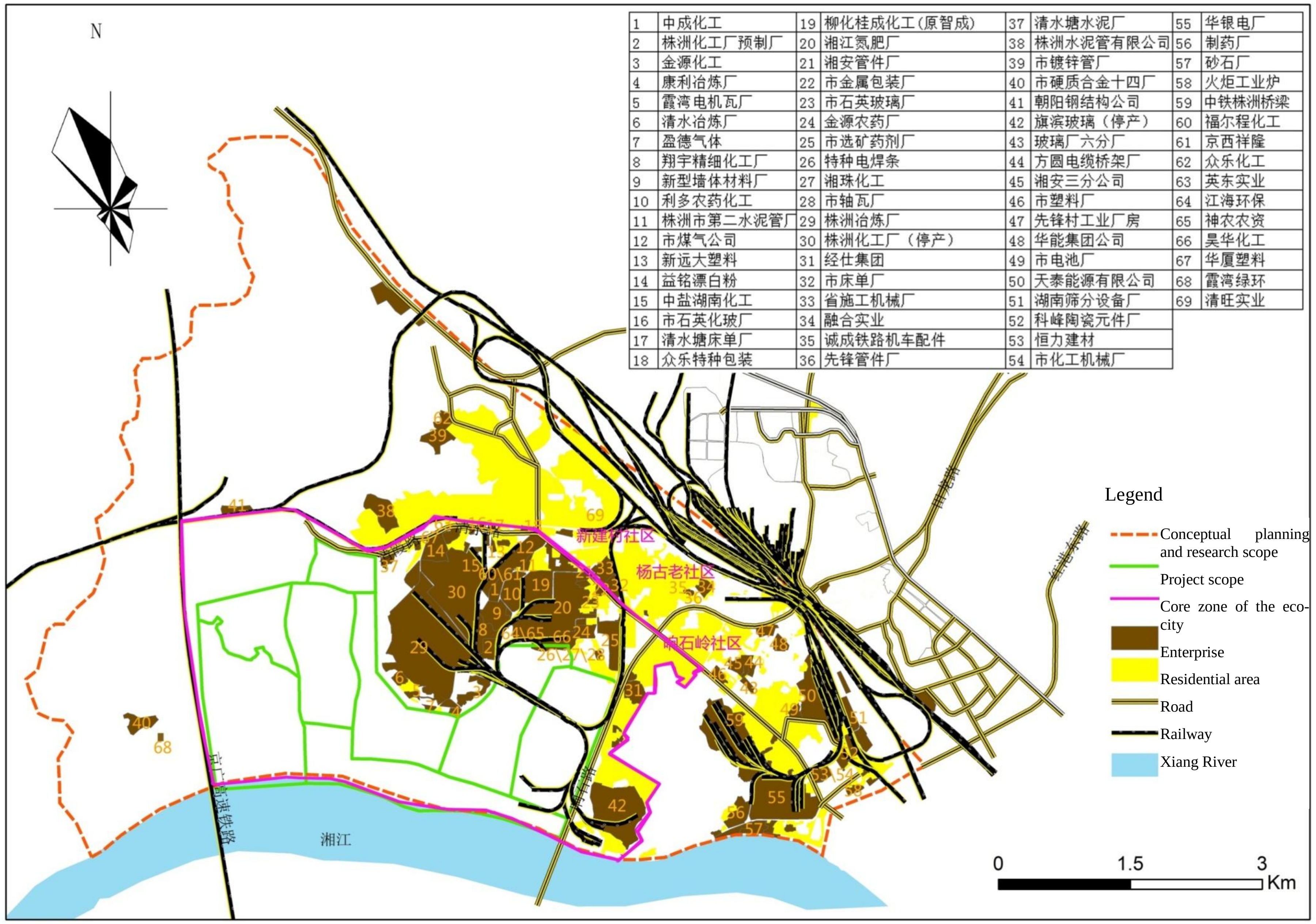


Figure10.1-2Location map for major in-production enterprises and communities outside of the project area

Table 10.1-2 Information of major enterprises in the assessment area but outside of the project area

No.	Enterprise name	Main products
1	Hunan Zhongcheng Chemical Industry Co., Ltd.	Sodium hydrosulfite
2	The Precast Plant of Zhuzhou Chemical Industry Plant	
3	Zhuzhou Jinyuan Chemical Industry Co., Ltd.	Lead nitrate, copper sulfate and lead oxide
4	Zhuzhou Kangli Smelter Plant	Blister copper
5	Xiawan Motor Tile Plant	
6	Qingshui Smelter Plant	
7	Zhuzhou Yingde Gas Co., Ltd.	Oxygen production
8	Xiangyu Fine Chemicals Plant	
9	New-type Wall Materials Plant	
10	Liduo Pesticide Chemicals	
11	Zhuzhou Second Cement Pipe Plant	Production of cement pressure pipe
12	Zhuzhou Gas Company	
13	Zhuzhou Xinyuanda Plastic Products Co., Ltd.	Membrane bag
14	Hangzhou Yiming Bleaching Powder Production Co., Ltd.	Bleaching powder
15	CNSG Hunan Zhuzhou Chemical Industry Group Co., Ltd.	PVC
16	Zhuzhou Quartzification Glass Plant	
17	Qingshuitang Sheet Factory	
18	Zhuzhou Zhongle Special Packaging Co., Ltd.	Production of steel drums and paper drums
19	Liuhua Guicheng Chemical Industry Co., Ltd. (Original Zhicheng)	Chemical fertilizer
20	Xiang River Nitrogenous Fertilizer Plant	Chemical fertilizer
21	Xiang'an Pipe Fittings Plant	
22	Zhuzhou Metal Packaging Plant	
23	Zhuzhou Quartz Glass Plant	
24	Jinyuan Agricultural Fertilizer Plant	
25	Zhuzhou Mineral Separation Agent Plant	Ethyl thio carbamate
26	Zhuzhou Special Welding Electrode Co., Ltd.	
27	Xiangzhu Chemicals	
28	Zhuzhou Bearing Bush Plant	
29	Zhuzhou Smelter Industry Group	Pb, Zn, Au, Ag, Im, Cd, Cu, S, Acid, Co, etc.
30	Zhuzhou Chemical Industry Plant	Sulfuric acid, hydrochloric acid, caustic soda, phosphatic fertilizer, pigment, PVC and cement
31	Hunan Jingshi Group Industry Co.,Ltd.	zinc sulfate, silica gel, zinc oxide, indium ingot and metal lead
32	Zhuzhou Sheet Plant	
33	Hunan Construction Machinery Plant	
34	Zhuzhou Ronghe Industry Co.,Ltd.	Second zinc oxide
35	Chengcheng Railway Locomotive Fittings Plant	
36	Xianfeng Pipe Fittings Plant	
37	Qingshuitang Cement Plant	

38	Zhuzhou Cement Pipe Co., Ltd.	
39	Zhuzhou Galvanized Pipe Plant	
40	Zhuzhou Hard Alloy 14th Plant	
41	Chaoyang Steel Structure Company	
42	Qibin Glass Plant (shut down)	Glass
43	The Sixth Glass Branch Plant	
44	Fangyuan Cable Bridge Plant	
45	Xiang'an Third Subsidiary	
46	Zhuzhou Plastics Plant	
47	Xianfeng Village Industrial Workshop	
48	Huneng Group Company	
49	Zhuzhou Battery Plant	
50	Tiantai Energy Co., Ltd.	
51	Hunan Screening Equipment Plant	
52	Kefeng Ceramic Elements Plant	
53	Hengli Building Materials	
54	Zhuzhou Chemical Industry Machinery Plant	
55	Datang Huayin Zhuzhou Electricity Generating Co., Ltd.	Electricity
56	Pharmaceutical Factory	
57	Gravel Plant	
58	Zhuzhou Huoju Engineering Co., Ltd.	Antiseptic products
59	China Railway Zhuzhou Bridge	Production of steel mould for electric pole
60	Zhuzhou Fuercheng Chemical Industry Co., Ltd.	SDD and activated zinc oxide
61	Hunan Jingxi Xianglong Chemical Industry Co., Ltd.	Sodium pentachlorophenate
62	Zhuzhou Zhongle Chemical Industry Co., Ltd.	NM activated zinc oxide
63	Zhuzhou Yingdong Industry Co., Ltd.	Hydrofluoric acid
64	Zhuzhou Jianghai Environmental Protection Industry Co., Ltd.	Ammonium chloride
65	Zhuzhou Shennong Agricultural Materials Co., Ltd.	Sodium chloride
66	Hunan Haohua Chemical Industry Co., Ltd.	100% pesticide
67	Zhuzhou Huaxia Plastic Processing Plant	Industrial plastic products
68	Zhuzhou Xiawan Green Ring Co., Ltd.	Ferrous sulfate pentahydrate
69	Zhuzhou Qingwang Industry Co., Ltd.	Iron casting and rivet welding pieces

10.2Information on contamination emission of enterprises in the project area

10.2.1 Information on wastewater discharge

See **Table 10.2-1** for the information of contamination emission of QingshuiTang Industrial Zone in 2013. According to the table, the annual emission of Cd, As and Pb is

496kg, 628kg and 1827kg respectively. at present the enterprises involving heavy metal emission mainly are Zhuzhou Smelter Group and Zhuzhou Chemical Industry Group.

See **Table 10.2-2～Table 10.2-6**.

The first two enterprises with the highest emission of COD are Zhuzhou Smelter Group and Zhicheng Chemicals; the first two enterprises with the highest emission of ammonia nitrogen are Zhicheng Chemicals and Zhuzhou Smelter Group; and the enterprises with emission of Pb, As, Cd and Hg are Zhuzhou Smelter Group and Zhuzhou Chemical Industry Group.

Now Zhuzhou Chemical Industry Group and Qibin have stopped production.

Table 10.2-1 Summary of emission of water contaminants in 2013

Name	Industrial source	Agricultural source	Domestic source	Total
Wastewater (10 thousand t)	2627.78	--	2655.5	5283.28
Chemical oxygen demand (t)	2740.98	1689.57	1263.0	5693.55
Ammonia nitrogen (t)	543.49	65.65	234.4	843.54
TN (t)	--	211.44		211.44
TP (t)	--	23.58	21.3	44.88
Petroleum (t)	30.17	--		30.17
Volatile phenol (t)	0.36	--		0.36
Cyanide (kg)	1321	--		1321
As (kg)	628	--		628
Total Cr (kg)	6	--		6
Cr^{6+}(kg)	6	--		6
Pb (kg)	1827	--		1827
Cd (kg)	496	--		496
Hg (kg)	126	--		126

Table 10.2-2Major enterprises with wastewater discharge in the project area

No.	Enterprise name	Discharge amount (10 thousand tons/year)
1	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	810
2	Hunan Zhicheng Chemical Industry Co., Ltd.	544.75
3	Zhuzhou Smelter Industry Group Co., Ltd.	201.3
4	Zhuzhou Gas Company	75
5	Zhuzhou Huayin Thermal Power Generating Co., Ltd.	60.54
6	Hunan Zhongcheng Chemical Industry Co., Ltd.	43.5
7	Hunan Tiantai Energy co., Ltd.	34.68
8	Zhuzhou Mineral Separation Agent Plant	31
9	Hunan Haohua Chemical Industry Co., Ltd.	31

10	Zhuzhou Qinbin Glass Group Co., Ltd.	18.54
11	Haohua	28
12	Haili	55
13	The 14th Workshop	21.6
Total		**1954.91**
Proportion in the total discharge of industrial wastewater in the project area		74.4%

Table 10.2-3 List of Major enterprises with emission of COD

No.	**Enterprise**	**COD emission (ton/year)**	**Ranking**
1	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	809	1
2	Hunan Zhicheng Chemical Industry Co., Ltd.	762.65	2
3	Zhuzhou Smelter Industry Group Co., Ltd.	149.17	5
4	Zhuzhou Mineral Separation Agent Plant	244	3
5	Zhuzhou Tiancheng Chemical Industry Co., Ltd.	220	4
6	Hunan Zhongcheng Chemical Industry Co., Ltd.	34	9
7	Zhuzhou Qinbin Glass Group Co., Ltd.	80	6
8	Hunan Haohua Chemical Industry Co., Ltd.	25	10
9	Hunan Haili Zhuzhou Fine Chemicals Co., Ltd.	50.05	7
10	The 14th Workshop	8.72	11
11	Zhuzhou Huayin Thermal Power Generating Co., Ltd.	42.74	8
Total		2425.33	
Proportion in the total COD emission in the project area		88.5	

Table 10.2-4List of major enterprises with emission of NH_3-N

No.	Enterprise name	Emission of ammonia nitrogen (ton/year)	Ranking
1	Hunan Zhicheng Chemical Industry Co., Ltd.	326.85	1
2	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	100	2
3	Zhuzhou Smelter Industry Group Co., Ltd.	27.57	3
4	Zhuzhou Mineral Separation Agent Plant	19.2	4
5	Zhuzhou Tiancheng Chemical Industry Co., Ltd.	18	5
6	Zhuzhou Shifeng District Lida Oil Tank Chemical Industry Co., Ltd.	4.02	6
7	The Branch of Zhuzhou Hard Alloy Group	3.24	7
8	Zhuzhou Jinyuan Chemical Industry Co., Ltd.	1.001	8
9	Haohua	0.21	9
Total		500.091	
Proportion in the total emission of ammonia nitrogen in the project area		92%	

Table 10.2-5Emission of heavy metal

Enterprise name	Emission of heavy metal (kg/a)			
	Pb	Cd	As	Hg
Zhuzhou Smelter Industry Group Co., Ltd.	1739	320	312	24
Hunan Zhuzhou Chemical Industry Group Co., Ltd.		171	312	102
Total	1739	491	624	126
Proportion in the total emission of heavy metal in the project area	94.58%	98.99%	99.36%	100.00%

Table 10.2-6 Emission of cyanide

No.	Enterprise name	Emission of cyanide (t/a)
1	Hunan Zhicheng Chemical Industry Co., Ltd.	1310
2	Haohua	10
Total		1320
Proportion in the total emission of cyanide in the project area		**100%**

10.2.2 Information on waste gas emission

In the project area, the total emission of sulfur dioxide in 2013 is 29499.86 tones (including 14553.36 tons during fuel combustion and 14946.5 tons during process), Fume dust 5080.49 tons, nitric oxide 25199.01 tons, industrial dust 1681.1 tons and fluoride 3.12 tons. See **Table 10.2-7** for statistical results.

See **Table 10.2-8～Table 10.2-14**

The enterprises with the highest emission of SO_2 are Zhuzhou Smelter Group and Huayin; the enterprises with the highest emission of Fume dust are Zhicheng and Huayin; the enterprises with the highest emission of industrial dust are Zhuzhou Smelter Group and Zhuzhou Chemical Industry Group; the enterprises with the highest emission of nitric oxide are Zhicheng and Zhuzhou Chemical Industry Group; the enterprises with the highest emission of fluoride are Zhuzhou Chemical Industry Group and Qibin.

Table 10.2-7 Enterprises with emission of waste gas in 2013

(Waste gas: 10 thousand m^3, others: t/a)

Contaminant	During fuel combustion	During process	Total
Industrial waste gas	3312464.51	3690478.23	7002942.74
Fume dust	5080.49	0	5080.49
SO_2	14553.36	14946.5	29499.86
Nitric oxide	25151.17	47.84	25199.01
Industrial dust	0	1681.1	1681.1
Fluoride	0	3.12	3.120

Table 10.2-8For enterprises with high emission of SO_2.

No.	Enterprise name	Emission of SO_2 (ton/year)	Ranking
1	Zhzhou Huayin Thermal Power Generating Co., Ltd.	5136	2
2	Zhuzhou Smelter Industry Group Co., Ltd.	12515.4	1
3	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	3789	3
4	Hunan Zhicheng Chemical Industry Co., Ltd.	2111	4
5	Zhuzhou Qinbin Glass Group Co., Ltd.	1273	5
6	Hongji Zinc Industry	128	7
7	Haili	159.1	6
8	Zhongcheng	16.4	8
Total		25127.9	
Proportion in the total emission of SO_2 in the project area		85.2%	

Table 10.2-9 List of enterprises with high emission of fume dust

No.	Enterprise name	Emission of fume dust (ton/year)	Ranking
1	Zhzhou Huayin Thermal Power Generating Co., Ltd.	796.8	2
2	Hunan Zhicheng Chemical Industry Co., Ltd.	2393	1
3	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	206	3
4	Zhuzhou Smelter Industry Group Co., Ltd.	4.29	8
5	Zhuzhou Gas Company	79.15	5
6	Zhuzhou Mineral Separation Agent Plant	14.6	7
7	Qinbin	147	4
8	Haili	15.4	6
Total		3656.24	
Proportion in the total emission of fume dust in the project area		72%	

Table 10.2-10 List of enterprises with high emission of industrial dust

No.	Enterprise name	Emission of industrial dust (ton/year)	Ranking
1	Zhuzhou Smelter Industry Group Co., Ltd.	754	1
2	Hunan Zhicheng Chemical Industry Co., Ltd.	64.7	4
3	Zhuzhou Gas Company	162.9	3
4	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	459	2
5	Zhuzhou Qingshui Cement Plant	42	5
6	China Railway Bridge Co., Ltd.	11.7	8
7	Hunan Haohua Chemical Industry Co., Ltd.	1	9
8	Zhuzhou Mineral Separation Agent Plant	0.05	10
9	Hongji Zinc Industry	40	6
10	Qibin	16.2	7
Total		1535.35	
Proportion in the total emission of industrial dust in the project area		91.3%	

Table 10.2-11 List of enterprises with high emission of nitric oxide

No.	Enterprise name	Emission of nitric oxide (ton/year)	Ranking
1	Zhuzou Smetler Group	13.08	7
2	Zhuzhou Chemical Industry Group	1286	3
3	Zhicheng	1102	4
4	Hongji Zinc Industry	40	6
5	Haili	51.7	5
6	Zhongcheng	0	8
7	Huayin	18615	1
8	Qibin	1457	2
Total		22564.78	
Proportion in the total emission in the project area		89.5	

Table 10.2-12 List of enterprises with high emission of fluoride

No.	**Enterprise name**	Emission of fluoride (kg)
1	Hunan Zhuzhou Chemical Industry Group Co., Ltd.	1.32
2	Qibin	1.6
Total		2.92
Proportion in the total emission of fluoride in the project area		93.6%

10.2.3 Information on waste solid discharge

(1)Information on discharge of general waste solids

Because smelter and chemical industry are the leading industries in the project area, they produce a great quantity of waste solids and complicated compositions. At present, there are 42 enterprises producing general solid wastes and the annual output is 2389950 tons (see **Table 10.2-13**), mainly including fly ash, furnace slag, nonferrous smelting waste and chemical waste slag. The output of fly ash is 844797 tons, accounting for 35.3%; other waste slag 616783 tons, accounting for 25.8%; and smelting wastes 348602 tons, accounting for 14.6%. The annual utilization quantity is 2350951 tons, and the utilization rate is 98.4%. The waste slag is basically utilized, and the utilization quantity of smelting wastes is larger than the output, decreasing the stock.

Table 10.2-13 Information on general solid wastes Unit:t

Waste name	Smelting waste	Fly ash	Furnace slag	Coal gangue	Tailings	FGD gypsum	Sludge	Others	Total
Output	348602	844797	356879	26380	7914	137754	50810	616783	2389950
Number of enterprises	7	17	28	1	1	6	3	8	42
Utilization quantity	497232	734560	348951	26380	0	123830	0	612084	2350951
Utilization of wastes produced in previous years	150151	153765	7532	0	0	0	0	0	311807
Disposal quantity	1880	58	460	0	0	315	50810	4699	58222
Disposal of wastes produced in previous years	0	0	0	0	0	0	0	0	0
Storage quantity	0	263944	15000	0	0	13609	0	0	292553
Storage of wastes produced in previous years	586000	153765	7532	0	0	0	0	0	747297
Discard quantity	0	0	0	0	0	0	0	0	0

(2) Information on production of hazardous wastes

In 2013, there were nine enterprises producing dazardous wastes, 11 types and 19952 tons (see **Table 10.2-14**), mainly including nonferrous metal smelting wastes, rectification and distillation residues, organic solvent. Among them, the quantity of nonferrous metal smelting wastes is 11994 tons, accounting for 60.1%; rectification and distillation residues 3480 tons, accounting for 17.4%; and zinc wastes 2566 tons, accounting for 12.9%.

The annual utilization quantity of hazardous wastes is 10195 tons, the utilization rate is 51.1%, and the storage quantity is 8474 tons. The increased accumulation of storage will be an environmental problem.

Table 10.2-14 Information on hazardous wastes Unit:t

Hazardous waste	Number of enterprises	Output	Utilization quantity	Disposal quantity	Storage quantity this year	Including: storage meeting the requirements of environmental protection	Discard quantity
Organic solvent	1	39.00	0.00	39.00	0.00	0.00	0.00
Used mineral oil	4	81.29	61.29	20.00	0.00	0.00	0.00
Waste oil and water mixture	1	49.80	0.00	49.80	0.00	0.00	0.00
Rectification and distillation residues	2	3480.31	3480.31	0.00	0.00	0.00	0.00
Dye and coating waste	1	460.74	0.00	460.74	0.00	0.00	0.00
Zinc waste	1	2566.26	2566.26	0.00	0.00	0.00	0.00
Mercury waste	2	503.44	0.00	503.44	0.00	0.00	0.00
Lead waste	1	567.00	567.00	0.00	0.00	0.00	0.00
Used organic solvent	1	30.50	0.00	30.50	0.00	0.00	0.00
Polychlorinated benzofuran	1	132.32	0.00	132.32	0.00	0.00	0.00
Nonferrous metal smelting waste	1	11994.82	3520.44	0.00	8474.38	8474.38	0.00
Other hazardous wastes	1	19.59	0.00	19.59	0.00	0.00	0.00

10.3Information on key enterprises reaching the standard

Zhuzhou Environmental Protection Center Station carries out routine monitoring on key enterprises in the assessment area for emission of waste gas and waste water. Zhuzhou Pinhe

Zinc Materials Co., Ltd, Zhuzhou Smelter Industry Group, CNSG Hunan Zhuzhou Chemical Industry Co., Ltd., Liuhua Guicheng Chemical Industry (original Zhicheng) and Datang Huayin Zhuzhou Electricity Generating Co., Ltd. are key state-controlled waste gas pollution sources in Hunan Province; and Zhuzhou Smelter Industry Group, Liuhua Guicheng Chemical Industry Co, Ltd. (original Zhicheng), Xiawan Sewage Treatment Plant and Qingshuitang Industrial Wastewater Treatment and Utilization Plant are state-controlled wastewater pollution sources in Hunan Province.

The monitoring data (attached list) from Zhuzhou Environmental Protection Monitoring Center Station on the emission of waste gas and wastewater of key enterprises in the assessment area between 2012 and 2014 and the supervision monitoring data on key state-controlled pollution sources in Hunan Province are collected for statistical analysis. The in-production enterprises which are not listed as key controlled pollution sources shall apply from pollution discharge license every year according to relevant regulations and shall submit the monitoring reports on pollution emission to the environmental protection administration department before obtaining the license. Only the enterprise with the monitoring results reach the standard can obtain the license for pollution emission and continue to operate.

10.3.1 Waste gas

See Attached List 1 for the monitoring information on waste gas between 2012 and 2015. See **Table 10.3-1** for the emission monitoring results.

The emission of Pb and Cd of Zhuzhou Smelter Group in 2012 and 2013 exceeds the standard. After intensified monitoring and management, the emission of Pb and Cd meets the standard in 2014, but the emission of fume dust and SO_2 still exceeds the standard. In the first quarter of 2015, monitoirng fume dust and SO_2 met the standard.

The contaminants of the four enterprises exceeding the standard are fume dust and SO_2, and no heavy metal emission exceeds the standard beforer 2014. In the first quarter of 2015, all have met compliance.

Table 10.3-1 Statistics of monitoring on waste gas emission of key enterprises between 2012 and 2014

No.	Location	Enterprise	Monitoring time	Monitoring factor	Whether up to standard	Monitoring time of over-standard emission	Over-standard factor	Max. concentration (mg/m3)	Max. times of ultra standard	Remark
1	Outside of the area	Zhuzhou Smelter Industry Group Co., Ltd.	All quarters in 2012- Q1, 2015	PM, SO_2, Pb, As and Cd	Some exceed the standard	First quarter in 2014	SO2	958	1.395	PM and SO2 monitoring data is from [1]; Pb, As and Cd monitoring data is from [2]
						Second quarter in 2014	PM	940.5	10.75	
							SO2	923.8	1.31	
						Second quarter in 2013	Cd	0.905	0.065	
						Second quarter in 2012	Pb	18.86	1.358	
						Third quarter in 2012	Pb	26.97	2.371	
							Cd	4.376	4.148	
2		CNSG Hunan Zhuzhou Chemical Industry Group Co., Ltd.	All quarters in 2012- 2014	Fume dust, SO2 and NOX	All reach the standard					Monitoring data is from [1]
3		Liuhua Guicheng Chemical Industry Co., Ltd. (Original Zhicheng)	All quarters in 2012- Q1, 2015	Fume dust, SO2 and NOX	Some exceed the standard	Fourth quarter in 2014	SO2	763.8	2.8	Monitoring data is from[1]
4		Datang Huayin	All quarters in 2012- Q1, 2015	Fume dust, SO2 and	All reach the standard					Monitoring data is from [1]

		Zhuzhou Electricity Generating Co., Ltd.		NOX						
5		Zhuzhou Jinyuan Chemical Industry Co., Ltd.	First quarter in 2014 and second quarter in 2013	Fume dust, Lead dust	Some exceed the standard	Second quarter in 2013	Fume dust	128	0.6	Monitoring data is from [2]
6		Zhuzou Jingshi Industry Co., Ltd.	First quarter in 2014 and first and second quarters in 2013	Sulfuric acid mist	All reach the standard					Monitoring data is from [2]
7		Hunan Zhongcheng Chemical Industry Co., Ltd.	Third quarter in 2014 and third quarter in 2013	Fume dust and SO2	Some exceed the standard	Third quarter in 2014	SO_2	561	0.02	Monitoring data is from [2]
8		Zhuzhou Fuercheng Chemical Industry Co., Ltd.	First quarter in 2013 and second quarter in 2012	Fume dust、SO2、PM	Up to standard					Monitoring data is from [2]
9		Zhuzhou Qingwang Industry Co., Ltd.	Second quarters in 2010 and 2012	Fume dust and SO2	Up to standard					Monitoring data is from [2]
10		Zhuzhou Xiawan Green Ring Co., Ltd.	September 2013	Fume dust and SO2	Up to standard					Monitoring data is from [2]
11		Hunan Tiantai Energy Co., Ltd.	February and October 2008	Dust	Up to standard					Monitoring data is from [2]
12	In the area	Hunan Haohua Chemical	First quarter in 2014	Fume dust, SO2 and	All reach the standard					Monitoring data is from [2]

		Industry Co., Ltd.		NOX						
13		Zhuzhou Yunlong Industry Co., Ltd.	September 2008	Fume dust and SO2	Up to standard					Monitoring data is from [2]
14		Zhuzhou Pinhe Zinc Material Co., Ltd.	Second, third and fourth quarters in 2014, first and second quarters in 2013 and first, second and third quarters in 2012	Fume dust, SO2 and NOX	Some exceed the standard	First quarter in 2012	SO_2	1659	0.843	Fourth quarter in 2014Monitoring data is from [1]； The other Monitoring data is from [2]
15		Hunan Haili Fine Chemicals Co., Ltd.	First quarter in 2014	Fume dust, SO2 and NOX	All reach the standard					Monitoring data is from [2]
16		Hunan Longke Fertilizer Industry Co., Ltd.	First quarter in 2012 and second quarter in 2013	Fume dust and SO_2	Up to standard					Monitoring data is from [2]

Note: [1] Supervision monitoring data on key state-controlled pollution sources in Hunan Province; [2] Monitoring data of Zhuzhou Environmental Monitoring Center Station

Note: The CNSG Hunan Zhuzhou Chemical Industry Group Co., Ltd has not been in operation in 2015; Zhuzhou Pinghe Zinc stopped operation in Jan-Feb, 2015; Zhuzhou Jingshi was not monitored in 2015.

10.3.2 Wastewater

Statistics of wastewater discharge between 2012 and 2015.

The monitoring data of over-standard data is taken into statistics and the statistical results show that between 2012 and 2014, the wastewater emission of the majority of key enterprises exceeds the standard to different extent. See **Table 10.3-2** for the monitoring factors exceeding the standard.

In the project area, there were five enterprises with emission exceeding the standard, including Qingshuitang Industrial Wastewater Treatment and Utilization Plant, Hunan Haili Fine Chemicals Co., Ltd., Xiawan Sewage Treatment Plant, Hunan Haohua Chemical Industry Co., Ltd. and Zhuzhou Pinhe Zinc Material Co., Ltd.

The over-standard factors of the first four enterprises are pH, COD and ammonia nitrogen, and no heavy metal contaminant is involved; the emission of As of Pinhe Zinc Material Company exceeded the standard in 2012 and 2013, and after transformation of sewage treatment facilities, the emission reached the standard in 2014-2015.

The other enterprises with emission exceeding the standard are outside of the project area, i.e. Zhuzhou Jingshi Industry Co., Ltd. and Zhuzhou Fuercheng Chemical Industry Co., Ltd. The emission of heavy metal of these two companies exceeded the standard in 2013 but reached the standard in 2014. Zhuzhou JIngshi has not discharge wastewater as it reccyle it fully.

It shows that the emission of contaminants in the project area is improved gradually, and the emission of heavy metal contaminants has reached the standard by 2014 due to transformation of sewage treatment facilities.

Zhuzhou Smelter Plant, Qingshuitang Industrial WWTP and Xiawan WWTP are nationally-control key pollution sources. They fully met relevant standards in Q1, 2015.

Table 10.3-2 Statistics of over-standard emission factors

No.	Enterprise name		Over-standard factors in 2012-2014	Over-standard concentration of heavy metal mg/m^3	Times of ultra standard of heavy metal contamination factor	Industrial Pollutant Discharge Standard – Pb and Zn GB 25466—2010
1	In the project area	Qingshuitang Industrial Wastewater Treatment and Utilization Plant	2014: pH, COD and ammonia nitrogen			
2		Hunan Haili Fine Chemicals Co., Ltd.	2014: COD, petroleum and volatile phenol 2013: SS, COD, petroleum and volatile phenol 2012: SS and COD			
3		Xiawan Sewage Treatment Plant	2014: ammonia nitrogen 2012: ammonia nitrogen			
4		Hunan Haohua Chemical Industry Co., Ltd.	2013: COD 2012: pH, COD and ammonia nitrogen			
5		Zhuzhou Pinhe Zinc Material Co., Ltd.	2014: pH and COD 2013: pH, COD, **As** and ammonia nitrogen 2012: pH, COD, **As** and ammonia nitrogen	2013: As 1.206 2012: As 0.475	2013: As 3.02 2012: As 0.583	As: 0.3
6	Outside of the project area	Zhuzhou Hard Alloy Group Co., Ltd.	Total emission: 2013: pH, COD and ammonia nitrogen 2012: COD TaNb business sector 2014: fluoride 2013: fluoride 2012: ammonia nitrogen			
7		Zhuzhou Bridge Plant	2012: pH			
8		Zhuzhou Jingshi Industry Co., Ltd.	2013: pH, Pb, Zn and Cd	Pb: 3.657 Zn: 321.5 Cd 6.86	Pb: 6.314 Zn: 213.3 Cd: 136.2	Pb: 0.5； Zn: 1.5； Cd: 0.05
9		Zhuzhou Fuercheng Chemical Industry Co., Ltd.	Total emission： 2014: pH, COD, ammonia nitrogen 2013: pH, COD, **Zn and** ammonia nitrogen 2012: COD, Zn and ammonia nitrogen Sewage treatment facilities: 2012: pH, COD, Zn and ammonia nitrogen and volatile phenol	2013, Zn : 453.5 2012, Zn: 574；Cd: 0.557	2013, Zn: 301.3 2012, Zn: 381.67；Cd: 10.14	Zn: 1.5； Cd: 0.05
10		Liduo Pesticides Company (Zhuzhou Jingxi Xianglong Chemical Industry Co., Ltd.)	2013: volatile phenol 2012: pH, ammonia nitrogen and volatile phenol			
11		Hunan Longke Fertilizer Industry Co., Ltd.	2014: COD and ammonia nitrogen 2013: SS, COD and ammonia nitrogen 2012: ammonia nitrogen			
12		Zhuzhou Xinyuanda Plastic Products Co., Ltd.	2013: COD and SS			
13		Zhuzhou Welding Electrode Plant (Xiang River Welding Electrode Plant)	2013: pH			
14		Zhuzhou Chemical Industry Plant (closed)	pH, COD and ammonia nitrogen			
15		Zhuzou Water Supply Co., Ltd.	2014: SS			
16		Zhuzhou Smelter Industry Group	2014: pH and COD			

10.4Control measures for emission of enterprises in the project area

10.4.1 Enterprise upgrading and transformation

The key enterprises both in and outside of the project area are gradually transforming their environmental protection facilities to reduce contaminant emission while pursuing their self- development.

Since the Eleventh-Five-Plan period, Zhuzhou Smelter group has built zero emission project for industrial wastewater, carried out remediation for emission of SO_2, exhaust gas and dust from smelting furnaces, completed a series of key waste gas remediation projects and clean production technology transformation projects, and realized the gradual reduction of total emission of SO_2 and dust.

Zhuzhou Pinhe Zinc Material Co., Ltd. carried out upgrading transformation for original sewage treatment facilities, and the emission of wastewater contaminants like As can reach the standard after transformation.

As section 10.3 indicated, monitoring reults of nationally-controlled key pollution sources show gradual improvement of compliance year by year. In Q1 2015, the wastewater, emission fully met the standards.

With the serious supervision and monitoring of the government on pollution enterprises, the enterprises will pay more attention to environmental protection and increase the investment in contamination remediation facilities, further reducing the emission of contaminants in the project area.

10.4.2 Government supervision

The new-revised *Environmental Protection Act* has been put into force since January 1, 2015. In order to better implement the *Environmental Protection Act* the Ministry of Environmental Protection and related departments continuously published a series of regulations, including *Methods for the Competent Authorities of Environmental Protection Implementing Successive Punishment by the Day, Methods for the Competent Authorities of Environmental Protection Implementing Closing Down and Detention, Methods for the*

Competent Authorities of Environmental Protection for Implementing Limited Production and Suspending-production Renovation, Methods for Disclosure of Environmental Information of Enterprises and Public Institutions, Interim Procedures for Competent Administrative Departments Transferring Environmental Violation Cases Applicable to Administrative Detention. The force of violation punishment is unprecedentedly severe. If violating the environmental protection act, the enterprise will be face huge economic punishment, and the directors will face unprecedented liabilities.

The new Environmental Protection Act grants the competent authorizes of environmental protection at all levels a lot of new supervision rights. The environmental supervision institutions can perform on-site inspection, close down and detain the facilities causing severe environmental pollution, and order the enterprises with contaminant emission exceeding the standard to limit the production or stop production for renovation. For environmental violations, the environmental protection departments can implement relevant measures as soon as possible. In order to respond to the new Environmental Protection Act, Zhuzhou Environmental Protection Bureau has carried out grid management for environmental supervision, and the city is divided into several environmental supervision grids and there are definite persons responsible for the pollution enterprises in each grid, in order to eliminate the dead spaces and blind areas. The enterprises discharging contaminants with violating laws and regulations or causing severe pollution may be closed down and the facilities and equipment causing pollution may be detained. According to the data, Zhuzhou Environmental Protection Bureau implemented night inspection in January 2015, and twelve enterprises including Zhuzhou Smelter Group, Haohua Chemicals, Zhicheng Chemicals, Haili Fine Chemicals and Jingshi Company and other regions were listed as the key objects. During the night inspection on January 1, 2015, the waste gas treatment facility of Hunan Zhuzhou Iron & Steel Company ran abnormally, and the law enforcement personnel immediately ordered the company to stop production and carry out renovation and put it on record for punishment. With the implementation of the new Environmental Protection Act, the environmental supervision and enforcement will be more and more serious.

10.4.3 Schedule of relocation and transformation of in-production enterprises

According to Implementation Program for Integral Relocation and Transformation of

Qingshuitang Old Industrial Zone in Zhuzhou City (2013-2022), the in-production enterprises in the project area will reserve or successively shut down, relocate and newly build the in-production plants and enterprise ownership land.

Because the relocation needs huge investment and relevant agreements shall be achieved with enterprises and employees, the relocation plan may lag behind the schedule. Prior to relocation, the emission of contaminants shall reach relevant national standards.

After the relocation and transformation is completed, the new project will be established for site investigation, risk assessment and site remediation, which is not included in this project. However, the project will carry out long-term monitoring on the emission of wastewater, waste gas and waste residues of the in-production enterprises, in order to prevent secondary pollution. See **Table 10.4-1** for the implementation schedule of relocation and transformation of in-production enterprises in the project area.

Table 10.4-1 Implementation schedule of relocation and transformation of in-production enterprises

Region	Enterprise name	Total assets (thousand yuan0	Output value (thousand yuan)	Industry	Population	Floor area (mu)	Category	Relocation orientation	Investment in reformation and new building	Schedule (year)								
										12	13	14	15	16	17	18	19	20
Yingfeng	Zhuzhou Sanxing Fluorine Plastics Plant	184	250	Plastic products	30	0.3	Relocation	-	-									
Qingshui	Zhuzhou Quxing Lime Building Materials Co., Ltd.	155	210	Mineral products	30	0.3	Closing	-	-									
Tongxia	Zhuzhou Xiawan Building Materials Co., Ltd.	35650	26519	Building materials	80	95.7	Relocation	Youxian Wangling Industrial Park	2.9									
Tongtangwan	Zhuzhou Qibin Group Stock Co., Ltd.	3388240	1676694	Building materials	1427	502	Relocation	Liling Dongfu Industrial Park	15.1									
Qingshi	Zhuzhou Smelter Industry Group	5933919	11503751	Smelting	5500	1848	Relocation	Youxian Wangling Industrial Park	108									
Qingshi	Zhuzhou Haili Fine Chemicals Co., Ltd.	241792	400020	Chemical industry	446	261	Relocation	Changsha Tongguan Circular Economy Industrial Park	7.8									
Qingshi	Hunan Haohua Chemical Industry Co., Ltd.	265232	145725	Chemical industry	585	221.5	Relocation	Changsha Tongguan Circular Economy Industrial Park	6.6									
Qingshi	Hunan Longke Fertilizer Industry Co., Ltd.	135116	245782	Chemical industry	337	54	Relocation	Changsha Tongguan Circular Economy	1.6									

								Industrial Park										
Qingshi	Zhuzhou Yunlong Industry Co., Ltd.	51613	7002	Building materials	107	91	Relocation	Liling Dongfu Industrial Park	2.7									
Qingshi	Zhuzhou Tongda Cement Pipes Co., Ltd.	563	764	Mineral products	16	1	Relocation	-	-									
Qingshi and Xiangshiling	Hunan Dongzheng Traffic Facilities Co., Ltd.	28526	38700	Device processing	40	50	Relocation	Lukou Economic Development Zone	1.5									
Qingshi and Xiangshiling	Hunan Zhuzhou Iron & Steel Co., Ltd.	245164	450000	Smelting	142	390	Closing	-	-									
Xiangsihling	Zhuzhou Special Welding Electrode Co., Ltd.	324955	165327	Processing	240	80	Closing	-	-									

11 Environment and Social & Economic Benefits of the Project

This project is an integrated urban industrial zone environmental improvement project for the good of public welfare. Execution of the project may realize harmless treatment of soil in Qingshuitang heavy-metal contaminated area, avoid potential risk of water pollution in Xiang River by heavy metal contained soil, improve water quality in the water area of Xiang River, leading to favorable social, economic and environmental benefits. With specific characteristics of environmental protection engineering, investment benefits of this project are featured by three aspects: (1) Indirect benefit. Major benefit of the project is more efficiency and less loss of other departments, thus direct investment return is low, and execution of the project necessitates financial subsidy to a given amount; (2) Intangible benefit. The ultimate benefit from project investment is prevention and control of water pollution, and ensuring the quality of domestic water and process water, which is likely to be dismissed by the people; (3) Disperse benefit. Due to the harm of water pollution relates to many social aspects, including life, production, tour, human health and etc, the benefit from project investment is relatively disperse. With such features of environmental improvement project, it’s hard to express its economic benefit with exact data.

11.1Ecological & Environmental Benefits

This project is planned to remove the soil in Qingshuitang heavy-metal contaminated area, eliminate one major potential environmental risk, improve water environmental quality of Xiang River in the reach of Zhuzhou and Changsha, ensure safe water supply in Changsha, Zhuzhou and Xiangtan cities, thus it’s of realistic significance to the protection of people’s health; also, the affliction of water pollution for decades will be controlled for additional far-reaching historic significance in the recovering of natural ecosystem in this area.

Construction of the project is urgent need for creation of a harmonious society and promotion of sustainable social and economic development in Changsha, Zhuzhou and Xiangtan cities, as well as the need for establishment of Zhuzhou as a national model city for environmental protection. Therefore, this project is a historic work for water environmental improvement of Xiang River.

Zhuzhou is an integrated unit of the city circle of Changsha, Zhuzhou and Xiangtan cities, Qingshuitang Industrial Zone is the source of pollution in Changsha, Xiangtan and Zhuzhou, water pollution in Qingshuitang Industrial Zone gives rise to catastrophic impact on downstream Changsha and Xiangtan, and air pollution in Qingshuitang Industrial Zone has adverse effect to whole urban area of Zhuzhou city.

Execution of the project may remove 173000m^3 contamination sediments, restore 90900m^3 contaminated soils in the premises of closed facilities, remedy and restore about 1374900m^3 soils in other contaminated fields, remove about 84700m^3 spoils, contaminated soil and contamination sediment are reclaimed by harmless treatment, leading to noticeable ecological & environmental benefits, mainly in terms of the following aspects:

(1) Remove heavy metal contaminations in the soil, such as cadmium, lead, arsenic and etc;

(2)After removal of heavy metals in the soil, internal pollution by heavy metals in Qingshuitang Industrial Zone is eliminate, and potential risk of heavy metal pollution is eliminated;

(3)After execution of the project, it’ll help improving water quality in downstream Xiang River, and water environmental quality of Xiang River will gradually upgrade.

11.2Social & Economic Benefits

Environmental improvement of Qingshuitang heavy-metal contaminated area project is an integrated environmental improvement engineering aiming to improve regional soil quality, eliminate potential risk to water environment, and ensure safe domestic water supply to downstream cities, the execution of the project will bring remarkable social benefit, mainly represented by following aspects:

11.2.1 Eradicate Contamination Source, Benefit the People with Modern Technology, Construct Habitable Ecotype City

Successful execution of the project may fully embody the governing concept of the people’s government in terms of “working for the well-being of the people, be highly responsible for the people”, which conforms to the meaningful thoughts of scientific outlook on development. By integrated control of Qingshuitang heavy-metal contamination, great efforts will be made to further improve environmental protection in favor of the people's livelihood, a great many environmental protection problems will be solved, and the public will also be more satisfied to environmental protection. The citizens will be able to breathe refreshing air, cherish clean soil, drink high-quality, safe and uncontaminated water, and enjoy the tangible feel of modern environmental protection technology. Furthermore, environmental improvement is an inevitable requirement of Zhuzhou for construction of “habitable ecotype city characterized by modern industrial civilization”, which calls for integrated control of environmental pollution in Qingshuitang Industrial Zone, strengthening of reduction in contamination discharge, prevention and control of pollution, strengthening of environmental protection and environmental construction, which is the essential requirement for sustainable development.

11.2.2 Coordinate with Urban General Planning, Improve Regional Investment Environment

According to general concept of “one-belt, double-core, three-axis, four-plot” set forth in Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, initiation and execution of integrated heavy-metal control in Qingshuitang Industrial Zone project will focus on the control of heavy-metal pollution, put into practice local integrated control, which will greatly improve ecological and investment environment in Qingshuitang, drive the development of related industries such as culture tourism, high-tech, commerce & trading, housing & leisure and etc by means of ecological construction, create favorable conditions for construction of Qignshuihu ecotype new city, expansion of urban space and improvement of urban grade, which is crucially significant to the improvement of local environment, so as to make a solid basis for establishment of Zhuzhou as a national civilized city as well as integration of Changsha, Zhuzhou and Xiangtan cities.

11.2.3 Drive Regional Economic Development, Facilitate Economic Restructuring

Integrated control of heavy-metal pollution in Qingshuitang is the precondition for construction of circular economic industrial zone, which has direct bearing on economic restructuring and radical transformation of the way of economic growth in Zhuzhou city, boosting the construction of “resource-conserving and environment-friendly” society 社会

construction, as well as cultivation and development of emerging industries of strategic significance, which will promote all aspects of circular economy and environmental protection industries in Hunan Province, and play a model role of pollution control and ecological restoration in heavy chemical industry area in China. Upon implementation of the planning, all traditional enterprises having high energy consumption and imposing high pollution in the core area will be moved away and replaced by development of modern logistic industry, industrial building economy and ecotype residential housing format, by construction of logistic and trade facilities to a gross amount of RMB100.0 billion, RMB50.0 billion gross industrial production value and 5000000 ㎡ commercial buildings within 10 years.

11.2.4 Develop and Utilize Land Resource, Expand Urban Development Space

Full consideration is given to multiple factors such as the requirements for environmental benefit, soil improvement, water pollution control, landfill of solid waste, construction of ecological landscape, detailed planning on the controllability of core area and etc in the heavy-metal pollution control in Qingshuitang Industrial Zone, and corresponding adjustment is made with the land use for regional urban development. In a vision for overall and long-term benefit, with all land in the region as the object, by land-centered use, general arrangement and long-term planning are made with respect to land development, land use, land remediation and land protection, macro-regulation of land use and plan management are strengthened, construction of auxiliary municipal infrastructure is configured scientifically, so as to expand urban development space, and provide the city with strong support for development in the future.

11.2.5 Revitalize Historic & Cultural Resources, Inherit Historic Veins in Zhuzhou

Zhuzhou is an emerging immigrant city in the spirit of “locomotive spirit” and a city of long history as well, where the mausoleum of Emperor Yandi, common ancestor of Chinese, is located in Yanling County, urban positioning of Zhuzhou is habitable ecotype city characterized by modern industrial civilization. Zhuzhou is known for its throughput and radiation as the largest intersection in south China, openness and inclusion of the largest immigrant city in Hunan Province, transitional development of habitable ecotype city characterized by modern industrial civilization, not only by construction of a platform for the rise of Zhuzhou city, but also will make Zhuzhou the main force in the giant regional economic zone of Changsha, Zhuzhou and Xiangtan cities. By revitalizing cultural resources of Zhuzhou, and integrated construction of Qingshuitang Industrial Zone in combination with culture heritage, Zhuzhou will develop a regional ecological structure supporting inheritance of historic veins as well as perfect integration of human, nature and culture. In the process of integrated environmental control, technical engineering demonstration base, environmental education demonstration base, improvement of heavy-metal contaminated fields and renovation of museum will be constructed to allow the people having an experience of Zhuzhou cultural veins from various perspectives and in various historic periods, so as to shape urban features, expand urban space and inherit historic veins of Zhuzhou city.

11.2.6 Establish Scientific Research Demonstration Project, Promote the Development of Environmental Protection Industries

Qingshuitang heavy-metal pollution control in Zhuzhou city involves in a key area of heavy metal pollution control of Xiang River drainage area, where soil improvement and remediation is a key field on which the success of Qingshuitang heavy-metal pollution control depends, thus it’s advisable to implement Qingshuitang heavy-metal pollution control from critical aspects; in order to eliminate heavy-metal pollution of Qingshuitang to Xiang River drainage area, and gain experience in the heavy-metal pollution control in Xiang River drainage area, and take the lead in exploring mass improvement and remediation of heavy-metal contained soil, materialize integration of technical outcome as well as early and pilot experiment of heavy-metal contained soil through engineering approach, so as to play a model role in the field of pollution control and ecological restoration in heavy chemical industry areas in China. Relying on logistics or energy flow transmission and like method, existing and new factories or enterprises in Qingshuitang circular economic industrial zone will be interconnected to develop industrial symbiosis combination for sharing resources and exchanging byproducts; initiatives will be made to develop environment-friendly oriented high-tech industries, and great efforts will be made to cultivate manufacturing of environmental protection equipments; advanced environmental protection technologies will be introduced from domestic market, especially those by developed countries in Europe and the United States of America, international cooperation will be carried out in the fields of environmental improvement and ecological restoration; existing industrial technologies and resources will be utilized to promote industrial upgrading and resources recycling.

11.2.7 Expand Project Related Capital Sources, Introduce Technologies for Quick Implementation

Given the crucial strategic value of Qingshuitang industrial zone in the development of Zhuzhou city, due attention should be paid to the worsening pollution in this industrial zone. However, there're many pollution sources and points in Qingshuitang, Zhuzhou city, making ecological and environmental protection and development a lengthy, tremendous and enormous task for integrated control. Overall control of Qingshuitang heavy-metal pollution zone needs large amount of capital and financial capacity of Zhuzhou city is far from enough. Application for World Bank's loan to support construction and control of Qingshuitang heavy-metal pollution zone helps solving realistic difficulty of Zhuzhou municipal financing and construction of a harmonious Zhuzhou.

Moreover, World Bank financed project is the carrier of advanced foreign technology, business practice and management method. International competitive bidding is required for application of World Bank loan, and technical service and follow-up inspection are focused on, which are helpful for introduction of advanced technical management and equipments, facilitating procedure and contract based project construction management, so as to gain more experience in and make a solid basis for the cause of heavy-metal pollution control in Xiang River drainage area.

To sum up, control of Qingshuitang heavy-metal pollution zone in Zhuzhou has become an urgent need for continuous and fast economic growth in Zhuzhou as well as better physical health and living environment of local citizens, project construction corresponds to national policy and carries the important task of regional development of "resource-conserving and environment-friendly" society and the public will. By project construction, it'll play an important role in the promotion of coordinated economic, social and environmental development, construction of ecotype habitable area, establishment of national-level circular economy experimental park that is recognized by international community, domestically first-class and internationally advanced area, construction of "resource-conserving and environment-friendly” society in Changsha, Zhuzhou and Xiangtan cities, as well as new model demonstration area of new industrialization and new urbanization.

12 Environmental Impact Assessment and Mitigation Measures

12.1 Environmental Impact and Mitigation Measures during Construction Period

12.1.1 Impact on Ambient Air during Construction Period and Mitigation Measures

12.1.1.1 Impact on Ambient Air during Construction Period

In field leveling and official construction stages of the project, main aspects of ambient air pollution are as follows: pollution of fugitive dust, exhaust gas of oil-fueled machinery and construction vehicles as well as malodor of dredged sediment.

1. Fugitive Dust of Construction

During the whole construction period, major operations producing fugitive dust are land leveling, excavation, backfill, open-air deposit, loading/unloading and etc; fugitive dust of construction will be intensified in case of dry and rainless season and windy weather.

Related investigation indicates that fugitive dust at construction site is mainly produced by running vehicles carrying building materials and spoils, which relates to road surface and running speed of construction vehicles, accounting for about 60% total fugitive dust; the volume of fugitive dust can be calculated by following empirical equation under fully dry condition:

$$Q = 0.123 \times \left(\frac{v}{5}\right)\left(\frac{W}{6.8}\right)^{0.85}\left(\frac{P}{0.5}\right)^{0.75}$$

Where: Q—fugitive dust from vehicle running, kg/km· vehicle;

v—running speed of vehicle, km/h;

W—carrying capacity of vehicle, t;

P—dust volume on road surface, kg/m^2.

For example, 1×5t truck runs through a section of 500m road surface, the volume of fugitive dust produced by the vehicle running on the road of different surface cleanliness at various speeds is as shown in **Table 12.1-1**.

Table 12.1-1 Volume of Fugitive Dust Produced by Vehicle Running on the Road of Different Cleanliness at Variable Speeds Unit: kg/km· vehicle

P(kg/m^2) Speed (km/h)	0.1	0.2	0.3	0.4	0.5	1.0
5	0.0283	0.0476	0.0646	0.0801	0.0947	0.1593
10	0.01806	0.0953	0.1291	0.1602	0.1894	0.3186
15	0.0850	0.1429	0.1937	0.2403	0.2841	0.4778
20	0.1133	0.1905	0.2583	0.3204	0.3788	0.6371

It's obvious from Table 11.2-1 that, under the same condition of road surface, the vehicle running faster produces more volume of fugitive dust; however, under the same condition of the vehicle running on poorer condition of road cleanliness at the same speed produces more volume of fugitive dust; base on this analog investigation, under general condition, affected area of fugitive dust produced at construction site and on construction road under the action of natural wind is within 100m.

Therefore, if no dustproof measures are taken during construction, the dust produced will cause major impact and pollution against leeward residents, in particular, when construction vehicle run on unhardened road surface, it'll stir large volume of fugitive dust and cause major environmental pollution of ambient air.

2. Exhaust Gas from Excavation of Organic Contaminated Soil

The volume of organic contaminated soil is relatively small, if appropriate measures are taken, such as spraying of inhibitor, enclosing in bag, cutting of foundation pit and covering with membrane, timely cleaning and removal, and the like, the severity of pollution is relatively minor and conforms to the requirement of Ambient Air Quality Standard (GB3095-2012), Class 2..

3. Tail Gas Emitted by Oil-fueled Machinery and Construction Vehicles

Major contaminations emitted by oil-fueled machinery and construction vehicle are carbon monoxide, nitrogen dioxide and total hydrocarbon; for a medium-size vehicle at average speed of 50km, emission of carbon monoxide is 30.18g/km per vehicle, and emission of nitrogen dioxide is 5.40g/km per vehicle; due to small number and disperse distribution of construction machinery, severity of pollution from construction machinery is relatively minor; according to available monitoring results of road construction site, average hourly concentrations of carbon monoxide and nitrogen dioxide1 in the area of 50m from the site are 0.1mg/m^3 and 0.18 mg/m^3, respectively; average daily concentrations of carbon monoxide and nitrogen dioxide1 in the area of 50m from the site are 0.13mg/m^3 and 0.07 mg/m^3, respectively; all meet the requirement of Ambient Air Quality Standard (GB3095-2012), Class 2..

4. Malodor of Dredged Sediment

During dredging of sediment, concentration of stinking air-borne contaminations near the riverbed will increase. According to investigation results of existing similar projects, stinking odor is felt within work area and sludge yard, the odor intensity is about Level 2-3 (Odor intensity is divided into Level 0, Level 1, Level 2, Level 3, Level 4 & Level 5, of which Level 3 indicates noticeable odor, Level 4 indicates intense odor, and Level 5 indicates unbearable odor), the affected area is about 50m; in case of wind action, affected area leeward is slightly intensified. Analog is applied for analyzing the level of odor intensity in environmental impact assessment, and references are made to pollution source of Mudan River Nanpaozi dredging project (Dry dredging in summer), the investigation results of odor levels are as shown in **Table 12.1-2**.

Table 12.1-2 Odor Intensity with Mudan River Nanpaozi Dredging Project (Dry Dredging in summer)

Distance	Sensory odor intensity	Level
Beside the bank	Noticeable odor	Level 3
30m from the bank	Minor odor	Level 2
80m from the bank	Very minor odor	Level 1
100m beyond the bank	No odor	Level 0

It’s obvious from **Table 12.1-2** that, stinking odor from sludge dredging work is minor in the area of 80m from the bank, and no odor is smelt in the area of 100m from the bank. Odor intensity reaches to Levels 2-3 in riverbed area and imposes major impact.

12.1.1.2 Air Pollution Mitigation Measures during Construction Period

(1) Fugitive Dust

a). Set up screening facility around the construction boundary not less than 3m in height and according to standard; set up special pileup ground such as earth ground at construction site;

b). Strengthen construction management, carry out civilized construction, load/unload building materials with special care; remove dirt stuck on the surface of vehicle before departing from construction site as possible; cover the vehicle carrying soil for remediation, lime, gravel, cement, coal ash and etc likely to produce fugitive dust with tarpaulin;

c). Fugitive dust at construction field and on construction road can be suppressed by watering and cleaning measures; if only watering and sweeping are carried out, the volume of fugitive dust may be reduced 70～80%; in case of sweeping after watering, dust suppression efficiency can be over 90%; related tests indicate that, with 1 watering cart configured at construction field, and maintain watering operation for 4～5 times per day, the distance of TSP pollution caused by fugitive dust can be reduced to be within 20～50m.

In addition, the yard for pileup of excavated soil, lime and sand should not be deposited in open air as possible; if open pileup is unavoidable, watering is required to increase surface water content and gain the effect of dust suppression.

d). Select competent construction contractor, use commercial ready-mix concrete and enclosed transport vehicle; for appointed commercial concrete producer, "three-concurrent" requirements are imposed, effective measures should be taken to minimize the impact of environmental pollution, environmental monitoring and environmental protection management measures should be strengthened to ensure protection of ambient air.

e). Vegetation should be restored immediately after use of temporary land, so as to avoid production of fugitive dust in the weather of strong wind.

(2) Exhaust Gas from Excavation of Organic Contaminated Soil

The excavation of organic contaminated soil may disturb the contaminants in soil, and some volatile organic compounds will spread into the air. According to the site investigation by Tiancheng Chemicals, the organic matters mainly include aniline and benzopyrene.

During soil removal and excavation, soil samples should be taken from boundary, side wall and underside, excavation control boundary should be determined based on test data; pave steel plates in object remediation areas, so as to protect the ground and prevent excavation and transport vehicles from pollution; all vehicles should be cleaned before departing from the site; in addition, transport vehicle should be covered with dustproof and waterproof cloth to prevent spill, overflow, dripping and leakage; for excavated foundation pit, covering of membrane for isolation should be carried out; after excavation, organic exhaust gas produced by contaminated soil can be treated by spraying odor inhibitor before loading in uniform bulk bags for storage.

The excavated contaminated organic soil shall be sealed and sent to Zhuzhou Cement Co., Ltd for incineration. According to the feasibility analysis on delegated disposal of contaminated organic soil described in Section 8.3.3.3, the amount of contaminated organic soil only accounts for 0.31% of the raw materials of Zhuzhou Zhongcai Cement Co., Ltd. As this is a small proportion, Zhuzhou Zhongcai Cement Co., Ltd. is fully able to treat it. According to periodic monitoring of the company in recent years of environment monitoring center, the company was able to properly discharge the waste gases, waste water, noise, and solid wastes from 2013 to 2014, Besides, Zhuzhou Zhongcai Cement Co., Ltd is able to meet the requirements specified *in Technical Specifications for Environmental Protection in Co-Processing Solid Waste by Cement Kiln* (HJ 662-2013). Therefore, it is feasible to delegate the disposal work of contaminated organic soil to Zhuzhou Zhongcai Cement Co., Ltd as it brings smaller environmental impact.

(3) Exhaust Gas Emitted by Oil-fueled Machinery & Construction Vehicle

Setup of screening in dredging are; strengthen management of heavy-duty construction machinery and construction vehicles, mechanical equipments should be equipped with corresponding smoke eliminating and dust removing devices; and such devices should be examined and maintained on a regular basis.

(4) Malodor of Dredged Sediment

a). It's recommended that watercourse dredging work is carried out in dry season by means of section construction. Dredging work should be done in winter, when it's unlikely to emit dredging odor, and the residents' windows are closed, thus disturbance of the residents by dredging odor is reduced; before commencement of dredging construction in a given period, construction contractor must inform surrounding residents to close their windows.

b). Mechanical dredging should be adopted; the sediment should be carried to dewatering ground immediately after dredging, instead of deposit at dredging site;

c). The construction workers should be protected properly, released personal protection equipments, checked and rescued if necessary;

d). The dredged sediment should be handled with enclosed tank car to prevent spill along the way; handling of dredged sediment should be kept away from downtown area and densely populated residential area.

12.1.2 Surface Water Environmental Impact and Mitigation Measures during Construction Period

12.1.2.1 Surface Water Environmental Impact during Construction Period

Wastewater produced during project construction period mainly includes domestic sewage of construction personnel, initial rainwater from demolition of closed facilities, wash water of construction vehicles and machinery, heavy-metal contained wastewater from washing of buildings/structures during demolition of enterprise premises, as well as dredging tail water from dredging work of port channel, pond and dry port.

(1) Domestic Sewage of Construction Personnel

During construction period, all construction personnel can be accommodated in nearby residential areas without construction of additional construction camp. Thus, the volume of additional domestic sewage during construction period is very small with minor impact to a negligible extent.

(2) Initial Rainwater from Demolition of Closed facilities

Initial rainwater is collected in storm sewer, and then temporarily stored in primary rainwater cistern; all rainwater is reused for washing structures and not discharged, thus its impact is minor.

(3) Wastewater from Cleaning of Construction Vehicles & Machinery

Washing wastewater is discharged to construction wastewater treatment plant for sedimentation, all treated wastewater is reused for ground watering dust suppression and not discharged, and thus its external environmental impact is minor.

(4) Heavy-metal Contained Wastewater from Washing of Buildings/Structures during Demolition of Enterprise Premises

Main contaminations in washing wastewater are SS, Cd, Hg, Zn, Pb, As, Cu and the like, all of which are collected in preliminary sedimentation tank via channel for static settlement; supernatant after settlement in mobile water treatment plant for further treatment and recycling, thus it has minor impact on surrounding water environment.

(5) Dredging Tail Water from Dredging Work of Port Channel, Pond and Dry Port

Major contaminations in dredging tail water are suspended matters; mobile wastewater treatment plant is adopted for treatment of dredging tail water of the project; tail water is treated according to Integrated Wastewater Discharge Standard (GB8978-1996), Table 4, Class 1., and then directly discharged to Xaiwan Port, and it has minor impact on water environment of Xaiwan Port,.

(6) Landfill and Quarry Seeper

After treatment of seeper by breakpoint chlorination, it is in compliance with Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class 1., and discharged in the stream beside Qingxia Road. It has minor water environmental impact.

12.1.2.2 Water Pollution & Mitigation Measures during Construction Period

(1) After demolition of enterprise workshops for project construction, build drainage ditch and collecting tank (Not less than 100m^3) , collected rainwater is reused for washing the buildings after sedimentation instead of discharging;

(2) Wash the vehicles to and from construction site at appointed location; set up oil separation tank and sedimentation tank at washing area for proper treatment of wash water before recycling;

(3) The wastewater in wash water after demolition of closed facilities is collected in sewage trench and delivered to preliminary sedimentation tank for static settlement, supernatant after sedimentation enters in mobile sewage treatment vehicle (Treatment capacity of 400m^3/d) and recycled for washing buildings instead of discharging. Sludge is delivered to stabilized treatment system for treatment. Rectangular sedimentation tank of brick-concrete structure is adopted. Major design parameters for pre-sedimentation tank of various closed facilities are as listed in **Table 12.1-3**:

Table 12.1-3 Major Design Parameters for Pre-sedimentation Tanks

No.	Enterprise	Wash water input/m^3	Size/m L×B×H	Water depth/m	Volume/m^3
1	Zhuzhou Xinda Smelting Co., Ltd	1410.9	5×5×2.2	2	55
2	Zhuzhou Brothers Industry Co., Ltd	0.0	-	-	-
3	Yongfa Refinery	1150.9	5×4×2.2		44
4	Zhuzhou Kangli Smelting Plant	384.6	3×3×1.2	1	10.8
5	Zhuzhou Tiancheng Chemical Co., Ltd	0.0	-	-	-
6	Zhuzhou Hehua Cement Plant	4170.4	7×7×3.2	3	156.8
	Total	7116.8	9×9×3.2	3	259.2

(4) Dredging Tail Water

Due to scattered ponds, the input dredging tail water is relatively small with each pond; 4×400m^3/d mobile wastewater treatment plants are designed for treatment of dredging tail water of the project according to Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class 1., and then directly discharged to the water area of Xiawangang.

Emergency plan: in case of poor water quality and failure of standard discharge by mobile wastewater treatment plant, consideration should be given to emergently add powdered activated carbon in effluent collecting tank, so as to improve effluent water quality. Dosage of activated carbon is 40 mg/L.

Treatment process of mobile wastewater treatment plant is as shown in **Figure12.1-1**:

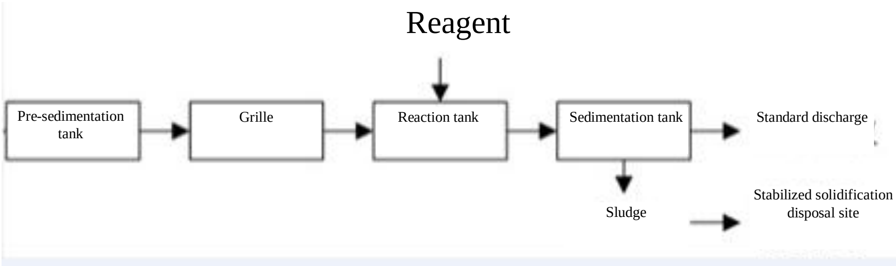


Figure12.1-1Treatment Process of Mobile Wastewater Treatment Plant

(5) Landfill & Quarry Seeper

Main contaminations in seeper are pH and ammonia-nitrogen。Project related seeper will be disposed by breakpoint chlorination treatment, a chemical denitrification process by which chlorine gas or sodium hypochlorite is added in wastewater for oxidation of N_2 from NH_3-N in wastewater. When chlorine gas is added in wastewater to a given dosage, content of free chlorine in wastewater is the lowest, and ammonia concentration is decreased to zero. When the input of chlorine gas exceeds such dosage, content of free chlorine in wastewater will increase; therefore, this point is called breakpoint, and chlorination in this state is called breakpoint chlorination. Actual volume of chlorine gas necessary for treatment of ammonia-nitrogen sewage depends on temperature, pH value and ammonia-nitrogen concentration. 9～10mg chlorine gas is required for oxidation of 1g ammonia-nitrogen. Contact time is 0.5～2h.

$$2NH_4^{+}+3HOCl \rightarrow N_2+HOCl+H^{+}+Cl^{-}$$

For process flow, see **Figure12.1-2**.

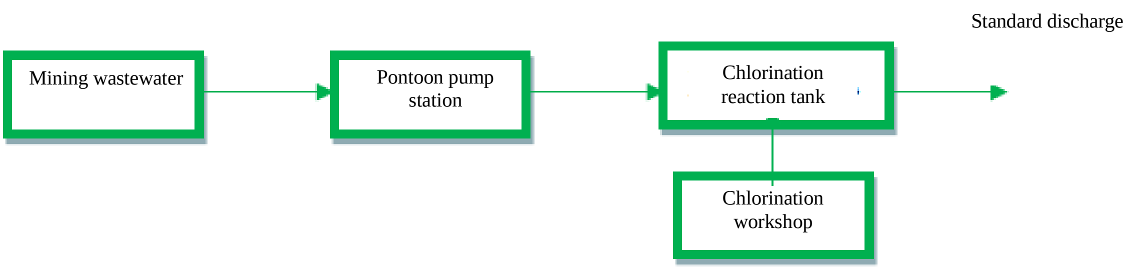


Figure12.1-2 Seeper Treatment Process Flowchart

For low concentration ammonia-nitrogen wastewater (Ammonia-nitrogen concentration less than 50mg/L) , it's e

conomic to apply breakpoint chlorination, with ammonia-nitrogen removal efficiency up to about 80%, and pH and ammonia-nitrogen of discharged water is in compliance with Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class 1..

1×500m³ reinforced concrete basin is built in the west of landfill to act as breakpoint chlorination reaction tank, which has a daily treatment capacity of 6000m^3 meeting the requirement; mining seeper is reacted in breakpoint chlorination reaction tank for standard treatment, and then discharged in the stream beside Qingxia Road. The location is as shown in **Figure6.10-3**.

12.1.3 Groundwater Environmental Impact & Mitigation Measures during Construction Period

12.1.3.1 Groundwater Environmental Impact during Construction Period

In the process of construction, cutting of working face and land clearing may disturb groundwater overburden, and construction wastewater and domestic sewage from such works are the cause of potential groundwater pollution.

The impact on groundwater quality during project construction is caused by various types of construction wastewater, seepage of sewage pipe and drainage pipe, as well as leaching from temporary deposit of various types of contamination solid waste.

1 Various types of construction wastewater: construction wastewater produced during construction period includes initial rainwater during demolition of closed facilities, wastewater containing heavy-metal from washing of buildings/structures, wastewater from washing vehicles and machinery, machinery cleaning, dredging tail water from dredging work of port, canal, pond and dry port, seeper at solid waste landfill; it's known from 12.1.2.1 that, various types of construction wastewater are treated with corresponding measures before recycling or re-discharging, however, sewage seepage from various reaction tanks or treatment tanks may still cause groundwater pollution; therefore, it's necessary to take anti-seepage measures for construction wastewater treatment tank or reaction tank to avoid pollution as a result of seepage.

2 Main approaches with impact of various types of sewage pipe and drainage pipe for carrying heavy-metal contained wastewater constructed during construction period on groundwater quality are contamination of groundwater by spillage, overflow, dropping and

leakage of pipe network. During construction design, strictly control design and construction quality, properly take pipe network anti-seepage measures, so as to prevent the impact of pipe network seepage on groundwater in an effective manner..

3 If solid waste dumping ground is disposed improperly, it'll cause contamination of groundwater quality due to infiltration of heavy-metal contained contaminations in groundwater as a result of rainwater runoff. During construction period of the project, output of main solid wastes includes excavated contaminated soil, dredged sediments of pond and ditch, waste residues and sludge from wastewater treatment; most heavy-metal contaminated soil, waste residues and sludge are temporarily deposited at stabilized/solidification plant; dredged sediment is temporarily deposited at dewatering site; geomembrane anti-seepage and drainage design are incorporated for dewatering site of the project, with which leaching output can be effectively reduced in temporary piling area; existing area of stabilized/solidification plant has been hardened; it's recommended in the environmental impact assessment that measures such as additional anti-seepage initial rainwater collecting tank, subsequent rainwater inverted pipe and ditch and etc should be taken, so as to effectively prevent remigration of heavy metal caused by rainwater runoff.

Base on above analysis, after proper implementation of anti-seepage and pollution prevention measures, the project related contaminations can be treated effectively with minor impact on groundwater quality.

12.1.3.2 Groundwater Pollution Mitigation Measures during Construction Period

(1) Of construction wastewater treatment plant, anti-seepage measures should be taken for initial rainwater collecting tank, oil separation tank, sedimentation tank and chlorination reaction tank, such as laying of geomembrane or tank hardening, so as to prevent secondary pollution. Buildings/structures washing ground of all closed facilities should also be hardened to prevent sewage infiltration.

(2) During project design, strictly control design and construction quality, carry out anti-seepage treatment of sewage pipe sufficiently and properly, ensure tight connection of sewage conveying pipe, and prevent pipeline leakage;

(3) For temporary piling area in all stations/yards, anti-seepage measures such as rainproof shelter and ground hardening should be taken; floor hardening should be

implemented according to anti-seepage standard for disposal field of Category II industrial solid waste; anti-seepage layer should be constructed with natural material or artificial material; anti-seepage thickness should be equivalent to anti-seepage performance of 1.5m thick clay layer having filtration coefficient of 1.0×10^{-7}cm/s, so as to prevent groundwater pollution.

1) Dump of stabilized/solidification ground

Rainproof drainage measures: construction of 75m^3 initial rainwater collecting tank at treatment site, and carry out anti-seepage treatment; stabilized ground surface initial rainwater is collected in storm sewer, then enters in primary rainwater cistern for temporary storage, all rainwater is recycled in stabilizing process without discharge; subsequent rainwater and rainwater in other area of dumping ground are discharged out of dumping ground via rainwater pipe drain.

Ground hardening measures: stabilized/solidification ground of the project is leased treatment field in Xinqiao, where the field has been hardened; environmental impact assessment requires testing of anti-seepage performance with hardened ground, if it fails anti-seepage performance of 1.5m thick clay layer having filtration coefficient of 1.0×10^{-7}cm/s, another ground hardening is necessary.

2) Temporary piling area of dewatering site

Rainproof drainage measures: for easy drainage of dewatering site, given drainage slope is required in the bottom of field construction, to a slope not less than 2%, drainage ditch and collecting well should be built around the field; 0.4m wide and 0.6m deep drainage ditch functions to collect sewage within the field; dewatering platform structure is as shown in **Figure12.1-3**:

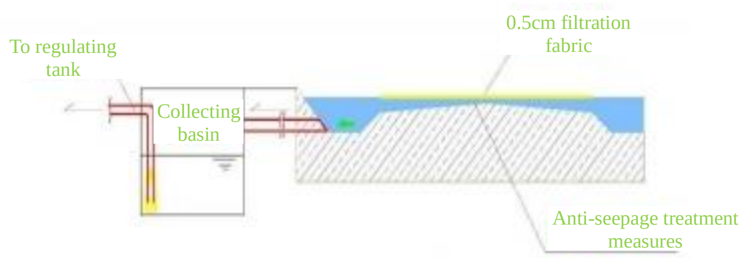


Figure12.1-3 Dewatering Platform Structure

Anti-seepage measures: to avoid sewage within the field from contaminating surrounding soil and groundwater impact, anti-seepage design is adopted for the field. Composition of anti-seepage system is as follows (From top to bottom): geotube-300mm gravel drainage layer-600g/m^2 non-woven polypropylene filament-2mm glossy HDPE geomembrane-600g/m^2 non-woven polypropylene filament-foundation.

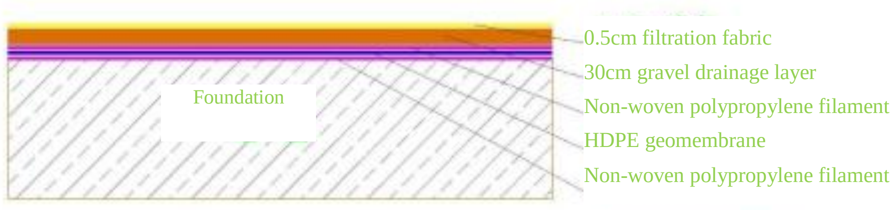


Figure12.1-4 Anti-seepage System

12.1.4 Acoustic Environmental Impact & Mitigation Measures during Construction Period

12.1.4.1 Acoustic Environmental Impact during Construction Period

1. Noise source and noise affected area during construction period

Main noise sources during construction period are emitting noise by construction machinery and transport vehicles; according to actual investigation and analog analysis, construction machinery such as excavator, scraper, dump truck, concrete mixer and vibrator has major environmental impact. The noise source intensity of construction machinery possibly to be used in construction phase is listed in the table below; in case of concurrent operation of multiple mechanical equipments, noise of all equipments will superpose; analog investigation indicates that superposed noise value is approx. 3-8dB and not exceeds 10dB in general case.

Table 12.1-4 Noise Level of Main Construction Mechanical Equipments

Construction machinery	Lw (A) (dB)	Lwref (r_0) (dB)	r_0(m)
Excavator	114	79	15
Scraper	110	75	15
Dump truck	95	70	15
Concrete vibrator	112	80	12
Concrete mixer	84	79	15

Note: Lw(A)-noise source intensity, dB; Lwref(r0)-noise level at the point of reference distance; r0- reference distance, m.

Operation of single construction machinery can be considered as point source; in case of distance doubling, noise reduces by 6dB(A); if air absorption is considered, additional attenuation of 0.5～1dB(A)/100m occurs; **Table 12.1-5** lists noise versus distance attenuation of key construction equipments, where r55 is called disturbance radius, refers to the distance necessary for attenuation of noise level to 55dB(A).

Table 12.1-5 Noise Attenuation Distance for Construction Machinery, Unit: m

No.	Construction machinery	r_{55}	R_{60}	R_{65}	R_{70}	R_{75}
1	Excavator	190	120	75	40	22
2	Scraper	185	105	60	35	20
3	Concrete vibrator	200	110	66	37	21
4	Concrete mixer	190	120	75	42	25
5	Mechanical dump truck	80	44	25	14	10

2. Analysis of construction noise environmental impact

(1) If single construction machinery is used, standard noise limit is achieved in the area 42m beyond construction site at daytime and 200m beyond construction site at nighttime in compliance with Emission Standard of Environment Noise for Boundary of Construction Site (GB12523 － 2011); however, multiple construction machinery is used during actual construction, the affected area of construction noise is bigger.

(2) In the case construction noise sensitive point is within about 14-42m from construction boundary, construction noise has major acoustic environmental impact on surrounding area. Thus, first row of residential buildings in construction area is disturbed in different extents at daytime; in particular, the residents are afflicted by construction noise at nighttime, rigorous measures must be taken to minimize the impact of construction noise on environmental protection objects.

(3) Upon completion of the project, impact of construction noise will disappear, thus adverse effect of construction noise to the environment is temporary and short-time action.

12.1.4.2 Noise Pollution Control Measures during Construction Period

Construction noise is one of the noise sources particularly sensitive to the residents. Given current machinery manufacturing level, construction noise is unavoidable and impossible to be radically eliminated by taking noise control measures. Base on the features of various noise pollution sources during construction period, corresponding noise pollution control countermeasures during construction period are proposed, construction contractor is recommended to take measures from following aspects, so as to mitigate adverse effect of project construction to living and work of surrounding communities.

(1) During construction, construction contractor should strictly comply with applicable regulations of Emission Standard of Environment Noise for Boundary of Construction Site (GB12523－2011), control operation time leading to noise pollution, and avoid occurrence of

construction disturbance incident.

(2) The time for construction operation should be arranged rationally, construction with high-noise equipment is banned at nighttime (22:00-6:00) ; construction activity generating noise should be avoided at noon (12:00-14:00) and nighttime (19:00-22:00) , so as not to disturb the rest of surrounding residents; if continuous construction operation at nighttime in unavoidable as required by construction work process requirement or special requirement, construction contractor must declare construction date and time to local environmental protection authority by presenting the certification of competent construction management authority 7 days prior to commencement of work, and put up public statement in surrounding residential communities, and proceed construction at nighttime unless and until such construction is approved and recorded by local environmental protection authority.

(3) Control from noise source: construction contractor should use low- noise mechanical equipment. In addition, during construction, construction contractor should appoint dedicated person for regular maintenance and servicing of construction equipment, training of construction personnel, and use of various types of machinery strictly according to operation specification.

(4) According to the Notice of Zhuzhou Municipal People’s Government Office on Prohibition of On-spot Concrete Mixing in City Zone (Zhu Zheng Ban Circular No. 〔2005〕33) , ready-mix concrete should be sued to avoid noise impact of concrete mixer and like machinery.

(5) Transportation should be arranged at nighttime as possible; the site for access of construction vehicles or soil solidification field with soil carrying vehicles and other construction site should be kept away from sensitive points as possible, vehicles passing in and out of the site should be driven at low speed and honking is prohibited.

(6) Construction machinery and construction intensity should be disposed rationally, construction organization should be arranged properly, high-noise construction machinery and equipment should be allocated for operation in the area far from residential communities, high-noise equipment should be located for operation in temporary equipment room to mitigate noise impact.

(7) Road traffic management should be strengthened, vehicles of poor operating condition and overloaded vehicles should be limited for access, speed limit and no honking signs should be erected on both ends of road section near sensitive points along transportation route (e.g. School, hospital, densely populated residential area), so as to effectively reduce source intensity of traffic noise pollution.

(2) Transport maintenance work should be strengthened to maintain required road surface levelness, and avoid traffic noise from vehicle bump due to poor road condition.

12.1.5 Solid Waste Environmental Impact & Mitigation Measures during Construction Period

12.1.5.1 Solid Waste Environmental Impact during Construction Period

Main sources of solid waste during construction period are construction waste, demolished building debris and sludge from wastewater treatment.

Construction waste includes refuse of building materials such as earth, stone, sand and the like, most of which can be reclaimed and recycled;

For demolished building debris, reclaimable part should be reclaimed and recycled, remaining part without residual heavy metal should be handled to landfill for burying treatment, and building debris with risk of heavy-metal pollution should be washing before landfill treatment.

Construction spoil may be temporarily stored at construction site, which, if not be protected properly during temporary storage, may cause soil erosion, blocking of spillway and even defacing of landscape after rainwater leaching, or give rise to fugitive dust secondary pollution and etc under wind action and degrading environmental health in construction area.

The sludge from wastewater treatment should be delivered to stabilized solidification ground for treatment before landfill.

12.1.5.2 Solid Waste Pollution Control Measures during Construction Period

In order to mitigate solid waste environmental impact during pollution control, following measures are recommended:

(1) Various types of construction solid waste produced in the process of construction should be cleaned in a timely manner, so as to maintain clean and orderly construction site;

(2) Vehicles Carrying bulk materials and wastes must be protected by enclosing, bundling, covering and like measures, free from overloading, without spillage along the way, and transport route should be kept away from sensitive areas such as residential area;

(3) Overhead littering of construction garbage and domestic waste is banned; such

wastes should be dumped at appointed location and timely handled away;

(4) According to the requirements of Provisions on the Administration of Urban Construction Garbage, hazardous goods should not be mixed in construction garbage, and construction garbage should not be disposed with domestic waste.

12.1.6 Environmental Impact & Mitigation Measures during Construction Period

12.1.6.1 Environmental Impact during Construction Period

1. Impact of construction land occupation and earthwork

The project related land occupation includes permanent construction land occupation and temporary construction land occupation; type of land occupation includes paddy field, dry land, other woodland, other grassland, rural homestead, road land, pit/pond water area and hydraulic structure land. The statistical area of above land occupation is listed in **Table 5.2-2**.

(1) Earthwork Calculation Results

According to earthwork allocation indicated in **Figure6.8-2**, cut volume and backfill volume of earthwork in project area are 2327700m^3 and 2327700m^3, respectively, of which ditch/pond dredged sediments after dewatering and treatment in various sub-regions as well as contaminated soil with high total heavy metal and low leaching toxicity are delivered to solid waste landfill in Qingshui sub-region where they're buried; this sub-region will raise 5-8m in the future, where earthwork balancing is achievable.

The function of land use is mainly changed with permanent construction land, however, project land occupation is construction land as stated in Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial, and thus construction land occupation conforms to land use planning.

2. Impact on terrestrial plants during construction period

Construction work of the project will inevitably damage local environment to some extent, disappearance of existing surface vegetation, what makes it worse is that, rolling of various motor vehicles, activity of construction personnel and earthwork dumping will also cause serious damage and impact of vegetation. With the progress of construction period, some species of plant in the area of requisition will disappear, the amount of majority of plant species will substantially decrease, leading to remarkable impact on local biological diversity. However, due to destructed vegetations are common types in assessment area, no national key protected species of rare and endangering plants and wild plant are involved; therefore, construction work of the project has minor impact on plantage and vegetation variety, will not result in disappearance and extinction of existing species and plant types in the area; moreover, with planting and landscaping construction at the end of construction period, vegetation will be restored gradually, and the loss of diversity of plant species will be compensated. The severity of impact on vegetation during construction period is as shown in **Table 12.1-6**.

Table 12.1-6 Factors Having Impact on Vegetation during Construction Period

No.	Construction aspect	Cause of impact	Range of impact
1	Manual cutting	Immediate damage of vegetation in cut area	Within 3m from both sides of cut area
2	Earth backfill	Violation of backfill procedure will cause serious loss of topsoil	Within 10m from both sides of the site
3	Mechanical operation	Rolling on the vegetation at construction site	Construction site
4	Temporary shed for machinery storage	Short-term and local temporary land occupation, damage of vegetation	Local

3. Impact on terrestrial animals during construction period

Immediate impact on terrestrial animals during construction period is mainly of disturbance of animals during centralized activity of construction personnel and project construction; indirect impact is mainly of damage of vegetation and soil by construction of industrial enterprise, leading to loss of habitat for some terrestrial animals. However, no trace of important beasts and amphibian reptiles is found in construction area, where main animals are small birds, frogs and saurian in common species, in small population, with strong migration capacity, thus, existence of these animals will not be disturbed during construction period; it should be noted, however, main beasts in construction area are rodents in large species and population, most of which are harmful to farming and forestry to various extents, of which the mice is most harmful. Due to densely populated construction personnel and rich food at construction camp during construction period, the density of mice may rise and spread to surrounding areas, leading to more mice surrounding construction area in terms of population and density; therefore, construction contractor must comply with the requirements of environmental management plan and properly carry out environmental health and epidemic prevention within the area of construction camp.

4. Impact on aquatic organism during construction period

The project includes diversion and dredging works of pond and port ditch in the construction area, and water related construction will result in turbid water area, change pH value of local water quality, potentially damage growth environment of plankton, and result in reduction of biological quantity in construction area; however, as water related construction area is very small in area to the whole river area, and plankton exists in all areas, and local water area has self-cleaning capacity, cofferdam construction may reduce affected area of plankton, it can be basically restored upon completion of construction.

Cofferdam construction will not impose noticeable adverse effect to water quality in water area, its impact on the fish in pond and port ditch is very low in probability, construction vibration and construction noise may disturb the fish in short term, but fish is adaptive to the environment in terms of phobotaxis, project construction will not have evident impact to the fish, and no spawning ground, nursery ground and wintering ground of key protected fish are distributed in construction water area, thus project construction has limited impact on the fish.

5. Impact on soil erosion during construction period

During project construction, roadbed filling, port ditch and pond dredging, temporary deposit of spoil and dregs, house demolition and other works will occupy, trample and damage surface vegetation, disturb topsoil structure, change current terrain, and likely to cause additional soil erosion under the action of gravity, raindrop strike, erosion of water current and etc.

Project site is featured by concentrated rainfall, and climate factors will substantially worsen soil erosion during construction period, therefore, construction period should avoid rainy season as possible.

According to construction characteristics, construction process in various project areas, as well as featured and status of soil erosion in these areas, factors having impact on soil erosion due to project construction are identified as listed in **Table 12.2-7**.

Table 12.1-7 Analysis on the Factors Having Impact on Soil erosion due to Project Construction

Construction activity	Cause of impact	Major impact aspect	Severity of impact
Excavation of cutting and slope, roadbed filling, pipeline excavation	Earthwork excavation, damage of soil structure, destruction of vegetation, exposure of slope surface	Slope, dregs and spoil	◇◎■
Land improvement	Disturbance of soil structure by construction and earthing	Foundation excavation and earthing	◇◎□
Spoil area	Damage of surface vegetation, damage of soil structure, dregs dumping, exposure of mining slope	Spoil and temporary earth mounting	◆◎■
Construction road	Damage of soil structure, destruction of vegetation, change of slope	Earthwork excavation and filling	◇◎■
Construction site	Destruction of vegetation, damage of soil structure, exposure of earth surface	New temporary facility, land use construction	◇◎□

Note: ◆/◇-long-term/short-term; ○/◎-favorable/unfavorable; ■/□-serious/moderate

According to related content in the Report on Water and Soil Conservation Plan, forecast analysis on soil erosion due to project construction, total area of land occupation by the project is 275.34hm^2; during construction period, project construction will disturb 111.05hm^2 earth surface, compensation area of water and soil conservation is 275.34hm^2, forecast total volume of soil erosion is 14849.01t, including additional volume of 13337.29t soil erosion. From the perspective of distribution area of soil erosion, Qingshui Lake sub-region and Tongtangwan sub-region are major sections of soil erosion. From the perspective of period of time of soil erosion, additional volume of soil erosion is large during construction period. Therefore, key control sections of project specific soil erosion are Qingshui Lakesub-region and Tongtangwan sub-region during construction period.

12.1.6.2 Environmental Impact Mitigation Measures during Construction Period

Grasses and trees in the median and roadside of road section should be transplanted and protected properly; it's unnecessary to destroy all of them for replanting, but temporary transplanting and subsequent complementary planting as per design; after construction, vegetation such as trees and greenbelt in adjacent areas should be protected with special care; during construction period, road construction should be carried out within red line as possible, earth and materials deposits should not inroad in nearby fields; during construction period, demolition work will form a patch of "ruin", thus demolition should be commenced in order and by area to avoid disorder of landscape and obstruction of landscape, baffle plates (Wooden, glass, sheet iron and the like) can be erected as enclosure to mitigate landscape pollution; earthwork excavation should be allocated rationally to avoid earth excavation and filling during rainfall, and prevent occurrence of soil erosion, pollution of water area and clogging of drainage pipe as a result of rainwater runoff; in addition to meeting construction requirements of the project, land occupation should be saved as possible, and construction progress should be scheduled logically; upon completion of construction, timely cleaning of construction site, retreating from land occupation, restoring original road and planting; construction term should be arranged properly to avoid construction in rainy season, so as to minimize soil erosion.

During construction period, construction management and supervision should be strengthened, construction activity should be standardized, construction land occupation and loss of vegetation by construction activity should be reduced as possible, and damage of wildlife habitat should be mitigated; construction activity should be standardized, construction should be carried out logically and orderly, construction organization should be optimized, gradual and progressive construction in the same direction should be carried out for the same construction section, adjacent construction sections should be carried out alternately to avoid construction peak, avoid massive and collective construction in the same sub-region, and reduce disturbance of terrestrial environment as a result of disorderly construction; during construction period, environmental protection publicity and education as well as popularization of common knowledge about protection of wildlife among construction personnel should be strengthened in the forms of public notice, flyer, billboard poster and meeting, so as to improve their awareness of environmental protection; hunting of frogs, snakes, beasts, birds and like wildlife, as well as other conduct against environmental protection by construction personnel is banned.

12.1.7 Social Environmental Impact during Construction Period

1. Impact of Requisition and Demolition

According to consolidated investigation information on resettlement of affected residents, general condition of project impact is as follows:

Range of affected areas: the project site is in the jurisdiction of Tongtangwan Subdistrict Office, Shifeng District, Zhuzhou City, involving in 7 communities (Villages) , namely, New Xiawan Village, Yingfeng Community, Qingxia Community, Jianshe Village, Tongtangwan Community, Dingshan Community and Zhushan Community. Requisition and demolition involves in Yingfeng Community, Qingxia Community and Jianshe Village, other communities are only affected by temporary land occupation.

Demolition impact:

The project needs to demolish 31539 ㎡ buildings, including 94 families of 21993 ㎡ houses, and 3 closed facilities of 9546.80 ㎡ workshops.

Land occupation impact:

The project needs 272.5-mu (18.17 hectares) requisition, including 215-mu (14.34hectare) collective land, 57.39-mu (3.83 hectare) state-owned land and 4189-mu (279 hectare) temporary land.

3. Analysis of Urban Traffic Impact

Main impact of project construction on local traffic is represented by earthwork dump and road excavation preventing public traffic and travel, soaring traffic of vehicles on the road disturbing traffic condition and etc.

During project execution phase in project area, such as construction of national highway 210 Tongxia Road and etc, traffic flow will increase, which will disturb daily travel of residents and impair traffic condition of internal vehicles to some extent.

Due to negative impact on local traffic and environment within the project area during construction period, it'll cause travel inconvenience and traffic obstruction against the residents dwelling around project area, together with environmental impact of noise and fugitive dust, passage of heavy-duty construction vehicles will impose certain potential traffic risk. However, such negative impact is short-termed; upon completion of the project, they'll benefit from positive impact such as a better living environment and convenient road traffic.

4. Analysis of Impact on Residents' Life

The impact of the project on residents' life during construction period is mainly represented by requisition and demolition impact, as discused in above section.

According to Action Plan on Resettlement of Affected Residents, major problem arising from project construction is loss of land and resettlement of aborigines as a result of requisition and demolition, by which they may expect a lower life quality. Base on investigation data, 372 persons of 94 affected families in project area will be forced to move to other places due to construction. However, with execution of resettlement measures, living or working environment of migrant residents and enterprises will be improved and enhanced.

Moreover, existing rural road, irrigation canal, power supply, communication facilities and etc may be blocked during construction, which will unavoidably cause some disturbance and inconvenience to normal life of local residents.

5. Analysis of Impact on Landscape

Due to execution of demolition construction, debris, timbers, stones and domestic wastes of demolished houses will be littered around and deface urban landscape and appearance, resulting in uncomfortable visual impact on surrounding residents.

6. Impact of Construction Camp

From the scale of project execution, construction work will extend to a long period, increase of construction workers may cause adverse effect in the area of densely populated construction personnel; on the one hand, it'll disturb living, health and safety against local residents; on the other hand, in case of incomplete living condition and poor hygienic condition at construction camp, incidence of epidemic disease may probably increase.

Major health risk is infectious diseases such as aids and venereal disease as a result of mobility of population in large amount during construction period. Unsanitary or unhealthy living habit of construction personnel may infect epidemic disease to local residents or other construction workers. Due to lack of isolation and control measures at construction site during road construction, it's like to hurt surrounding residents, especially children lack of awareness of personal safety.

6. Offer More Job Opportunities

More job opportunities will be offered during construction period of the project, so that a lot of agricultural labor in rural area may have part-time job at construction site during project construction.

12.1.8 Resettlement of Affected Residents during Construction Period

12.1.8.1 Status of Impact

12.1.8.1.1 Impact of Project Land Use

The project land use includes permanent requisition and temporary land use. Permanent requisition includes necessary permanent land use to which engineering measures need to be taken during control of heavy-metal contaminated soil, this part of land will be requisition by ZREIDC through Shifeng District Requisition & Compensation Office, and the land property will be transformed from collective land to state-owned land. Temporary land use will be occupied by ZREIDC in the form of lease during soil pollution control construction, and it'll be returned to the land owner upon expiry of land lease, without change of land property.

According to investigation statistics, for pollution control and project construction, needed area of requisition is 272.5mu, including 57.3-mustate-owned land and 215.1-mu collective land. Necessary collective land area by temporary lease is 4189.9-mu. The acquired collectively owned land belongs to 3 communities (Villages) . From the area of requisition, most land is located in Yingfeng Community, mainly of construction land. In addition, Yingfeng Community is one of the communities neighboring chemical enterprises of Zhuzhou Smelter and Kangli Smelter and subject to the most severe pollution. Most efforts are made to project related pollution control in Yingfeng Community, where there're many houses to be demolished, and the area of requisition for construction is the largest.

Remaining 2 communities only involve in small amount of temporary land lease. It's known from the information of Tongtangwan Subdistrict Office that, of permanent requisition as agricultural land of changed property in Qingxia Community, Yingfeng Community and Jianshe Village, the proportions of requisition account for 2.22%, 1.12% and 0.18% existing lands of these villages (Communities) , respectively, thus the impact of requisition is minor.

In addition to requisition of above collective land, construction of solid waste landfill for the project will need to expropriate one plot of state-owned construction land not included for land management, the area of this plot is 57.93-mu, currently a waste pit after mining.

Base on technical line adopted for control of project specific heavy-metal contamination of soil, within the land management area of 2.73 square kilometers and out of 272-mu requisition, other lands within the range of management will be granted right of land use during land management by lease, and soil pollution control will be carried out in the form of temporary land use. Statistics indicate that, the area of temporary land use within the range of management is 4189.97-mu (279 hectare) ; these lands mainly include woodland, unused cropland, road and etc; they do not constitute source of income for the owner of land-use right, thus, temporary lease will not materially degrade their standard of living.

12.1.8.1.2 Demolished Private Buildings

According to demolition plan established based upon extent of impact and technical line for soil pollution control submitted by design institute, the information from site investigation is that, the project needs to demolish 21993 ㎡ houses of 94 families, including 372 affected family members.

12.1.8.1.3 Affected Enterprises

Before launch of the project, enterprises of substandard discharge and backward production capacity in Qingshuitang area of Zhuzhou City were closed and relocated during 2011-2013. within management scope of the project, a total of 6 enterprises were closed. Former site of closed facilities is included in the scope of soil pollution control; these enterprises were compensated and resettled by Zhuzhou government in 2011-2013. Project Management Office specially prepared a report of due diligence regarding compensation and resettlement of these closed facilities.

Table 12.1-8 Pollution Control of Closed Facilities

No.	Enterprise	Content of management			
		Area of uncovered soil	Area of demolished buildings	Buildings need cleaning	Demolition of other attachments
1	Zhuzhou Xinda Smelting Co., Ltd	1840.59	4753.60	97.80	N/A
2	Zhuzhou Brothers Industry Co., Ltd	1146.4955	0	0	N/A
3	Yongfa Refinery	1146.50	0.00	0.00	Rotary kiln

4	Zhuzhou Kangli Smelting Plant	1837.332	1116.2	116.5	N/A
5	Zhuzhou Tiancheng Chemical Co., Ltd	1916.88	3677.00	180.00	N/A
6	Zhuzhou Hehua Cement Plant	4331.904	0	7316.46	N/A
Total		115409.5	9546.80	7710.76	

Given internal pollution status of these enterprises, various technical lines of pollution control are adopted for the project; according to pollution control plan proposed in feasibility study report, uncovered contaminated soil of these 6 enterprises will be controlled by land lease, partial buildings will need to be demolished for the sake of pollution control. Of the 3 enterprises needed for demolition of partial buildings, total area of buildings to be demolished is 9546.80 ㎡, in addition, 7710.76 ㎡ buildings may achieve control objective by cleaning; as these facilities are closed, they'll not cause impact on production operation. The project needs only compensation to these enterprises for demolished buildings and production equipments.

12.1.8.1.4 Affected Infrastructures

Site investigation found that, major impact of project related requisition and demolition and construction on the infrastructure includes two aspects, of which the first impact is blockage of country cement road; the traffic is blocked in 1500m road section along low discharge channel due to road construction; 2000m hardened road in Qingxia Mayuan Village is blocked; and the second impact is interruption of power facility in demolished residential areas, including 3 power transformers and 20×200V utility poles.

12.1.8.1.5 Affected Fragile Group

Fragile group of the project means the group of affected population that is most apt to hurt and unable to adapt to the change from project construction. Fragile group mainly includes the following types of population:

● The elderly living alone: those senior citizens who are over 65 years old, single and without legally obligatory supporter.

● Single-parent family: family of single householder with minor children.

● Orphan: children less than 16 years old with parents passed away or abandoned by parents.

● Poverty-stricken households.

● The disabled: any person of lost or abnormal tissue or function in terms of metal, physiological or physical structure, leading to whole of partial loss of ability to do something in a normal way.

● Households suffer other special tough condition.

By investigation and search, 10 fragile families are identified among affected population, including 36 family members, 2605 ㎡ affected houses, per capita 72.36 ㎡ houses; it's known from the average level that these families own moderate residential area, except 2 families having small housing area, which is less than 100 ㎡, and special care should be given to these families in the process of resettlement.

Table 12.1-9 Affected Fragile Families

No.	Village/community	Householder name	Population per family	Demolition area	Description of difficulty
1	New Xiawan Village	FENG Zaoliang	6	520	Handicapped, low-income family
2	New Xiawan Village	LIU Jihong	4	330	Handicapped
3	New Xiawan Village	LIU Furong	4	380	Low-income family
4	New Xiawan Village	LIU Lixin	5	240	Low-income family
5	New Xiawan Village	FENG Meisheng	3	260	Low-income family
6	Yingfeng Community	GUO Zhenghai	4	360	Low-income family
7	Jianshe Village	YE Lin	3	240	Low-income family
8	Qingxia Community	KUANG Tianmin	1	60	Five guaranteed family
9	Qingxia Community	WU Xiangrong	3	170	Low-income family
10	Qingxia Community	HE Ju	3	45	Low-income family
Total			36	2605	

12.1.8.2 Compensation Standard for Resettlement of Affected Residents

Various compensation standards for requisition and demolition listed in the Plan on Resettlement of Affected Residents are established based on in-depth investigation and study, according to applicable national laws and regulations, applicable laws and regulations in Hunan Province and World Bank's Policy on Involuntary Resettlement Operation, aiming to restore and improve standard of living of affected population in short term after resettlement, and by fully consulting with related governmental body of Zhuzhou City and affected population. If new and more preferential policy is enacted by Hunan Provincial People's Government or Zhuzhou Municipal People's Government during project execution, new policy will apply.

According to the spirit of the Notice of Hunan Provincial People's Government on Adjustment of Requisition Compensation Standard》 (Xiang Zheng Fa Circular NO.〔2012〕46) , new requisition compensation standard consists of two parts, namely, land compensation and resettlement subsidy, not including crop compensation, ground attachment compensation and social insurance. Crop compensation, ground attachment compensation and social insurance are separate disbursed.

12.1.8.2.1 Compensation Standard for Collective Requisition

a). Requisition compensation: applicable requisition compensation standard is RMB72000/mu; social insurance cost for requisition farmers is RMB6000/mu.

b). Crop compensation: to execute by the type of dry land, namely, RMB1200/mu;

c). Ground attachment compensation standard:

Ground attachment compensation standard is established for various ground production facilities in the Notice of Zhuzhou Municipal People's Government on Statement of Requisition Compensation Standard by Zhuzhou Municipal People's Government, for particular information, see **Table 12.1-10**.

Table 12.1-10 Compensation Standard for Ground Production Facilities on Requisition Land

No.	Item	Unit	Compensation amount (RMB)
1	Brick dust production pool (Cesspool)	m^3	30
2	Three-sand production pool (Cesspool)	m^3	12
3	Earth cesspool	m^3	10
4	Brick ammonia tank	m^3	70
5	Brick hothouse (Garden)	㎡	20
6	Brick well	m	150
7	Stone well	m	160
8	Earth well	m	20
9	Drilled well (Manual pumping well)	Well	800
10	Mud gravel road	㎡	6
11	Concrete road	㎡	12
12	Cement floor	㎡	30
13	Concrete floor	㎡	12
14	Brick open ditch	m	30
15	Brick blind ditch	m	40
16	Riprap slope	m^3	130
17	Brick slope	m^3	150
18	Unreinforced concrete	m^3	180
19	Reinforced concrete	m^3	220
20	Concealed concrete culvert	m	20
21	Concealed concrete culvert	m	30
22	Square cement wire pole	Pole	80
23	Round cement wire pole	Pole	100
24	Wooden wire pole	Pole	60
25	Concrete slab	㎡	15

12.1.8.2.2 State-owned Land Compensation Standard

The project needs to expropriate 57.93-mu state-owned construction land; according to base land price for urban land type and compensation standard in Zhuzhou City published by Zhuzhou Municipal People's Government, the land to be requisition for the project belongs to Class III mining and warehousing land, compensation standard is RMB452/㎡, amount to RMB301484/mu.

12.1.8.2.3 Demolished House Compensation Standard

In actual execution of the project, minimum compensation standard is RMB1420/㎡ for private houses of brick-concrete structure and RMB1000/㎡ for private houses of brick-wood structure.

For affected families willing to move in resettlement houses, Shifeng District will provide house-demolished families supporting the project with resettlement houses. The price of resettlement houses is: RMB1280/㎡ for small high-rise resettlement houses; RMB1780/㎡ for high-rise houses with elevator.

No matter resettlement method is selected, on the basis of compensation to demolished houses in the form of requisition by procurement, house-demolished families will receive house procurement subsidy, standard for house procurement subsidy is shown in **Table 12.1-11**.

Table 12.1-11 Standard for House Procurement Subsidy

Item	Standard
Resettlement house procurement subsidy	Resettlement population×45m^2/person×RMB500/m^2
Commercial house procurement subsidy	Resettlement population ×45m^2/person×RMB2800/m^2

For building decoration and auxiliary living establishment of house demolished families, appropriate compensation will be paid, compensation standard is shown in **Table 12.1-12**.

Table 12.1-12 Lump-sum Compensation Standard for Building Decoration & Living Establishment

Unit: RMB/㎡

Item	Brick-concrete structure	Brick-wood structure	Civil structure
Decoration compensation	300	280	200
Lump-sum compensation to production and living establishments	RMB7000/person		
Note: 1. Decoration compensation to be calculated by legal area of house; 2. Decoration compensation is not included for houses of simple structure.			

No matter resettlement method is selected, moving subsidy will be paid to house-demolished families; particular standard for moving cost is as shown in Table 11.2-17. resettled families willing to live in resettlement houses will receive transition subsidy; transition period does not exceed 12 months; if transition period exceeds 12 months, transition subsidy for additional 6 months will be granted; if transition period exceeds 18 months, double transition subsidy will be paid.

Table 12.1-13 Compensation Standard of Moving Subsidy & Transition Subsidy for Demolished Houses

Permanent population	Moving subsidy (RMB/household)	Transition subsidy (RMB/month)
Not more than 3 persons (Including)	600	600
More than 3 persons	Additional RMB100 for 1 additional person	Additional RMB100 for 1 additional person

In addition to above compensation, for families signing house requisition compensation within stated time limit and resettlement agreement and moving as scheduled, RMB500/㎡ moving reward will be paid according to the standard of 120 ㎡ house/person.

Estimated total expenditure for resettlement of affected residents of the project is RMB 200110737.86.

12.1.8.3 Resettlement & Restoration Implementation Plan

12.1.8.3.1 Resettlement of House Demolished Households

Most immediate and significant impact of the project on residents in project area is the requirements for resettlement of house-demolished residents to the location outside but near the project area. Taking into full consideration of various factors, including monitoring of pollution level by project planning unit, design of technical line for pollution control, willingness of resettlement of residents in affected areas and etc, it’s finally determined for the project that residential houses of residents from 94 families need to be demolished for soil pollution control, and the number of affected residents is 372 persons.

Base on the policy on compensation to demolished houses and resettlement of migrants set forth in the Measures of Zhuzhou City for Compensation to Demolished Houses on Collective Land & Resettlement of Migrants, during May 2014 and May 2015, consultations were organized by Project Management Office and Tongtangwan Subdistrict Office for Resettlement of Affected Residents with the residents in affected areas for many times to hear their opinions and suggestions about compensation to demolished houses and resettlement of migrants. Finally, following policy on compensation to demolished houses and resettlement of migrants is established:

First, for compensation to demolished houses and resettlement of migrants as affected residents supporting the project, resettlement in resettlement houses and monetary compensation for procurement of commercial houses are optional by free will of house-demolished families.

Resettlement in resettlement houses means that, after compensation according to requisition procurement standard, house-demolished residents eligible for housing resettlement may purchase 45 ㎡ resettlement house per person and receive house procurement subsidy according to applicable regulation; purchase price of resettlement house is divided into two types, namely, RMB1280/㎡ small high-rise building, and RMB1780/㎡ high-rise building with elevator.

Resettlement by monetary compensation for purchase of commercial houses by the resettlers means that, after receiving compensation by house-demolished residents eligible for resettlement according to requisition procurement standard, the government will pay subsidy for commercial house purchase, so that house-demolished residents are fordable to purchase commercial house by themselves.

No matter the resettlement method is selected by house-demolished families, in addition to compensation to demolished houses in the form of requisition by purchase, house-demolished families will be paid house purchase subsidy. For house-demolished families select to purchase resettlement houses, RMB500/㎡ subsidy will be paid by 45 ㎡ resettlement area per person for resettlement population. For house-demolished families select to receive monetary compensation to purchase commercial houses, RMB2800/㎡ subsidy will be paid by 45 ㎡ resettlement area per person for resettlement population.

Second, legal qualification of resettlement of house-demolished residents will be certified and public noticed collectively by local public security, planning, land & resources authorities, Tongtangwan Subdistrict Office, affected community (Village) neighborhood committees and etc organized by Shifeng District People's Government according to following regulations.

(1.) The house-demolished families holding Certificate of Land Use Right, Property Ownership Certificate or other legal and valid certificate will be qualified for resettlement.

(2.) The house-demolished families not holding Certificate of Land Use Right, Property Ownership Certificate or other legal and valid certificate but conforming to following provisions will be qualified for resettlement after review of qualification and payment of RMB10/㎡ house building poundage.

1. The house-demolished families are qualified as house building villagers;

2. The house-demolished families are disqualified by house building approval formality due to governmental planning and control;

3. The demolished house is with complete living utility and occupied by house-demolished families all the time.

Third, legal qualification of resettlement of house-demolished residents will be reviewed, approved and public noticed collectively by local public security, planning, land & resources authorities, Tongtangwan Subdistrict Office, affected community (Village) neighborhood committees and etc organized by Shifeng District People's Government according to following regulations.

The house-demolished families for housing resettlement will be qualified according to following principles:

(1.) The qualifiers of housing resettlement mean permanent population from the families actually living in requisition area, members of collective economic organization in census register, exercise of rights and obligations as the members of such collective economic organization, including parents, spouses and children.

(2.) One additional qualifier of housing resettlement will be approved in either of the following cases:

1. Single chilled;

2. Newlywed holding Certificate of Permitted Birth;

3. Eligible unmarried youth above the normal age for marriage;

4. Either of the spouse with native place from other region in census register.

Fourth, persons in following special cases will be approved as qualifiers of housing resettlement.

1. Person belonging to member of collective economic organization, then granted registered permanent residence with blue signet or paid urban capacity increasing fee for non-agricultural registered permanent residence, but actually residing and living in native place (Original place);

2. Person of serviceman in active service and retiree (Active military officer is not included) subject to village (Neighborhood) committee in census register, students of university/college/polytechnical school or students with census register kept by the university/college/polytechnical school after graduation, as well as those under re-education through labor and in prison;

3. Children of permitted birth not included in census register for registered permanent residence;

4. Other qualifiers of housing resettlement supported by applicable laws, regulations and policies.

Fifth, moving subsidy and transition subsidy will be paid to house-demolished families.

House-demolished families will be paid moving subsidy. For housing resettlement of house-demolished families, twice moving costs are calculated, with transition duration not exceeding 12 months; for house-demolished families of resettlement by purchase of commercial house, once moving cost is calculated; standard for each moving subsidy is RMB600/household with 3 and less family members; additional RMB100 moving subsidy will be paid to each additional member for family with more than 3 members.

House-demolished families selecting resettlement in resettlement houses will be paid transition subsidy. For families with 3 and less family members, standard for transition subsidy is RMB600/household per month; For families with more than family members; additional RMB100 transition subsidy will be paid to each additional member; generally, transitional period is not more than 12 months; if transitional period extends to more than 12 months, additional transition subsidy will be paid for another 6 months; if transitional period extends to more than 18 months, double transition subsidy will be paid.

Sixth, house-demolished residents signing house demolition agreement and resettled within stated time limit will be rewarded.

According to Article 20 of the Measures of Zhuzhou City for Compensation to Demolished Houses on Collective Land & Resettlement of Migrants published on January 30, 2011, if house-demolished residents sign house demolition agreement within stated time limit, they'll be rewarded RMB80/㎡ by legal construction area of the demolished house; if house-demolished residents move and vacate the homestead within stated time limit, they'll be rewarded additional RMB70/㎡ by legal construction area of the demolished house. On July 8, 2011, Zhuzhou Municipal People's Government set forth in the Reply to the Problems regarding Implementation of Measures of Zhuzhou City for Compensation to Demolished Houses on Collective Land & Resettlement of Migrants that, in order to encourage house-demolished residents to make early moving and vacation of homestead to support national construction, house-demolished families are granted for special reward. In addition to the reward stated in Article 20 above, early moving and vacation reward is established, with additional RMB350/㎡ reward by legal construction area of the demolished house. Therefore, house-demolished families are entitled to receive additional RMB500/㎡ moving reward.

Seventh, the poverty-stricken families of house-demolished families will be given special supports, by following major measures:

1. Orphan, "five guaranteed family" and handicapped qualified for resettlement but cannot afford house purchase (Building) will be paid RMB30,000-50,000 subsidy per household for house purchase (Building) after review and approval by county/city/district people's government and public statement.

2. If house-demolished families with legal construction area less than 120 ㎡/person, RMB750/㎡ will be paid as supplementation for the balance part.

3. In selecting resettlement houses, these families will be granted priority for selection; in particular, considering most of these families having handicapped or vulnerable and sick family members, such families will be arranged to live in the first floor or in low-rise

buildings for convenient residence.

4. During moving, special labor and necessary assistance will be arranged to help then moving.

5. PMO will work with the village committee of vulnerable families to arrange temporary housing for these families before moving. If ready resettlement housing source is available, these families will be granted for prior selection.

Zhuzhou Circular Economy Investment Development Co., Ltd, as the project owner, is authorized by Zhuzhou Municipal People's Government to take charge of soil pollution control and primary development of Qingshuitang area; the plan on replanning and development of whole Qingshuitang area by stages has been initiated, and the plan on massive construction of resettlement houses is under execution. According to information provided by the project owner, 13 planned resettlement communities include total land area of 631.1-mu, total construction area of 821283.64 ㎡ and total investment of RMB2.03324 billion, including RMB788.06 million budgetary total investment for the year of 2014 for supply of about 6000 apartments. Therefore, 94 house-demolished families included in World Bank financed project are fully ensured resettlement housing.

Figure12.1-5 1st Resettlement Houses in New Xiawan Village are Roof Sealed

Figure12.1-6 2nd Resettlement Houses in New Xiawan Village are under Construction

Table 12.1-14 Status of Construction of Resettlement Houses in Qingshuitang Area

No.	Project title	Basic information	Construction progress
1	Jiulangshan A resettlement community	79.5-mu land occupation, 105050 ㎡ construction area, 822 apartments available	Expected completion of construction by March 2015
2	1st construction of Jinglong resettlement community	59-mu land occupation, 29800 ㎡ construction area, 240 apartments available	Roof-sealing of framework completed, interior and exterior decoration works underway
3	1st construction of Xiawan resettlement community	65-mu land occupation, 55849 ㎡ construction area, 336 apartments available	Manual hole digging piles and in-situ concrete pouring construction of underground garage underway
4	Xinming Resettlement community	40-mu land occupation, 57053 ㎡ construction area, 316 apartments available	Construction of bounding wall, vehicle washing pool, modular house, earth carrying road and etc underway
5	Baima resettlement community	22-mu land occupation, 16646 ㎡ construction area, 156 apartments available	Planned commencement of work in2015
6	1st construction of Tongtangwan resettlement community	46-mu land occupation, 102070 ㎡ construction area, 6083 apartments available	Planned commencement of work in2015
7	2nd construction of Jinglong resettlement community	56-mu land occupation, 67039 ㎡ construction area, 510 apartments available	Planned commencement of work in2015

8	Jiaojiling resettlement community	62-mu land occupation, 102109 ㎡ construction area, 800 apartments available	Planned commencement of work in2015
9	Changshi resettlement community	16-mu land occupation, 12800 ㎡ construction area, 100 apartments available	Planned commencement of work in2015
10	3rd construction of Xianfeng resettlement community	~12.6-mutotal land area, 28405.64 ㎡ total construction area, 246 total resettlement households	Surface clearing work of construction site completed
11	2nd construction of Xiawan resettlement community	34-mu land occupation, 90813 ㎡ construction area, 675 apartments available	Planned commencement of work in2015
12	Dachong resettlement community	61-mu land occupation, 30749 ㎡ construction area, 262 apartments available	Planned commencement of work in2015
13	Xinming resettlement community	58-mu land occupation, 122900 ㎡ construction area, 892 apartments available	Planned commencement of work in2015

According to above resettlement and compensation policies, new houses are available for all affected families in resettlement communities without environmental pollution and with favorable residential condition, or they may purchase their favorite houses from commercial housing market. Their residential environment and condition will be improved substantially, and the value of their household properties will also be increased notably.

Special Column: Analysis on the Fairness of Compensation and Resettlement of House-demolished Families

Base on resettlement and compensation policy on the project specific house-demolished families, Mr. Li, a veteran in the field of requisition and demolition management from Tongtangwan Subdistrict Resettlement Office, communicates with house-demolished householders by accounting. After accounting of Mr. Li with the householders face to face in light of their household conditions, all members of house-demolished families are pleased, expressing their satisfaction to project specific resettlement compensation policy, and longing for a better life in the future.

Mr. Li explains that, according to current policy, regardless of existing residential condition with house-demolished families, each member of house-demolished families will at least receive RMB230,000 compensation, including:

1) At least RMB108,000 compensation for requisition by purchase of 120 ㎡ brick-wooden structure house (i.e. 120*900=RMB108,000, in case of brick-concrete structure house, 120*950=RMB114,000) ;

2) At least RMB 33,600 (120*280) decoration compensation;

3) RMB7,000 living utility compensation per person;

4) Moving subsidy (Twice, RMB 600 per time) ;

5) RMB 7,200 transition subsidy (600RMB per month, 12 months) ;

6) RMB 22,500 subsidy for house purchase (To calculate by 45 ㎡ per person, 500RMB/㎡) ;

7) RMB 60,000 moving reward (120*500) .

So, subsidy is not calculated by household but family members in average, each family member will receive compensation for at least RMB 108,000+ RMB 33,600+ RMB 7,000+ RMB 22,500+ RMB 60,000= RMB 231,100.

Mr. Li so analyzes, that average population of each family is 4.1 persons, so each family will at least receive RMB 947,510; 45 ㎡/person resettlement house, the area of buyable resettlement house is185 ㎡ by each family; if small high-rise is selected, price of resettlement house is RMB 1,280/㎡, house procurement cost is RMB236,800, with RMB710,710 balance; if high-rise with elevator is selected, price of resettlement house is RMB 1,780/㎡, house procurement cost is RMB329,300, with RMB618,210 balance.

What is meaning of RMB610,000-710,000 balance to these families? Average price of commercial houses in Zhuzhou Hexi Development Area is RMB5,000/㎡, that is to say, all families, after procurement 45 ㎡ resettlement house per person at discount price in Shifeng District Qingshuitang resettlement area, their remaining compensation funds are enough for procurement another 120-140 ㎡ commercial house in Hexi Development Area.

"You have no idea before accounting, but everything is enjoyable after accounting," Mr. Li concludes his feeling after communication with house-demolished householders. Due to compensation and resettlement will greatly improve the affected residents' residential condition and environment, and notably increase asset income of these families, demolition and resettlement compensation policy of the project is very popular among them. Many families yet to be included in the list of demolition can not wait to be considered for demolition and resettlement as early as possible.

12.1.8.3.2 Resettlement of Requisition Affected Population

The project related land use, regardless of permanent requisition or temporary land lease, will not cause any impact on the standard of living of land owners, this is because:

Firstly, Circular No. 748 issued by Ministry of Land and Resources of the People's

Republic of China in November 2008 includes express statement that the soil of polluted area in Qingshuitan is no longer suitable for planting crops and should be changed by land classification; according to the requirements of this circular of Ministry of Land and Resources of the People's Republic of China, agricultural land in the areas within 6.7 square kilometers from Qingshuitang core area was changed property to construction land in 2009; the residents from communities and villages in the jurisdiction of Tongtangwan Subdistrict Office were changed to township citizens and included in employment and social insurance network of township citizens; former land contracted from collective economic organization does not constitute the source of income by local residents. Although some residents are occasionally found plating vegetables or other economic crops on idle land within project site, they confess in the interview that they know the soil is contaminated, where the crops planted are not edible and unsuitable to sell in the market. Many interviewees express that they plant vegetables and crops not for food, but hate to let the land to be desolated.

Secondly, investigation of source of income and will of affected residents in project area indicates that 89% residents believe soil heavy-metal pollution control in area Qingshuitang has no negative impact on their income level, 17% residents believe this will have positive impact to their families, so they support construction of the project; 10.87% residents believe that execution of the project may cause negative impact on their household income, mainly in terms of inconvenience of enterprises in production and business operation in affected area, disturbance of their work and production, but without immediate impact on requisition and temporary occupation. Most interviewees express that requisition and land use help making economic benefit from previously idle land, which is actually the welfare of local residents. After soil pollution control, they'll be able to make full use of currently contaminated and non-arable soil for more income.

For income from requisition and temporary land use, according to applicable national regulations and by learning from recognized local practice in recent years, determination is made to adopt following distribution method after full consultation with residents from affected communities (Villages) :

1. Compensation funds for requisition of collective land will directly allocated to special account established by Tongtangwan Subdistrict Office.

2. For requisition land formerly contracted by households, land compensation and 70% resettlement subsidy will be directly paid to land-requisition families, remaining 30% resettlement subsidy will be allocated for collective use; All affected community (Village) committees will calculate compensation amount, prepare booking and registration by land

contracting area of land-requisition families and according to publicized compensation standard, publicize the calculations and bookkeeping on poster and accept supervision of residents from affected communities (Villages) and examination by superior. Compensation funds will be directly credited in the form of bankbook to special account of land-requisition families opened by Tongtangwan Street Committee, without any intermediary aspect. Skimp and appropriations of compensation funds in any other name are prohibited.

3. Compensation funds for requisition of collective owned land not contracted to the residents will be paid to collective organization, such funds will be deposited in special escrow account opened by Subdistrict Office in affected area. Particular approach of use of such funds should be consulted in the form of meeting of villager representatives and the like, and reported for approval by Subdistrict Office in affected area, such funds should mainly be used for collective public welfare undertaking. Land compensation funds and resettlement subsidy should be distributed and used under supervision and auditing of superior unit.

4. The compensation for attachments and crops on requisition land will directly be paid to the land owner.

5. For temporary land occupation necessary in the process of soil pollution control, compensation will be paid for crop price and actual number of years of land occupation (Less than a year is counted as one full year); if temporary land use right is owned by household, compensation for temporary land use will directly be paid to affected families; if temporary land use right is owned by collective organization, compensation for temporary land use will be owned by collective organization.

12.1.8.3.3 Compensation to Affected Enterprises

Total area of enterprise buildings needs for project related pollution control after demolition is 9546.80 ㎡. These buildings are office buildings or production workshops respectively owned by three closed facilities, namely, Zhuzhou Xinda Smelting Co., Ltd, Yongfa Refinery and Zhuzhou Kangli Smelting Plant. At the time of closing, compensation to these enterprises was paid by Shifeng District, and these enterprises were properly resettled (For related content, see due diligence report on the resettlement and compensation of closed facilities) . Demolition of these buildings will not cause any loss of production and business operation of closed facilities. Demolished buildings and production facilities will be priced for compensation by engaging qualified professional organization by market appraisal, and compensation will be paid in cash.

In order to protected legal rights and interests of closed facilities, in-depth consultation was held by Project Management Office and related authority of Shifeng District People's

Government with affected enterprises during November 2014 and February 2015, so as to understand resettlement and compensation situation after closing of business, exchange information with regard to pollution status in the area of affected enterprises, and communicate with each other the plan of pollution control. Final agreed plan is that: all enterprises support and actively cooperate with the project owner for control of soil heavy-metal pollution, Project Management Office paid compensation to closed facilities for demolished buildings at market appraisal price. To this end, the project owner has signed intent of pollution control agreement with 6 enterprises.

1. Zhuzhou Yongfa Metal Refining Co., Ltd (Zhuzhou Hongji Zinc Industry Co., Ltd) : this enterprise has been closed, only compensation will be paid for demolished buildings and rotary kiln at market appraisal price;

2. Zhuzhou Kangli Smelting Plant: for demolished buildings of Kangli Smeltery, only compensation will be paid at market appraisal price;

3. Zhuzhou Xinda Smelting Co., Ltd: this smeltery has been demolished, demolition of such buildings will have no any impact on its production and business operation, only compensation will be paid at market appraisal price.

12.1.8.3.4 Resettlement & Restoration of Affected Vulnerable Group

For affected families of fragile group by the project, PMO and affected communities (Villages) will given them special hand and care, mainly by following measures:

●In selecting resettlement houses, these families will be granted priority for selection; in particular, considering most of these families having handicapped or vulnerable and sick family members, such families will be arranged to live in the first floor or in low-rise buildings for convenient residence.

● During moving, special labor and necessary assistance will be arranged to help then moving;

● PMO will work with villagers' committee of fragile families to accommodate them in transition houses; if ready source of resettlement houses is available, they'll be prioritized for selection;

● During construction work of the project, affected fragile families will be first provided with appropriate job opportunities to increase their economic income;

● The fragile families will be first handled social insurance formality of land-lost population; imitative will be taken to declare to relevant authorities such as civil affairs department for handling of low-income guarantee formality;

● Members of fragile families willing to and able to work will be freely trained for employment, and first recommended to employ by enterprises in industrial park;

● During resettlement and transition, fragile families will be issued domestic subsidy, as the case may be;

Firstly, orphan, “five guaranteed family” and handicapped eligible for resettlement but can not afford house purchase (Building), after investigation and statistics by their communities and villages, will be reviewed and identified by Tongtangwan Subdistrict Office, reported to further review and approval by Shifeng District People’s Government and public noticed, and each family will be paid RMB30,000-50,000 subsidy for house purchase (Building).

Secondly, if per capita construction area of house-demolished families is less than 120 ㎡, such families will be supplemented to 120 ㎡ construction area per person.

12.1.8.3.5 Scheduling of Resettlement and Restoration

The soil pollution control construction of the project is planned for commencement from 2016; scheduling of various activities for resettlement of affected residents is as shown in **Table 12.1-15**.

Table 12.1-15 Scheduling of Activities for Resettlement of Affected Residents

Content of activity	2014				2015				2016-2022			
	1	2	3	4	1	2	3	4	1	2	3	4
PMO	■											
Setup of subdistrict resettlement of affected residents organization	■											
Investigation of requisition and demolition		■										
Preliminary consultation of resettlement plan		■										
Draft resettlement action Plan		■	■									
Supplementary investigation			■	■								
Revision of resettlement action plan			■	■								
Re-consultation of resettlement plan			■	■								
Improvement of resettlement plan				■	■	■						
Approval of resettlement plan						■						
Actual action of resettlement of affected residents							■					
Internal monitoring							■	■	■	■	■	■
External monitoring							■	■	■	■	■	■

12.1.8.4 Setup of Resettlement of Affected Residents Organizations

Major organizations of the project related to the activities of resettlement of affected residents are as follows:

- Zhuzhou Leading Group for Utilization of World Bank Financed Project
- Zhuzhou World Bank Financed Project Management Office
- Shifeng District Resettlement of Affected Residents Office
- Tongtangwan Subdistrict Resettlement of Affected Residents Office
- Resettlement of Affected Residents Consulting Agency

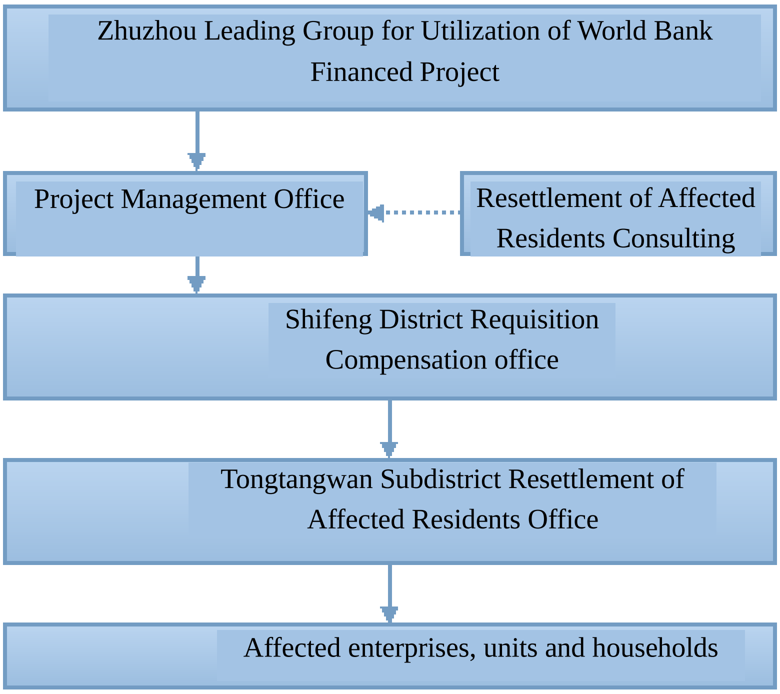


Figure12.1-7 Organizations Relating to Resettlement of Affected Residents by Heavy-metal Pollution Environmental Improvement Project in Qingshuitang Area, Zhuzhou City

12.2Environmental Impact & Mitigation Measures during operation period

12.2.1 Ambient Air Impact & Mitigation Measures

12.2.1.1 Forecast & Assessment of Air Environmental Impact

12.2.1.1.1 Analysis of Meteorological Background of Regional Pollution

Project area belongs to mild and humid subtropical monsoon climate, according to the data of Zhuzhou Observatory, Zhuzhou City belongs to humid subtropical monsoon climate zone, where it's featured by four distinct seasons, ample precipitation, milk weather, light and heat conditions, represented by variable temperature in spring, scorching heat in summer, clear and refreshing autumn and bitter cold in winter; years of average air temperature at 17.4℃, lowest monthly average air temperature in January, highest monthly average air temperature in July, extremely highest air temperature at 40.2℃, extremely lowest air temperature at -11.5℃; yearly average rainfall of 1442.7mm, concentrated precipitation during April and August; yearly average relative humidity 80%, yearly average air pressure of 1007.1hpa; perennial prevailing wind of NW-N wind, calm frequency of 23％; yearly average wind speed of 2.0m/s; longitude and latitude of Zhuzhou Observatory are 113.17° and 27.87°, respectively, in the east of core area, and 7km from east boundary of this area.

Records of 1971-2000 meteorological data of Zhuzhou City are as shown in **Table 12.2-1** below:

Table 12.2-1 Statistics of Various Meteorological Elements of Zhuzhou City by Years & Months During 1971-2000

Item	Number of years	Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Average air pressure of observatory	30		10172	10147	10108	10055	10015	9970	9954	9969	10039	10103	10149	10176	10071
Average air temperature	30		51	69	108	172	221	258	292	284	240	186	129	75	174
Yearly difference	30														241
Extremely highest air temperature	30		249	288	324	335	365	377	402	389	377	351	306	249	402
Date of occurrence			22	21	14	23	24	21	2T	6	6	4	4	20	2T/7
Year of occurrence			1972	1979	1988	2N	1991	1981	1971	1983	1995	1983	1979	1979	1971
Extremely lowest air temperature	30		-70	-79	-8	25	98	131	186	169	127	30	-17	-115	-115
Date of occurrence			30	1	11	4	6	7	30	31	27	29	24	29	29/12
Year of occurrence			1977	1990	1996	1996	1984	1987	1989	1993	1982	1978	1975	1991	1991
Average vapor pressure	30		73	83	109	162	213	267	292	293	233	168	115	81	174
Average relative humidity	30		83	83	83	82	81	81	74	77	79	79	77	78	80

Minimum relative humidity	30		15	0	0	0	21	0	30	30	21	0	16	12	0
Date of occurrence			11	28T	31T	30T	2T	29	15	10	23	31T	3T	28	21T/6Y
Year of occurrence			1976	1995	1995	1995	2N	1996	2000	1987	1995	1995	3N	1973	2N
Average total cloud cover	30		77	81	83	80	77	77	65	64	65	65	63	61	72
Average low cloud cover	30		31	36	41	37	33	34	24	28	28	27	23	20	30
Number of fine days	30		30	17	15	13	23	19	29	35	48	65	62	67	423
Number of cloudy days	30		189	186	215	185	186	170	117	116	131	150	141	136	1921
Precipitation	30		783	1013	1456	2026	1915	1997	1194	1310	715	911	669	438	14427
Max. daily precipitation	30		361	547	681	1271	927	1794	1063	1482	880	844	657	395	1794
Date of occurrence			13	17	17	18	5	25	26	5	2	17	14	2	June 25
Year of occurrence			1998	1985	1981	1979	1974	1973	1993	1975	2000	1981	1986	1974	1973
Evaporation	30		373	423	614	981	1377	1571	2465	2105	1449	1052	716	542	13668
Average wind speed	30		19	20	21	21	20	20	24	21	21	20	19	18	20
Max wind speed	26		123	120	200	213	180	154	170	153	120	170	170	130	213
Concurrent			NNW	2G	NNW	NNW	NNW	NNW	SSW	ENE	NNW	N	NNW	NNW	NNW

wind direction															
Date of occurrence			15	2T	23	13	2	6	14	6	1	27	4	2T	13/4
Year of occurrence			1978	2N	1977	1980	1981	1992	1977	1984	1984	1978	1979	2N	1980
Most wind direction	30		NNW	NNW	NNW	NNW	NNW	N	SSE	NNW	NNW	NNW	NNW	NNW	NNW
Frequency	26		26	24,25	21,22	14.24	13,24	10,20	16	12,20	21	21,24	23,29	22,29	18,23

It's obvious from **Table 12.2-2** that, prevailing wind in this area is NNW, frequency 18％,except for prevailing N and SSE wind in June and July, prevailing wind in other months are NNW; annual calm frequency is 23％.

According to statistical average wind speed measured at Zhuzhou Observatory by months in recent years, average wind speed is relatively strong in July in assessment area, which is 2.4m/s, and yearly average wind speed is 2.0m/s.

Statistical frequency of wind direction for the last 5 years is as shown in **Figure12.2-1**, it's obvious that prevailing wind of Zhuzhou City in the past 5 years is NW.

Table 12.2-2 Statistical Frequency of Wind Direction in Zhuzhou City during 2004-2008 Years

Prevailing wind	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Frequency (%)	12	5	5	4	4	4	6	8	5	2	2	2	2	5	12	15

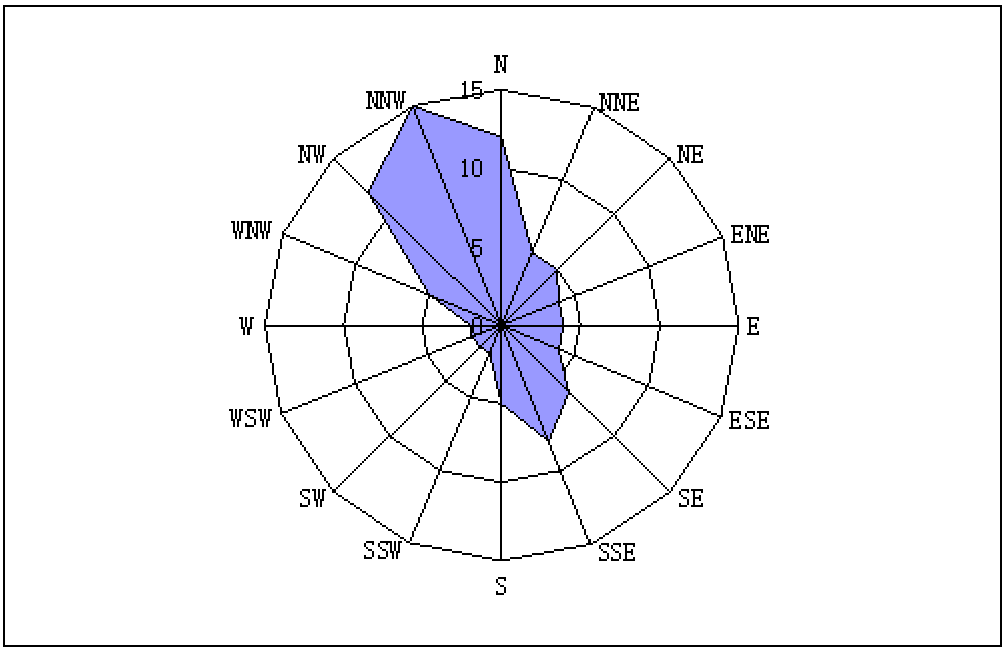


Figure12.2-1 Rose Diagram of Frequency of Wind Direction in Zhuzhou City during 2004-2008 Years

12.2.1.1.2 Forecast Factors & Source Intensity

With dewatering site, unorganized discharge of ammonia and sulfureted hydrogen at solidification/stabilization ground, unorganized discharge of dust at solidification/stabilization ground, fugitive dust at landfill as forecast factors, forecast of source intensity is as shown in **Table 12.2-3**.

Table 12.2-3 Forecast of Air Contamination Source Intensity

No.	Location	Contamination name	Emission (t/a)	Length of non-point	Width of non-point	Height of non-point

				source (m)	source (m)	source (m)
1	Solidification/stabilization plant in Xinqiao spoil area	Ammonia	0.12	66	60	6
2		Sulfureted hydrogen	0.01	66	60	6
3		Dust	1.256	40	30	6
4	Dewatering site near Xinqiao solidification /stabilization ground	Ammonia	0.08	70	60	6
5		Sulfureted hydrogen	0.0058	70	60	6
6	Xiawangang dewatering site	Ammonia	0.1	78	70	6
7		Sulfureted hydrogen	0.008	78	70	6
8	Landfill	TSP	11.835	225	150	6

12.2.1.1.3 Forecast Results

The calculation model recommended in Guidelines for Environmental Impact Assessment: Atmospheric Environment (HJ2.2-2008) is adopted; forecast results are as shown in **Table 12.2-4**, statistical results are as shown in **Table 12.2-5**.

Table 12.2-4 Forecast Results (Concentration Unit: ug/m^3, Percentage, %)

No.	Distance	Xinqiao solidification /stabilization ground						Xinqiao dewatering site			
		Ammonia concentration	Ammonia percentage	H_2S concentration	H_2S percentage	TSP concentration	TSP percentage	Ammonia concentration	Ammonia percentage	H_2S concentration	H2S percentage
1	10	2.246	1.12	0.1883	1.88	23.46	2.61	1.488	0.74	0.1072	1.07
2	100	6.253	3.13	0.5242	5.24	65.3	7.26	4.082	2.04	0.2942	2.94
3	200	6.638	3.32	0.5565	5.57	69.33	7.7	4.34	2.17	0.3128	3.13
4	300	6.706	3.35	0.5622	5.62	70.04	7.78	4.381	2.19	0.3158	3.16
5	347	6.687	3.34	0.5606	5.61	69.84	7.76	4.371	2.19	0.3151	3.15
6	400	6.087	3.04	0.5102	5.1	63.56	7.06	3.996	2	0.288	2.88
7	500	5.245	2.62	0.4397	4.4	54.77	6.09	3.456	1.73	0.2491	2.49
8	600	4.46	2.23	0.3739	3.74	46.58	5.18	2.949	1.47	0.2126	2.13
9	700	3.799	1.9	0.3185	3.19	39.67	4.41	2.519	1.26	0.1816	1.82
10	800	3.283	1.64	0.2753	2.75	34.29	3.81	2.181	1.09	0.1572	1.57
11	900	2.862	1.43	0.2399	2.4	29.89	3.32	1.902	0.95	0.1371	1.37
12	1000	2.516	1.26	0.2109	2.11	26.27	2.92	1.672	0.84	0.1205	1.21
13	1100	2.235	1.12	0.1874	1.87	23.34	2.59	1.486	0.74	0.1071	1.07
14	1200	2	1	0.1677	1.68	20.88	2.32	1.329	0.66	9.58E-02	0.96
15	1300	1.802	0.9	0.1511	1.51	18.82	2.09	1.198	0.6	8.63E-02	0.86
16	1400	1.632	0.82	0.1368	1.37	17.04	1.89	1.085	0.54	7.82E-02	0.78
17	1500	1.487	0.74	0.1247	1.25	15.53	1.73	0.9884	0.49	7.12E-02	0.71
18	1600	1.361	0.68	0.1141	1.14	14.21	1.58	0.9044	0.45	6.52E-02	0.65
19	1700	1.251	0.63	0.1049	1.05	13.06	1.45	0.8313	0.42	5.99E-02	0.6
20	1800	1.155	0.58	9.68E-02	0.97	12.06	1.34	0.7674	0.38	5.53E-02	0.55
21	1900	1.07	0.54	8.97E-02	0.9	11.18	1.24	0.7113	0.36	5.13E-02	0.51
22	2000	0.9948	0.5	8.34E-02	0.83	10.39	1.15	0.6612	0.33	4.77E-02	0.48
23	2100	0.9312	0.47	7.81E-02	0.78	9.725	1.08	0.6189	0.31	4.46E-02	0.45
24	2200	0.8742	0.44	7.33E-02	0.73	9.13	1.01	0.5811	0.29	4.19E-02	0.42
25	2300	0.8231	0.41	6.90E-02	0.69	8.596	0.96	0.5471	0.27	3.94E-02	0.39
26	2400	0.777	0.39	6.51E-02	0.65	8.115	0.9	0.5165	0.26	3.72E-02	0.37

27	2500	0.7343	0.37	6.16E-02	0.62	7.669	0.85	0.4881	0.24	3.52E-02	0.35
28	2600	0.6955	0.35	5.83E-02	0.58	7.264	0.81	0.4623	0.23	3.33E-02	0.33
29	2700	0.6602	0.33	5.54E-02	0.55	6.894	0.77	0.4388	0.22	3.16E-02	0.32
30	2800	0.6278	0.31	5.26E-02	0.53	6.556	0.73	0.4172	0.21	3.01E-02	0.3
31	2900	0.5979	0.3	5.01E-02	0.5	6.244	0.69	0.3974	0.2	2.86E-02	0.29
32	3000	0.5705	0.29	4.78E-02	0.48	5.958	0.66	0.3792	0.19	2.73E-02	0.27
33	3500	0.4655	0.23	3.90E-02	0.39	4.861	0.54	0.3094	0.15	2.23E-02	0.22
34	4000	0.3899	0.19	3.27E-02	0.33	4.072	0.45	0.2592	0.13	1.87E-02	0.19
35	4500	0.3334	0.17	2.80E-02	0.28	3.481	0.39	0.2216	0.11	1.60E-02	0.16
36	5000	0.2898	0.14	2.43E-02	0.24	3.026	0.34	0.1926	0.1	1.39E-02	0.14

Table 12.2-5 Forecast Results (Concentration Unit: ug/m^3, Percentage, %)

No.	Distance	Xiawangang dewatering site				Landfill	
		Ammonia concentration	Ammonia percentage	H_2S concentration	H_2S percentage	TSP concentration	TSP percentage
1	10	1.209	0.6	9.57E-02	0.96	19.56	2.17
2	100	2.511	1.26	0.1987	1.99	33.05	3.67
3	200	3.235	1.62	0.256	2.56	48.15	5.35
4	300	3.306	1.65	0.2616	2.62	52.06	5.78
5	347	3.318	1.66	0.2626	2.63	53.18	5.91
6	400	3.199	1.6	0.2532	2.53	52.36	5.82
7	500	2.909	1.45	0.2302	2.3	48.5	5.39
8	600	2.606	1.3	0.2063	2.06	44.04	4.89
9	700	2.335	1.17	0.1848	1.85	39.99	4.44
10	800	2.11	1.06	0.167	1.67	36.56	4.06
11	900	1.912	0.96	0.1513	1.51	33.66	3.74
12	1000	1.734	0.87	0.1372	1.37	31.15	3.46
13	1100	1.579	0.79	0.1249	1.25	28.99	3.22
14	1200	1.442	0.72	0.1142	1.14	27.09	3.01
15	1300	1.321	0.66	0.1046	1.05	25.37	2.82
16	1400	1.214	0.61	9.61E-02	0.96	23.77	2.64

17	1500	1.119	0.56	8.86E-02	0.89	22.29	2.48
18	1600	1.035	0.52	8.19E-02	0.82	20.92	2.32
19	1700	0.9596	0.48	7.59E-02	0.76	19.66	2.18
20	1800	0.8922	0.45	7.06E-02	0.71	18.5	2.06
21	1900	0.8321	0.42	6.59E-02	0.66	17.44	1.94
22	2000	0.7786	0.39	6.16E-02	0.62	16.47	1.83
23	2100	0.7318	0.37	5.79E-02	0.58	15.61	1.73
24	2200	0.6903	0.35	5.46E-02	0.55	14.83	1.65
25	2300	0.6524	0.33	5.16E-02	0.52	14.11	1.57
26	2400	0.6175	0.31	4.89E-02	0.49	13.44	1.49
27	2500	0.5856	0.29	4.63E-02	0.46	12.81	1.42
28	2600	0.5567	0.28	4.41E-02	0.44	12.23	1.36
29	2700	0.53	0.27	4.19E-02	0.42	11.7	1.3
30	2800	0.5049	0.25	4.00E-02	0.4	11.19	1.24
31	2900	0.4818	0.24	3.81E-02	0.38	10.72	1.19
32	3000	0.4606	0.23	3.65E-02	0.36	10.29	1.14
33	3500	0.3786	0.19	3.00E-02	0.3	8.566	0.95
34	4000	0.3187	0.16	2.52E-02	0.25	7.275	0.81
35	4500	0.2734	0.14	2.16E-02	0.22	6.282	0.7
36	5000	0.238	0.12	1.88E-02	0.19	5.5	0.61

Above results suggest that, maximum percentage of emitted air contaminations of the project is 7.78% (<10%) ; leeward maximum concentrations of malodorous substances of ammonia and sulfureted hydrogen are 0.00671mg/m^3 and 0.00056mg/m^3, respectively, both are less than corresponding olfactory threshold (Olfactory threshold of ammonia is 1.54ppm, i.e. 0.5mg/m^3, olfactory threshold of sulfureted hydrogen is 0.0047ppm, i.e. 0.0008mg/m^3) ; leeward maximum concentrations of all contaminations are less than boundary monitoring concentration. Therefore, upon completion of the project, it will have minor environmental impact on the surroundings, and can ensure all sensitive points complying with Ambient Air Quality Standard (GB3095-2012) , Class 2., and the requirements of Sanitary Standard for the Design of Industrial Enterprise (TJ36-79).

12.2.1.1.4 Air environmental Protection Distance

Recommended model of air environmental protection distance is adopted to calculate air environmental protection distance with various emission sources. Calculated distance is control distance with pollution source center as starting point, the range of control distance is determined in terms of layout plan of various stations, and the range beyond boundary is taken as air environmental protection area of the project.

The calculated air environmental protection distance from emissions of exhaust gas of the project is as shown in **Table 12.2-6**.

Table 12.2-6 Calculations of Air Environmental Protection Distance of the Project

Location of pollution source	Effective height of non-point source (m)	Length of non-point source (m)	Width of non-point source (m)	Contamination name	Emitting velocity (g/s)	Model calculation distance (m)
Xinqiao solidification/stabilization plant	6	66	60	Ammonia	0.00464	No exceedance point
				Sulfureted hydrogen	0.00039	No exceedance point
				Dust	0.04844	No exceedance point
Dewatering site near Xinqiao solidification /stabilization ground	6	70	60	Ammonia	0.00308	No exceedance point
				Sulfureted hydrogen	0.00022	No exceedance point

Xiawangang dewatering site	6	78	70	Ammonia	0.00386	No exceedance point
				Sulfureted hydrogen	0.00031	No exceedance point
Landfill	6	225	150	TSP	0.0913	No exceedance point

It's obvious from above table that, emission of exhaust gas of the project is small, thus no setting of air environmental protection distance is required.

12.2.1.1.5 Health Protection Distance

Health protection distance L is calculated by following equation:

$$\frac{Q_c}{C_m} = \frac{1}{A}(BL^C + 0.25r^2)^{0.50} L^D$$

Where: Cm—standard concentration limit (mg/m^3) ;

Qc—achievable control level of unorganized emission of noxious gas by industrial enterprise (kg/h) ;

r—equivalent radius of production unit as unorganized emission source of noxious gas (m) ;

L—health protection distance necessary for industrial enterprise (m) ;

A, B, C & D-calculation coefficient of health protection distance, see **Table 12.2-7**.

Calculations of health protection distance are as shown in **Table 12.2-8**.

Table 12.2-7 Calculation Coefficient of Health Protection Distance

Calculation coefficient	5-year average wind speed (m/s)	Health protection distance L (m)								
		L≤1000			1000＜L≤2000			L＞2000		
		Composition category of industrial air pollution source								
		Ⅰ	Ⅱ	Ⅲ	Ⅰ	Ⅱ	Ⅲ	Ⅰ	Ⅱ	Ⅲ
A	＜2	400	400	400	400	400	400	80	80	80
	2~4	700	470	350*	700	470	350	380	250	190
	＞4	530	350	260	530	350	260	290	190	140
B	＜2	0.01			0.015			0.015		
	＞2	0.021*			0.036			0.036		
C	＜2	1.85			1.79			1.79		
	＞2	1.85*			1.77			1.77		
D	＜2	0.78			0.78			0.57		
	＞2	0.84*			0.84			0.76		

*:Calculation coefficient applied to the project.

Table 12.2-8 Calculations of Health Protection Distance

Location of pollution source	Contamination name	Q_c (kg/h)	C_m (mg/m^3)	Area (m^2)	L 计 (m)
Xinqiao solidification/stabilization plant	ammonia	0.0167	0.2	4000	1.810
	sulfureted hydrogen	0.0014	0.01	4000	3.348
	Dust	0.1744	0.9	4000	4.928
Dewatering site near Xinqiao solidification /stabilization ground	ammonia	0.0111	0.2	4200	1.075
	sulfureted hydrogen	0.0008	0.01	4200	1.661
Xiawangang dewatering site	ammonia	0.0139	0.2	5500	1.197
	sulfureted hydrogen	0.0011	0.01	5500	2.067
Landfill	TSP	3.2875	0.9	33750	45.187

According to the provisions on health protection distance and comprehensive consideration of calculations about dewatering site, solidification /stabilization ground and landfill, the project specific health protection distance is determined to be 100m beyond Xinqiao solidification/stabilization plant, 50m beyond dewatering site near Xinqiao solidification /stabilization ground, 50m beyond Xiawan dewatering site and 50m beyond landfill, respectively, the range of health protection distance is shown in **Figure1.5-2**～**Figure1.5-5**.

The figures show that residents reside within protection distance from Xinqiao solidification/stabilization ground, Xinqiao dewatering site and Xiawan dewatering site, however, these stations are temporary construction, which will be demolished at the end of regional soil remediation; during operation of solidification/stabilization ground and dewatering site, sediments should be dumped by layer, cover plate or protective greenbelt should be set in the position of concentrated odor source to mitigate malodorous impact; haulage road should be sprayed water to suppress dust. Low-noise equipment should be used;

high-noise equipment should be allocated in the position far from residential area, handling operation route should be arranged logically to reduce noise disturbance of surrounding residents.

At present, there're 4 households residing within health protection distance from landfill; according to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, the land plot of these 4 households is planned as industrial and office land in the controlling detailed planning of ecotype new industrial city of Qingshui Lake, Zhuzhou City, and their houses will be demolished; before demolition of their houses, fugitive dust on the road by vehicle transport and landfill operation should be controlled strictly at landfill during construction period and operation period, spraying water, timed and quantified watering should be applied to suppress dust, transport vehicles should not be overloaded, no leakage and spill of carriage is allowed, vehicle should be covered with tarpaulin, road management should be strengthened, and damaged section of haulage road should be trimmed and repair if necessary.

12.2.1.1.6 Summary

To sum up, maximum percentage of air contaminations emitted by the project is 7.78% (<10%) ; leeward maximum concentrations of malodorous substances of ammonia and sulfureted hydrogen are 0.00671mg/m^3 and 0.00056mg/m^3, respectively, both are less than corresponding olfactory threshold (Olfactory threshold of ammonia is 1.54ppm, i.e. 0.5mg/m^3, olfactory threshold of sulfureted hydrogen is 0.0047ppm, i.e. 0.0008mg/m^3) ; leeward maximum concentrations of all contaminations are less than those monitored at the boundary; therefore, upon completion of the project, it has minor environmental impact on surrounding areas, and can ensure all sensitive points complying with Ambient Air Quality Standard (GB3095-2012) , Class 2., or meeting the requirements of corresponding emission standard.

Base on calculations, no air environmental protection distance needs to be set. The project specific health protection distances are 100m beyond Xinqiao solidification/stabilization plant, 50m beyond dewatering site near Xinqiao solidification /stabilization ground, 50m beyond Xiawan dewatering site and 50m beyond landfill, respectively.

There're residents residing within protection distance from Xinqiao solidification/stabilization ground, Xinqiao dewatering site and Xiawan dewatering site, however, these stations are temporary construction, which will be demolished at the end of regional soil remediation; during operation of solidification/stabilization ground and dewatering site, sediments should be dumped by layer, cover plate or protective greenbelt should be set in the position of concentrated odor source to mitigate malodorous impact; haulage road should be sprayed water to suppress dust. Low-noise equipment should be used; high-noise equipment should be allocated in the position far from residential area, handling operation route should be arranged logically to reduce noise disturbance of surrounding residents.

At present, there're 4 households residing within health protection distance from landfill; according to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, the land plot of these 4 households is planned as industrial and office land in the controlling detailed planning of ecotype new industrial city of Qingshui Lake, Zhuzhou City, and their houses will be demolished; before demolition of their houses, fugitive dust on the road by vehicle transport and landfill operation should be controlled strictly at landfill during construction period and operation period, spraying water, timed and quantified watering should be applied to suppress dust, transport vehicles should not be overloaded, no leakage and spill of carriage is allowed, vehicle should be covered with tarpaulin, road management should be strengthened, and damaged section of haulage road should be trimmed and repair if necessary.

12.2.1.2 Air Pollution Control Measures

According to project analysis, major ambient air pollution of the project includes dust produced by mixing and sieving operation during stabilization treatment, as well as malodor from reaction of dredged sediments during dewatering and stabilization dumping.

(1) Malodor

According to project analysis, main source of ambient air pollution of the project is malodor reaction of dredged sediments during dewatering and stabilization dumping. Due to the products of reductive malodorous substances (H2S and NH3) from decomposition of organic matters by microbes, such malodorous substances emit from the surface layer to the air environment, and emission mode of which belongs to unorganized emission non-point source.

It's recommended that the principle of dump by layer to be adopted to deposit surface sludge in the bottom of dump ground; malodor impact mainly occurs during depositing of surface sludge; malodor impact is minor by covering up bottom sludge; in addition, cover plate or protective greenbelt will be set in the position as concentrated odor source, main buildings as the odor source will be isolated or enclosed; also, leeward arrangement of facility structures will be considered in the design, greenbelt of flowers, grasses and trees will be constructed in surrounding areas to beautify the environment while isolate odor radiation, so as to mitigate environmental impact by the odor in an effective manner; therefore, malodorous gas of the project has minor impact on the objectives for air environmental protection.

(2) Mixing & sieving dust

To ensure water content of soil, sediment, waste residue and ingredients, automatic feeding is adopted for solidification mixing, finished mixture is stored in enclosed workshop; during solidification batching, water is added by ejecting around mixing tank; be taking above measures, fugitive dust is suppressed effectively, and these measures are workable.

(3) Fugitive dust at landfill

During fine and dry days, watering for dust suppression is advisable at landfill, which can remove more than 80% dust and mitigate negative impact of the dust on external environment. For road borne fugitive dust due to vehicle transport, spraying water and timed and quantified watering are effective for dust suppression during actual production; transport vehicles should not be overloaded, no leakage and spill of carriage is allowed, vehicle should be covered with tarpaulin, road management should be strengthened, and damaged section of haulage road should be trimmed and repair if necessary, and haulage road surface should be maintained in good condition, all are critical to dust suppression management.

12.2.2 Analysis of Noise Impact & Noise Pollution Control Measures

12.2.2.1 Forecast & Assessment of Noise Impact

12.2.2.1.1 noise source intensity

The noise level of crusher, mixer and vibrating screen used in Xinqiao solidification/stabilization ground of the project is about 85-90 dB(A); noise level of equipments such as excavator, bulldozer and the like used at landfill is about 80-90 dB(A); the noise level of transport vehicle is about 65-85dB(A).

Forecast and assessment of noise impact by bulldozer, excavator and transport vehicle are the same as those during construction period, read 8.1.4 for more details.

During operation period, noise source intensity of crusher, mixer and vibrating screen used in Xinqiao solidification/stabilization ground is as shown in **Table 12.2-9**.

Table 12.2-9 Noise Source Intensity during Operation Period

Equipment name	Value of sound level, dB(A)	Quantity	Operating position	Nearest distance from boundary (m)
Crusher	88	2	Xinqiao solidification/stabilization ground	N, 20
Mixer	92	2		N, 20
Vibrating screen	93	1		N, 20

12.2.2.1.2 Forecast Mode

according to Guidelines for Environmental Impact Assessment: Acoustic Environment (HJ 2.4-2009) , basic formula for noise forecast calculation is as follows:

(1) Basic formula for calculation of sound level at forecast point with single outdoor point source

$$L_p(r)=L_w+D_c-A$$

$$A= A_{div}+A_{atm} +A_{bar}+A_{gr} +A_{misc}$$

Where: $L_p(r)$ —octave band sound pressure level at forecast point, dB;

L_w—octave band sound power level, dB;

D_c—directional correction, dB;

A — octave band attenuation, dB;

A_{div}—octave band attenuation caused by geometric divergence, dB;

A_{atm}—octave band attenuation caused by atmospheric absorption, dB;

A_{gr}—octave band attenuation caused by ground effect, dB;

A_{bar}—octave band attenuation caused by sound barrier, dB;

A_{misc}—octave band attenuation caused by other diverse effects, dB.

（1） Method for calculation of equivalent sound power level of Indoor sound source and outdoor sound source

1 Calculation of octave band sound pressure level generated by a given indoor sound source close to enclosure structure

Lp2= Lp1- (TL+6)

Where: Lp2 —sound pressure level of a given outdoor octave band, dB;

Lp1 —sound pressure level of a given indoor octave band, dB;

TL—octave band sound insulation quantity by partition wall (Or window), dB.

2 Calculation of octave band sound pressure level generated by a given indoor sound source close to enclosure structure

$$Lp1 = Lw + 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right)$$

Where: Q —directional factor; in general, for omnidirectional sound source, when sound source is located at the center of the room, Q=1; when sound source is located at the center of a wall, Q=2; when sound source is located at the corner of two walls, Q=4; when sound source is located at the center of three walls, Q=8.

R—room constant; R =Sα/(1-α) , S=interior area of the room, ㎡; α=average sound absorption coefficient.

r—distance of sound source from a given point close to enclosure structure, m.

3 Calculation of indoor octave band superposed sound pressure with all indoor sound sources

$$L_{p1i}(T) = 10\lg\left(\sum_{j=1}^{N} 10^{0.1 L_{p1ij}}\right)$$

Where: LP1i (T)—superposed octave band sound pressure level i of N indoor sound sources close to enclosure, dB;

LP1ij (T)—octave band sound pressure level j of indoor sound source i, dB;

N—total number of indoor sound sources.

4Calculation of sound pressure level at a given point close to outdoor enclosure structure

LP2i (T)= LP1i (T)- (Tli+6)

Where: LP2i (T)—superposed octave band sound pressure level of N outdoor sound sources i close to enclosure structure, dB;

Tli—sound insulation quantity by octave band i close to enclosure structure, dB.

5Calculation of octave band sound power level of equivalent sound source at the center of sonolucent area (S) of equivalent outdoor sound source

Lw= LP2i (T) +10lgs

(3) Calculation of sound level at forecast point A

$$L_A(r)=10\lg\left\{\sum_{i=1}^{8}10^{[0.1L_{Pi}(r)-\Delta L_i]}\right\}$$

Where: $L_A(r)$ —sound level at forecast point (r) A, dB (A) ;

$L_{Pi}(r)$ —number i octave band sound pressure level at forecast point (r) , dB;

Δl_i—weighted network corrected value of i octave band at forecast point A, dB.

(4) Calculation of total sound pressure level at forecast point A

Assume number i outdoor sound source generating sound level L_{Ai} at forecast point A, working time ti of the sound source during time T; number j equivalent outdoor generating sound level sound source L_{Aj} at forecast point A, working time t_j of the sound source during time T; then, contribution value (L_{eqg}) of sound source with planned construction to forecast point is as follows:

$$L_{eqg}=10\lg\left[\frac{1}{T}\sum_{i=1}^{N}t_i10^{0.1L_{Ai}}+\sum_{j=1}^{M}t_j10^{0.1L_{Aj}}\right]$$

Where: t_j—working time of sound source j during time T, s;

t_i—working time of sound source i during time T, s;

T—T factored for calculation of equivalent sound level, s;

N—number of outdoor sound sources;

M—number of equivalent outdoor sound sources.

12.2.2.1.3 Analysis of Forecast Results

Base on noise forecast mode and equipment noise source, forecast is made with numerical value of environmental impact beyond solidification /stabilization ground by project related noise; monitored noise level at current monitoring point Z10 near solidification /stabilization ground is taken as background value; calculated results after superposition with background value are as shown in **Table 12.2-10** and **Table 12.2-11**.

Table 12.2-10 Forecast Results of Boundary Noise at Daytime, Unit: dB (A)

No.	Position of measuring point	Background value	Contribution value of impact	Forecast noise value
1	Eastern boundary	57.5	36.57	57.73
2	Southern boundary	57.5	36.49	57.53
3	Western boundary	57.5	35.62	57.53
4	Northern boundary	57.5	49.52	58.16
Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008), Class 3		65		

Table 12.2-11 Forecast Results of Boundary Noise at Nighttime, Unit: dB (A)

No.	Position of measuring point	Background value	Contribution value of impact	Forecast noise value
1	Eastern boundary	49.9	34.07	50.01
2	Southern boundary	49.9	31.02	49.96
3	Western boundary	49.9	33.62	49.96
4	Northern boundary	49.9	36.68	50.1
Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008), Class 3		55		

It's obvious from above forecast results that, noise generated by high-noise equipments in solidification/stabilization ground at daytime and nighttime after superposing with background noise complies with Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) , Class 3 (Daytime≤65dB(A), nighttime≤55dB(A)) .

12.2.2.2 Acoustic Pollution Control Measures

The noise level of crusher, mixer and vibrating screen used in Xinqiao solidification/stabilization ground of the project is about 85-90 dB(A); noise level of equipments such as excavator and bulldozer used at landfill is about 80-90 dB(A); the noise level of transport vehicle is about 65-85dB(A); following noise reduction measures are taken:

(1) In addition to meeting production requirement, low-noise equipments and machinery are used, imported high-quality low-noise equipments are used;

(2) According to the principle of separation of noisy and quiet equipments and machinery in Xinqiao solidification/stabilization ground as indicated on general arrangement, high-noise equipments are located far from boundary and internal office area as possible, and the impact of boundary noise is controlled by means of distance attenuation;

(3) Crusher, mixer, vibrating screen and like high-noise equipments are installed in the workshop, which acts as sound barrier for sound insulation, it's expected that this method may reduce noise to about 20-25dB(A);

(4) Shockproof cushions are added to the bottom of high-noise equipments, which may reduce noise to about 5～10dB(A);

(5) Maintenance management of noisy equipments is strengthened to avoid intensification of noise led by abnormal operation;

(6) Operation time at landfill is logically arranged; construction operation is banned at nighttime (22:00-6:00) ; construction operation is avoided at noon (12:00-14:00) and nighttime (19:00-22:00) ;

(7) Maintenance of construction machinery at landfill is strengthened by periodical examination and repair; construction equipments should be maintained immediately after discovery of abnormal operation to ensure normal operation;

(8) Traffic dispersion is strengthened, transport vehicles are management properly, and honking of solid waste handling vehicle on the road of landfill is reduced.

By taking above measures, boundary noise of the project can meet the requirements of Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) , Class 3. therefore, noise pollution control measures for the project are workable.

12.2.3 Analysis of Surface Water Environmental Impact & Pollution Control Measures

12.2.3.1 Forecast & Assessment of Surface Water Impact

Average output of wastewater from dewatering of heavy-metal contaminated sediment of the project is 55m^3/d, dewatering period is about 4 years, discharged wastewater complying with Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class 1., is discharged in the river nearby, and finally flows into Xiang River, which has minor impact on water quality and water flow of Xiang River.

The leaching pipe at landfill is connected to Qingshuitang industrial wastewater treatment and reclaiming plant for treatment; tail water is discharged to Xiang River; collected initial rainwater at all stations are recycled without discharging; Lavatory wash water from landfill is connected to Xiawan wastewater treatment plant for treatment, and tail water is discharged to Xiang River.

As the impact of tail water discharging on Xiang River has been forecast in environmental impact assessment of Qingshuitang industrial wastewater treatment and reclaiming plant and Xiawan wastewater treatment plant, no further forecast is made herein. During execution of the project, all wastewater can be connected to wastewater treatment plant for treatment before standard discharging, and imposes minor impact on Xiang River.

12.2.3.2 Surface Water Pollution Control Measures

12.2.3.2.1 Wastewater from Dewatering of Heavy-metal Contaminated Sediment

The wastewater output from dewatering of heavy-metal contaminated sediment is 79800m^3 (Average 55m^3/d) ; base on above analysis of the quality of wastewater from sediment dewatering, dewatering of heavy-metal contaminated sediment is planned to be achieved by treatment with mobile treatment equipment to Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class 1., before discharging to the river nearby.

Sediment dewatering treatment equipment is the same as dredging wastewater treatment equipment used during construction period; effectiveness analysis of these measures is described above.

12.2.3.2.2 Leaching at Landfill

Leaching is directly connected to Qingshuitang industrial wastewater treatment and reclaiming plant for further treatment; following is analysis of the feasibility of takeover.

1. Overview of Qingshuitang industrial wastewater treatment and reclaiming plant

Qingshuitang industrial wastewater treatment and reclaiming plant is located in Jianshe Village subject to Tongtangwan Subdistrict Office, Shifeng District, Zhuzhou City; design treatment capacity is 30,000m^3/d; at present, actual treatment capacity is about 15,900m^3/d, with 14,100 m^3/d to be supplemented; the scope of service is Qingshuitang Circular Economy Industrial Zone; treatment process is hydrolytic acidification+AO+MBR denitrification; treated effluent complies with Discharge Standard of Contaminations for Municipal Wastewater Treatment Plant (GB18918-2002) , Class 1., B.

Influent quality of wastewater treatment plant is shown in detail in **Table 12.2-12**; effluent quality should comply with requirement of Integrated Wastewater Discharge Standard》 (GB8978-1996) , Class I.

Table 12.2-12 Quality of Influent & Effluent of Wastewater Treatment Plant (Unit: mg/l, pH is Dimensionless)

No.	Contamination	Wastewater treatment plant takeover standard	Tail water discharge standard
1	pH	6-9	6-9
2	COD	100	60
3	SS	70	20
4	Total cadmium	0.1	0.01
5	Total chrome	1.5	0.1
6	Hg	0.05	0.001
7	Lead	1.0	0.1
8	Arsenic	0.5	0.1

2. Takeover feasibility:

(1) Scope of takeover

Qingshuitang industrial wastewater treatment and reclaiming plant mainly takes over industrial wastewater in Qingshuitang Circular Economy Industrial Zone. The project related dewatering site and landfill are located in Qingshuitang Circular Economy Industrial Zone, which is included in the scope of takeover by Qingshuitang industrial wastewater treatment and reclaiming plant.

(2) Feasibility analysis of takeover of wastewater quantity

At present, Qingshuitang industrial wastewater treatment and reclaiming plant has 14,100 m^3/d redundant wastewater treatment capacity; the project related wastewater output is 400m^3/d, accounting for 2.83% redundant wastewater treatment capacity of the wastewater treatment plant; therefore, Qingshuitang industrial wastewater treatment and reclaiming plant is fully able to accommodate the project related wastewater.

(3) Feasibility analysis of wastewater quality after treatment

Base on above analysis of wastewater quality after treatment, the quality of leaching and wastewater at landfill complies with the takeover requirements of Integrated Wastewater Discharge Standard (GB8978-1996) , Class I, and which will not cause major impact on treatment process of Qingshuitang industrial wastewater treatment and reclaiming plant.

(4) Status of pipe network laying

Municipal main sewage pipe has been constructed along Gongye Road within landfill of the project; sewage pipe network along Gongye Road is interconnected to Qingshuitang industrial wastewater treatment and reclaiming plant.

(5) Conclusion of feasibility analysis of takeover

Therefore, the quality of leaching and wastewater at landfill complies with the takeover requirements of Integrated Wastewater Discharge Standard (GB8978-1996) , Class I, and will not cause major impact on treatment process of Qingshuitang industrial wastewater treatment and reclaiming plant, and the wastewater treatment plant has redundant wastewater treatment capacity to accommodate the project related sediment dewatering wastewater as well as leaching wastewater at landfill; sewage pipe network of the wastewater treatment plant has be laid to the area in landfill; thus, it's feasible to take over leaching wastewater at landfill by Qingshuitang industrial wastewater treatment and reclaiming plant for further treatment.

12.2.3.2.3 Initial Rainwater at Various Stations

75m^3, 75m^3, 100m^3 and 180m^3 initial rainwater collecting tanks are constructed in Xinqiao solidification/stabilization treatment, Xinqiao dewatering site, Xiawan dewatering site and temporary piling area, respectively, and anti-seepage treatment is conducted. Road surface initial rainwater, after collecting by storm sewer, flows in primary rainwater cistern for temporary storage; all initial rainwater in solidification/stabilization ground is recycled in stabilization process; initial rainwater in dewatering site and temporary piling area is treated by mobile water treatment equipment and fully used for watering the road without discharging; subsequent rainwater and rainwater in other areas are discharged via rainwater diversion channel. Treatment measures are feasible.

12.2.3.2.4 Wastewater at Landfill

No construction quarters and eatery are built for the project, the staffs of solidification/stabilization ground and landfill live scattered in nearby rental houses, domestic sewage is discharged with other residents' domestic sewage to municipal sewer pipe network; no quantitative analysis is made herein.

Output of domestic sewage at landfill is about 934t/a; the planned water reclaiming system will converge domestic sewage (Wastewater) generated by daily operation of landfill for reclamation and recycling, which will be used for ground cleaning, flower watering, lavatory washing and etc at landfill without direct contact with human body, so as to improve utilization of water resource.

(1) Standard of water quality

The effluent wastewater quality complies with The Reuse of Urban Recycling Water: Water Quality Standard for Urban Miscellaneous Water Consumption (GB/T 18920-2002) as waster for lavatory washing, road cleaning and city greening, of which recycling water for lavatory washing miscellaneous water consumption is the highest in quality, which will apply to wastewater quality.

(2) Treatment process

Water recycling system at landfill consists of two independent subsystems for wastewater treatment and domestic sewage treatment; domestic washing and bathing wastewater and small part of domestic sewage are purified by traditional SBR treatment technology and membrane bioreactor technology of wastewater source, respectively, particular processes are illustrated in **Figure12.2-2**. this reclaimed water recycling system produces qualified reclaimed water and collects it in reclaimed water tank for direct use of lavatory washing, greening irrigation and road cleaning.

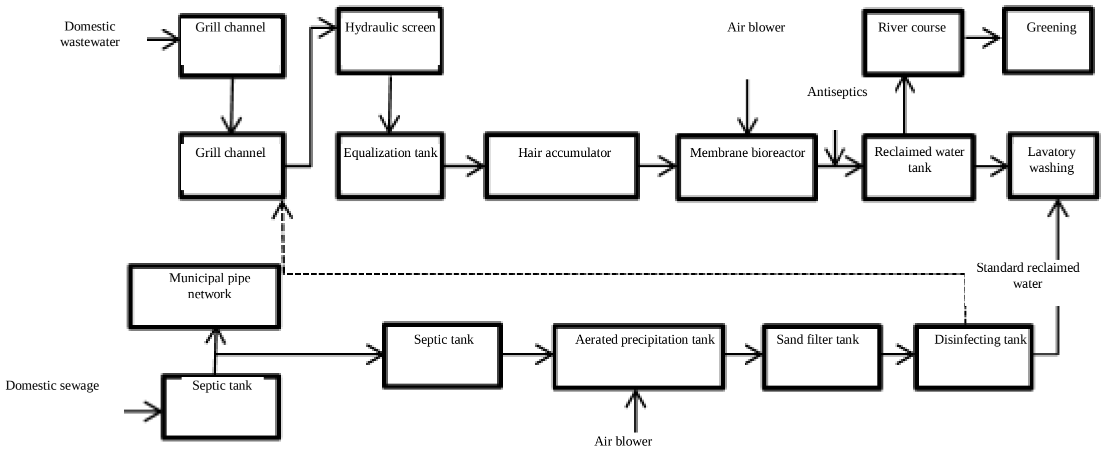


Figure12.2-2Reclaimed Water Recycling Treatment Process

After treatment in biochemical tank, lavatory washing wastewater enters in urban domestic sewage pipe network system under construction, and then enters in Xiawan wastewater treatment plant for further treatment.

(3) Treatment equipment

The project adopts buried integrated reclaimed water recycling equipment, several units for reclaimed water recycling treatment are integrated in one equipment; the equipment is characterized by compact structure, occupation of small land area, high automation, with logic system structure and powerful control function enabling proper control and stable and reliable operation of all equipments, as well as safe and valid recycling of reclaimed water. Full treatment flow path is buried type; after construction of underground part, the earth surface will be covered with vegetation, as part of outdoor landscape setting of the center.

12.2.4 Analysis of Groundwater Environmental Impact & Pollution Control Measures

12.2.4.1 Analysis of Groundwater Impact

Major groundwater environmental impact during operation period of the project is represented in the aspect of groundwater quality, main approaches of potential pollution are: seepage of wastewater from dewatering of heavy-metal contaminated sediment and leaching of dewatered remaining sludge by rainwater runoff may cause groundwater pollution; seepage of initial rainwater in solidification/stabilization ground will cause groundwater pollution; leaching at landfill will degrade groundwater quality; discharge of landfill, wastewater and solid waste may cause groundwater pollution.

(1) Wastewater from dewatering of heavy-metal contaminated sediment

Proper rainproof drainage measures have been taken and anti-seepage design has been incorporated for dewatering site of the project, which is effective in avoiding the impact on surrounding groundwater by the sewage in dewatering site; the part of content is introduced in detail in foregoing sections and not repeated here.

The wastewater from sediment dewatering needs to be treated according to Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class I before discharging to nearby area; although comprehensive anti-seepage measures are designed for dewatering site, wastewater in various wastewater pretreatment facilities may probably infiltrate in groundwater and cause groundwater environmental pollution. Therefore, the environmental impact assessment requires anti-seepage measures to be taken for all collecting tanks of wastewater from sediment dewatering, so as to avoid groundwater pollution by wastewater seepage.

(2) Dewatering sludge and initial rainwater in solidification/stabilization ground

Dewatering sludge is mainly delivered to stabilized/solidification plant for treatment; before treatment, dewatering sludge needs to be stored temporarily in the dump of stabilized/solidification plant; leaching after rainwater runoff may cause adverse impact on groundwater.

The ground of treatment field is hardened and able to prevent sewage filtration. Road surface initial rainwater in stabilization ground is collected in storm sewer, and then enters in primary rainwater cistern after temporary storage, and then reused without discharging.

Therefore, dewatering sludge and initial rainwater in solidification/stabilization ground basically has no impact on groundwater.

(3) Leaching in solid waste temporary storage site and landfill

According to the design of feasibility study, solid waste is temporarily stored in modular houses for enclosed storage in the solid waste temporary storage site of the project, thus rainwater leaching will not occur; moreover, geotube—300mm gravel drainage layer—600g/m^2 non-woven polypropylene filament—2mm gloss HDPE geomembrane—600g/m^2 non-woven polypropylene filament—foundation anti-seepage system are designed from top to bottom, which is effective to prevent the impact on groundwater by the water contained in solid waste.

According to the calculations in the section of project analysis, leaching output at landfill of the project is about 400m^3/d. Solid waste at landfill belongs to “Class Ⅱ general industrial solid waste”, which will not cause excess leaching, but leaching seepage may still cause groundwater pollution. According to the requirements for landfill of Class Ⅱ general industrial solid waste, landfill of the project is designed reservoir bed anti-seepage construction with anti-seepage system and leaching treatment system; in general case, there’s no seepage impact; possible seepage impact is only with regulation of leaching in emergency reaction tank; by taking proper anti-seepage measures for equalization tank, leaching at landfill will impose minor impact on groundwater.

(4) Wastewater and domestic waste at landfill

Wastewater at landfill is composed mainly of domestic sewage (Wastewater), output of wastewater is about 934t/a; washing and bathing water and small part of domestic sewage are treated by buried integrated reclaimed water recycling equipment and then reused for lavatory washing, greening irrigation and road cleaning; lavatory washing wastewater is treated in biochemical tank before entering in urban domestic sewage pipe network system under construction, and finally delivered to Xiawan wastewater treatment plant for further treatment; garbage dumps (Bins) are set at many points of landfill; domestic waste is timely handled to municipal waste transfer station, cleared and carried away by sanitation department; output of domestic waste is cleared and carried away on a daily basis; according to above analysis, wastewater and domestic waste at landfill can be treated effectively and basically have no impact on groundwater.

12.2.4.2 Groundwater Pollution Control Measures

(1) Heavy-metal contaminated sediment dewatering wastewater

Geomembrane or body hardening anti-seepage measures are taken for collecting tank of wastewater from dewatering of heavy-metal contaminated sediment, so as to prevent wastewater seepage. Anti-seepage performance equivalent to filtration coefficient of 1.0×-7cm/s and 1.5m thick clay layer should be achieved.

(2) Dewatering sludge and initial rainwater in solidification/stabilization ground

Anti-seepage performance of existing hardened solidification/stabilization ground should be tested, if existing ground fails to meet the standard, it should be hardened to achieve anti-seepage performance equivalent to filtration coefficient of 1.0×-7cm/s and 1.5m thick clay layer. 75m^3, 75m^3, 100m^3 and 180m^3 initial rainwater collecting tank are constructed for Xinqiao solidification/stabilization plant, Xinqiao dewatering site, Xiawan dewatering site and temporary piling area, respectively, and anti-seepage treatment is conducted. Road surface initial rainwater in stabilization ground is collected in storm sewer, and then enters in primary rainwater cistern for temporary storage, and finally reused in stabilization process without discharging.

(3) Leaching in solid waste temporary storage site

Solid waste is temporarily stored in modular houses for enclosed storage in the solid waste temporary storage site of the project, thus rainwater leaching will not occur; moreover, geotube—300mm gravel drainage layer—600g/m^2 non-woven polypropylene filament—2mm gloss HDPE geomembrane—600g/m^2 non-woven polypropylene filament—foundation anti-seepage system are designed from top to bottom. According to feasibility study report, the project related solid waste belongs to Class Ⅱ general industrial solid waste, however, the type of solid waste temporary storage site is not mentioned in feasibility study report, for this reason, the environmental impact assessment requires that, according to Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes (GB1859-2001) , relevant requirements on deposit site of Class Ⅱ general solid waste should be revised for construction of solid waste temporary storage site.

(4) Leaching at landfill

1) Anti-seepage system of landfill

The landfill of the project should be constructed according to requirements for Class Ⅱ general industrial solid waste landfill. However, due to the project is featured by complex terrain, steep slope and bare rocks, and in order to ensure safety and long-term stability of the project, bottom anti-seepage treatment should be carried out by setup of double anti-seepage structure, and slope base should be reinforced by anchoring shotcrete treatment.

a. Bottom anti-seepage measures

On 1.0m thick backfill of clay bed, one layer of 4800g/m^2 GCL should be paved, covered with one layer of 600g/m^2 filament non-woven geotextile, one layer of 2.0mm HDPE membrane, one layer of 2.0mm HDPE membrane, and then one layer of 600 g/m^2 filament non-woven geotextile, as anti-seepage structure of leaching;

On main anti-seepage system, one layer of 7mm thick compound geomembrane drainage net should be paved to accelerate horizontal drainage, covered with one layer of 0.3m thick graded gravel-HDPE conduit as leaching collecting system;

On leaching collecting system, one protective layer of 200 g/m^2 woven filter geotextile should be paved, covered with solid waste landfill.

b. Slope anti-seepage measures

The topsoil vegetation in planned fill area of slope should be cleared, and then reinforced by anchoring shotcrete treatment; the surface layer should be flat and smooth;

The anti-seepage mode similar to that of reservoir bottom should be adopted for the slope of general valley-type or pit-type waste landfill, i.e. pavement of HDPE membrane; one end of HDPE membrane is positioned and fixed by the anchors on both ends of each section of slope; for rocky foundation, the form of anchorage trench is adopted in most cases; on concrete, brick-stone structure and reliable rock bed, it’s generally fastened with cinch bolt, fastener or special HDPE buried locking bar; reservoir area of the project is featured by side retaining wall of steep slope and compact rocks, it’s difficult for excavation of anchorage trench; what’s more, the cliff surface is too rough to take other anchorage measures, even if it’s leveled by shotcrete, it’s hard to gain overall levelness as that of the surface of concrete and brick-stone structure, and it’s difficult to pave membrane, as a result, special anti-seepage measures need to be taken for side retaining wall in reservoir area of the project; base on these engineering features, the project design incorporates “concrete + inorganic penetration-resistant agent ” for anti-seepage treatment of side retaining wall, namely, first fully fill the cliff fractures with cement mortar, then pour one layer of 30cm C30 concrete, and finally paste one layer of 1mm thick 1.2kg/m^2 inorganic penetration-resistant agent.

2) Leaching treatment construction

a. Water-sewage separation system

in order to ensure safe flood control of solid waste landfill, and reduce the volume of influent rainwater runoff, maintain minimum volume of leaching, one flood intercepting trench should be constructed around solid waste reservoir; according to Design Specification for Urban Flood Control Project (GB/T50805-2012) , design flood control standard of the project is 50-year recurrence, and checking flood control standard of the project is 100-year recurrence; flood flow is calculated by corresponding frequency of daily rainfall, base on which section size of flood intercepting trench is determined; given the feature of surrounding terrain on pit roof, one flood intercepting trench is constructed circumferentially along the reservoir ; the size of flood intercepting trench is a trapeziform section, width of lower side is 300mm, width of upper side is 800mm, 500mm in depth, slope 1～5; intercepted rainwater is drained by sections to nearby area; if the slope of waste pit is sufficiently small, flood intercepting trench should be constructed along 30m, 40m, 50m and 60m contour lines, respectively; at first, excavate 30m flood intercepting trench, drain form above solid waste to the area beyond the reservoir; when landfill level of solid waste reaches to 30m, flood intercepting trench will be gradually buried in solid waste and reconstructed to act as blind trench of leaching; then, 40m level flood intercepting trench is constructed and connected to reserved flood intercepting trench along outer side of solid waste slope; to repeat the process, until 60m level flood intercepting trench on pit roof becomes permanent flood intercepting trench.

b. Leaching collecting system

In order to drain and collect more landfill gas and leaching in the waste, intermediate drainage gravel blind ditch should be constructed for each 30m additional waste; lay DN200 UPVC pipe inside blind ditch, fill with 30～100mm gravel, and cover with one layer of 150g/m^2 inverted filter geotextile; as intermediate blind ditch is laid above intermediate cover, leaching collected in this layer may also flow into vertical gabion well via blind ditch, and then flows in blind ditch collecting system on reservoir bottom; two leaching collecting main blind ditches are constructed in the lowest part of landfill, of which one blind ditch runs from south to north, and the other blind ditch runs from east to west; main blind ditch of upper platform is connected to main blind ditch of the lowest platform with DN300 HDPE pipe; trapeziform section is adopted for main blind ditch, width of lower side is 500mm, width of upper side is 1250mm, 500mm in depth, bury DN300 perforated HDPE pipe in main blind ditch, then bury DN300 perforated HDPE pipe; circumferentially cover drainage pipe withΦ20～50mm gravel, and form inverted structure with Φ9～20mm gravel before backfilling gravel, moderate coarse sand to flush with the ditch, then longitudinal main blind ditch is formed; branch blind ditch traverses across main blind ditch, with trapeziform section, width of lower side is 400mm, width of upper side is 1000mm, 400mm in depth, the construction method is identical to that of main blind ditch. The slope of main and branch blind ditches should not be less than 2%.

c. Leaching collecting tank

base on terrain features of landfill, one leaching collecting well is constructed in northwest corner and south of landfill, respectively.

d. Effluent wastewater quality and treatment process

As the landfill solid waste belongs to “Class Ⅱ general industrial solid waste”, contamination concentration in leaching is lower than maximum permissible discharge concentration as stated in integrated wastewater discharge standard, thus, no further treatment is necessary, and directly discharging in collecting pipe of industrial wastewater treatment plant is permissible. However, for the sake of control of risk, a new emergency treatment tank will be built for simple treatment of leaching before discharging in emergency.

e. Treatment scale

after treatment in equalization tank, maximum scale of leaching is $400m^3/d$.

f. Treatment equipment

As all contaminated soil and sediment belong to Class Ⅱ industrial solid waste, without excess leaching, and $1\times500m^3$ equalizing pond is built for drainage of seeper, it is changed to use as emergency reaction tank for leaching equalization, which directly discharge under normal condition, and discharges after adding chemical in emergency; to prevent filtration of seeper in equalizing pond to underground area, geomembrane pavement or body hardening of equalizing pond is required.

3) In addition to proper anti-seepage construction and leaching treatment measures, it’s necessary for regular inspection and maintenance of anti-seepage construction, leaching collection and drainage facilities, leaching treatment facility, regular monitoring of leaching effluent and quality of treated leaching; immediately upon discovery of obstructed collection and drainage facilities or quality of treated leaching beyond the limit of local contamination emission standard, remedial measures should be taken.

After taking above measures, solid waste landfill is basically free from leaching filtration of, and will not cause groundwater pollution.

12.2.5 Analysis of Solid Waste Impact & Pollution Control Measures

Garbage dumps (Bins) are set at many points of landfill; domestic waste is timely handled to municipal waste transfer station, cleared and carried away by sanitation department; output of domestic waste is cleared and carried away on a daily basis.

Therefore, output of solid waste of the project can be disposed effectively, and solid waste control measures are workable.

12.2.6 Analysis of Soil Secondary Pollution Control Measures

Full consideration should be given to secondary pollution control measures during cutting, clearing and disposal of contaminated soil:

(1) Maintain frequent watering in surrounding areas of excavation site, haulage road and vehicle turnaround area, so as to suppress fugitive dust;

(2) Strictly limit the range of activity of excavators and transport vehicles, so as to prevent contaminated soil being carried to other areas within or beyond excavation site;

(3) Make effective precipitation before excavation of foundation pit, so as to prevent disturbed soil from giving rise to new groundwater pollution;

(4) Slow down and lower the fall during loading/unloading soil, so as to reduce spreading of artificial secondary pollution;

(5) Set cleaning pond at the exit of work area for timely clearing and cleaning of types of construction vehicles and transport vehicles, as well as contaminated soil tainted in other parts, so as to reduce inactive transport of contaminated soil;

(6) Carefully cover contaminated soil loaded in the vehicle with tarpaulin before transportation, so as to prevent soil spill;

(7) Cover the soil in temporary staging area with tarpaulin, so as to prevent contaminations from spreading in the air;

(8) At the end of work in each day, clean apparatuses directly contacting contaminated soil during work, and collect contaminated soil to store in appointed area;

(9) Do not carry out construction during strong wind or rain, cover excavated earth with

tarpaulin, so as to reduce fugitive dust or rainwater runoff, and avoid occurrence of secondary pollution.

12.2.7 Social & Environmental Impact during Operation Period

1. Impact on Local Economic Development

Integrated control of Qingshuitang heavy-metal pollution is the precondition for construction of Circular Economy Industrial Zone, directed related to radical transformation of economic restructuring and economic growth mode in Zhuzhou City, matters further progress of construction of "resource-conserving and environment-friendly" society and cultivation and development of strategic emerging industries, which will drive in all aspects the development of circular economy and environmental protection industries in Hunan Province, play demonstration role in pollution control and ecological restoration of heavy chemical regions in China. Upon execution of the planning, all traditional enterprises of high energy consumption and massive pollution will retreat from core area for development of modern logistic industry, industrial building economy and ecological commercial housing format; 500 ㎡ commercial buildings with estimated RMB100.0 billion total logistic trade volume and RMB50.0 billion total industrial production value will be constructed within 10 years.

2. Impact of the project on Standard of Living and Life Quality of Local Residents

By integrated control of Qingshuitang heavy-metal pollution, full efforts will be made to drive further environmental protection for the good of public livelihood, a lot of environmental protection problems will be solved, and public satisfaction to environmental protection will be increased; the citizens will be able to breathe refreshing air, cherish clean soil, drink high-quality and safe water, and experience in every aspect environmental improvement from environmental protection technology.

3. The Project Increase Job Opportunities for Local Residents

Inevitably, urban construction necessitates land occupation and housing demolition, which could cause population migration and resettlement of labor in construction area; with the progress of urban construction, land property is changed from agricultural land to urban land, and the farmers are transformed from farming to service, employee and businessman, thus social impact of the project is permissible; in the long run, development in project area will provide local residents with new job opportunities.

4. Analysis of Impact from Land Use

Comprehensive consideration is given to multiple important factors such as requirements for ecological benefit, soil improvement, water pollution control, solid waste landfilling, ecological landscape construction and controlling detailed planning with regard to heavy-metal pollution control of Qingshuitang Industrial Zone, and corresponding restructuring is made with land use for urban development land. From the perspective of overall situation and long-term benefit, with all land plots in project area as the object, and center on effective land use, general arrangement and long-term planning are conducted in the aspects of development, utilization, control and protection of land recourse, macro-regulation and plan management of land use are strengthened, construction of supporting municipal infrastructure is configured scientifically, urban development space is expanded, so as to strongly support future development.

12.3Measures during Closing Period of Landfill

12.3.1 Construction Measures

Upon expiry of service period of landfill, earthing and planting will be carried out on the basis of ensuring ecological safety of landfill; earthing of landfill will be carried out in a planned manner, when earthing and vegetation planting procedures should be followed to spread the soil on leveled earthing area for growing vegetation; to prevent direct exposure and rainwater filtration of landfill, the topsoil should be overburdened for twice during closing period, of which the first overburden is isolation layer of 20~45cm thick clay, compacted to prevent infiltration of rainwater in dry residues; the second overburden is the cover of natural soil in favor of plant growth, the thickness of the second overburden depends on the species of plant.

12.3.2 Management Measures

(1) Closing design and construction plan of landfill should conform to applicable national laws, regulations and technical specifications.

(2) Closing construction should not be commenced until qualified examination of closing design and construction plan of landfill by safe production supervisory and regulatory department.

(3) Upon completion of closing construction of landfill, it must be reported to safe production supervisory and regulatory department, which will organize construction acceptance, and closing is allowed only after satisfactory acceptance.

(4) Safety management of closed landfill is the responsibility of the enterprise in question; in case of reuse or refitting of closed landfill, it must be demonstrated by feasibility design and reported to safe production supervisory and regulatory department for examination and approval.

(5) Warning signs should be posted around closed landfill.

12.3.3 Wastewater Treatment Measures for Closed Landfill

Full-time staffs should be assigned to watch closed landfill, and such staffs should not evacuate until whole treatment procedure is completed.

After closing of landfill, leaching monitoring system should be maintained continuous normal operation, until stabilized water quality is obtained; groundwater monitoring system should be maintained continuous normal operation.

12.4Environmental Impact on Remediation Area in Project Area by Enterprise in Production

Upon execution of the project, land parcels in various areas of Qingshuitang Industrial Zone will achieve clearing target value in the planning of type of land use, and potential risk of soil and groundwater pollution will be basically eliminated. Due to there’re numerous enterprises in and out of the project area, represented by Zhuzhou Kangli Smelting Plant and CNSIC Zhuzhou Chemical Plant, if contaminations such as exhaust gas, wastewater, waste residue and etc are discharged not in compliance with corresponding standard during production of these enterprises, they’re likely to cause air pollution, surface water pollution, soil contamination and groundwater environmental pollution in the project area.

In order to prevent environmental pollution by the enterprises in operation in and out of the project area, following suggestions are proposed in the environmental impact assessment:

(1) The enterprises in operation should properly control production pollution. Qualified enterprises may arrange internal wastewater and waste residue treatment facility and field for standard discharge of wastewater and safe disposal of waste residue; remaining enterprises should treat their own output of wastewater and waste residue by sewage conduit of

wastewater treatment plant and with the help of qualified solid waste treatment unit, so as to realize standard discharge of contaminations; furthermore, the enterprises are required to ensure ground hardening, strengthen sewage and waste residue treatment facility and field, as well as sewage conduit anti-seepage treatment and daily maintenance and servicing, so as to ensure normal operation of pollution control facility, prevent spillage, overflow, dropping and leakage of sewage, and eradicate the output of pollution from the source.

(2) With enactment of newly revised Environmental Protection Law of the People's Republic of China, punishment is more stringent than in the past against contamination discharging unit violating the law. However, a few enterprises secretly discharge nonstandard contaminations in fluke mind for evasion of legal sanction; therefore, it's necessary for environmental protection department working with industrial park to strengthen supervision and management of enterprises in and out of the project area, conduct regular and irregular inspection of normal operation of pollution control facility as well as standard discharge of contaminations by these enterprises; also, environmental supervision and management officers should be engaged by groups to take charge strict supervision and management of unlawful acts leading to wastewater, exhaust gas and noise pollution.

(3) Accelerate industrial transformation and relocation progress

For control of enterprises as pollution source in project area, planned control construction should be carried out on the principle of industrial transformation of core enterprises, relocation and upgrading of pillar enterprises and closing and transformation of small-and-medium enterprises SMEs in the short term.

There's only one core enterprise, namely, Zhuzhou Kangli Smelting Plant; polluting production line will be closed in the short term, and rough machining smelting production line with highly polluting emission will be eliminated, so as to achieve the objective of transformation to find smelting.

There're seven pillars enterprises, including Zhuzhou Mingzhu Concentration Plant, Zhuzhou Ironworks, Hunan Haohua Chemical Co., Ltd, Hunan Haili Chemical Industry Co., Ltd, CNSIC Zhuzhou Chemical Plant, Liuzhou (Zhongcheng) Chemical Industry Co., Ltd and Liuzhou (Zhicheng) Chemical Industry Co., Ltd; in the short term, headquarters of key pillar enterprises supporting the development of industrial zone are reserved, development of headquarters economy and industrial transformation are given priority; production line of pillar enterprises will be moved to other places step by step.

For small-and-medium enterprises, more than 100 small-and-medium enterprises in project area will be closed and relocated by means of governmental guidance, social supervision, enterprise discretion and supporting policy, so as to reduce pollution source effectively.

The land of enterprise premises will be planned again after remediation, so as to eliminate local contamination impact from the source.

By taking above measures, industrial pollution source of the enterprises in operation in and out of the project area can be controlled effectively, and prevent environmental impact in the project area from contaminations discharged by the enterprises in operation.

12.5Water and Soil Conservation Measures

According to Report on Water and Soil Conservation Plan, various temporary protection measures will be supplemented and improved on the basis of the design in feasibility study, so as to reduce soil erosion; consideration should be given to following aspects with control measures:

(1) Logically arrange construction season, avoid construction in rainy season as possible; strengthen preparation of construction protection and drainage in the progress of construction, ensure free drainage during construction period, avoid occurrence of waterlogging of working face in seeper;

(2) Earthwork should be carried out with timely protection, handling, backfilling and compaction immediately after excavation, without loose earth, and shorten exposure of uncovered soil area;

(3) Logically arrange construction progress, properly coordinate various construction procedures, timely complete supporting water and soil conservation measures on the principle of “three- simultaneousness” in terms of compact and orderly working procedures, so as to reduce the amount of soil erosion during construction period;

(4) Optimize earthwork balance of main construction, avoid casual excavation and littering of spoil, and reduce occurrence of artificial soil erosion as possible.

12.5.1 Xiangshiling Sub-region

Control area of Xiangshiling sub-region is 10.06hm^2, consisting of closed enterprise sites and other contaminated soil control area; the closed enterprise sites are mainly planned as Class 2. residential land and protection greenbelt, for planned Class 2. residential land with P≥1.5, soil in this area is treated by ex-situ stabilization/solidification or incineration;

closed enterprise areas are treated by ex-situ stabilization plus cappting.

(1.) Disposal of Control Measures

(1) Disposal of water and soil conservation listed and included in the plan

a). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

b). After ex-situ treatment of contaminated soil, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During ex-situ treatment of contaminated soil, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

(2.) Control quantity

a). Planting measures

10 dogbanes, 7 crape myrtles and 8 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 0.16hm^2.

b). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; the plan includes additional 182m temporary masonry drainage ditch, 1 temporary masonry grit chamber, 0.16hm^2 compound geomembrane covering and 559 baffle plates.

Table 12.5-1 Statistics of Water and Soil Conservation Measures for Xiangshiling Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm^2</td><td>0.16</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>10</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>7</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>8</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>182</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m^3</td><td>102</td><td></td></tr>
<tr><td>Shove joint</td><td>m^3</td><td>39</td><td></td></tr>
</table>

		brickwork			
3	Grit chamber	Masonry grit chamber	Chamber	1	Additional
		Earth excavation	m3	9	
		Shove joint brickwork	m^3	6	
4	Covering with compound geomembrane		hm^2	0.16	Additional
5	Baffle plate		Plate	559	Additional

12.5.2 Qingshi Sub-region

Control area of Qingshi sub-region is 8.89hm^2, composed of closed facilities control area and other control area; control areas are mainly planned as Class 1. logistic and warehousing land, commercial facility land, urban road land, park greenbelt and power supply land, of which the soil in planned Class 1. logistic and warehousing land with P≥2 is treated by ex-situ stabilization/solidification.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

b). After ex-situ treatment of contaminated soil, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.;

(2) Disposal of additional water and soil conservation in the plan

a). During ex-situ treatment of contaminated soil, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

(II) Control quantity

a). Planting measures

153 dogbanes, 109 crape myrtles and 121 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 2.35hm^2.

b). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; the plan includes additional 1358m temporary masonry drainage ditch, 6 temporary masonry grit chambers, 2.35hm2 compound geomembrane covering and 945 baffle plates.

Table 12.5-2 Statistics of Water and Soil Conservation Measures for Qingshi Sub-region

No.	Measures and construction type		Unit	Quantity	Remark
1.	Planting measures				
1	Planting area		hm2	2.35	Existing
2	Dogbane		Tree	153	Existing
3	Crape myrtle		Tree	109	Existing
4	Cinnamomum camphora		Tree	121	Existing
2.	Temporary measures				
1	Vehicle washing trough		Trough	2	Existing
2	Temporary drainage ditch	Masonry drainage ditch	m	1385	Additional
		Earth excavation	m3	776	
		Shove joint brickwork	m3	299	
3	grit chamber	Masonry grit chamber	Chamber	6	Additional
		earth excavation	m3	51	
		shove joint brickwork	m3	33	
4	Covering with compound geomembrane		hm2	2.35	Additional
5	Baffle plate		Plate	945	Additional

12.5.3 Tongtangwan Sub-region

Control area of Tongtangwan sub-region is 61.84hm^2, composed of pond control area, ditch control area, closed facilities control area and other contaminated soil control areas.

The control areas are mainly planned as water area, greenbelt, port land, administration office land, commercial facility land, square land and urban road land, of which the soil in the area of planned commercial land, road, utility land with P≥2 is treated by ex-situ stabilization/solidification; the soil in the area of planned water area with P≥1.5 is treated by ex-situ stabilization/solidification; the soil in the area of planned water area with 1<P≤1.5 is relocated to solid waste landfill for landfilling; the soil in other control areas is treated by in-situ stabilization or ecological restoration technology.

The area causing pollution to the mountain is controlled by ecological interception; ecological intercepting ditch mainly functions for collecting non-point source pollution runoff, and pretreatment of collected runoff.

Control area of pond, by dredging of dry pond, and measures are taken to reduce disturbance to pond bed, pumped pond seeper is treated by mobile wastewater treatment equipment, after water quality is in compliance with Class III surface water after testing, it's discharged to Xiawangang.

Control area of channels is 2.93 hm^2, the channels involved are old Xiawangang and Xinqiao low discharge channel downstream section; sectional cofferdam construction is adopted; after cofferdam construction, cofferdam upstream port water is pumped to downstream river course, and measures are taken to reduce disturbance to downstream riverbed; DN1000 HDPE pipe is sued as temporary diversion pipe; it's 300m long and reusable.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). Ecological intercepting ditch is constructed around the area causing pollution to the mountain.

b). During the control of channel sediment, DN1000 HDPE diversion pipe is sued; it's 300m long and reusable.

c). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

d). After treatment of contaminated soil by ex-situ control or displacement to solid waste landfill, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During ex-situ treatment of contaminated soil, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

d). During the control of pond sediment, in order to solve the problem of channel or drain outlet along pond, each drain outlet is blocked with sandbag, surrounding channels converging to pond channel is diverted to downstream channel by pumping; DN1000 HDPE pipe is used as temporary diversion pipe; it's 300m long and reusable.

(II) Control quantity

a). Construction measures

677m ecological intercepting ditch is designed for main construction.

b). Plant measures

1634 dogbanes, 1163 crape myrtles and 1292 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 25.09hm2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; together with 100m DN1000 HDPE diversion pipe and 300m DN1000 HDPE diversion pipe; the plan includes additional 6780m temporary masonry drainage ditch, 23 temporary masonry grit chambers, 25.09hm^2 compound geomembrane covering and 5472 baffle plates.

Table 12.5-3 Statistics of Water and Soil Conservation Measures for Tongtangwan Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Construction measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Ecological intercepting ditch</td><td>m</td><td>677</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm2</td><td>25.09</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>1634</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>1163</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>1292</td><td>Existing</td></tr>
<tr><td>3.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">DN1000 HDPE diversion pipe</td><td>m</td><td>100</td><td>Existing, reusable</td></tr>
<tr><td>3</td><td colspan="2">DN600 HDPE diversion pipe</td><td>m</td><td>300</td><td>Additional, reusable</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>6780</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>3797</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>1464</td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Grit chamber</td><td>Masonry grit chamber</td><td>Chamber</td><td>23</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>197</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>128</td><td></td></tr>
<tr><td>6</td><td colspan="2">Covering with compound geomembrane</td><td>hm2</td><td>25.09</td><td>新增</td></tr>
<tr><td>7</td><td colspan="2">Baffle plate</td><td>Plate</td><td>5472</td><td>新增</td></tr>
</table>

12.5.4 Tongxia Sub-region

Control area of Tongtangwan sub-region is 5.16hm^2, composed of pond control area, channel control area, closed facilities control area, waste residue site control area and other contaminated soil control areas.

The control area is mainly planned as water area, greenbelt, commercial facility land, gymnasium land, Class 1. industrial land, Class 2. residential land, urban road land and etc, of which the soil in the area for planned residential land and culture & education land is treated by ex-situ control; the soil in the area of planned commercial land, road and utility land with $P \geq 2$ is treated by ex-situ stabilization/solidification; the soil in the area of planned water area with $P \geq 1.5$ is treated by ex-situ stabilization/solidification; the soil in the area of planned water area with $1 < P \leq 1.5$ is displaced to solid waste landfill for landfilling; the soil in other control areas is treated by in-situ stabilization or ecological restoration technology.

The area causing pollution to the mountain is controlled by ecological interception; ecological intercepting ditch mainly functions for collecting non-point source pollution runoff, and pretreatment of collected runoff.

Control area of pond by dredging of dry pond, and measures are taken to reduce disturbance to pond bed, pumped pond seeper is treated by mobile wastewater treatment equipment, after water quality is in compliance with Class III surface water after testing, it's discharged to Xiawangang.

Channel control area is 1.21hm^2, the channels involved are old Xiawangang and Xinqiao low discharge channel downstream section; sectional cofferdam construction is adopted; after cofferdam construction, cofferdam upstream port water is pumped to downstream river course, and measures are taken to reduce disturbance to downstream riverbed; DN1000 HDPE pipe is sued as temporary diversion pipe; it's 300m long and reusable.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). Ecological intercepting ditch is constructed around the area causing pollution to the mountain;

b). During the control of channel sediment, DN1000 HDPE diversion pipe is used; it's 300m long and reusable;

c). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

d). After treatment of contaminated soil by ex-situ control or displacement to solid waste landfill, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During contaminated soil construction by ex-situ control or displacement to solid waste landfill, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ control of contaminated soil or displacement to solid waste landfill, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

d). During the control of pond sediment, in order to solve the problem of channel or drain outlet along pond, each drain outlet is blocked with sandbag, surrounding channels converging to pond channel is diverted to downstream channel by pumping; DN1000 HDPE pipe is used as temporary diversion pipe; it’s 400m long and reusable.

(2.) Control quantity

a). Construction measures

670m ecological intercepting ditch is designed for main construction.

b). Planting measures

1012 dogbanes, 721 crape myrtles and 800 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 15.54hm^2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; together with 100m DN1000 HDPE diversion pipe and 300m DN1000 HDPE diversion pipe; the plan includes additional 3652m temporary masonry drainage ditch, 12 temporary masonry grit chambers, 15.54hm^2 compound geomembrane covering and 3502 baffle plates.

Table 12.5-4 Statistics of Water and Soil Conservation Measures for Tongxia Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Construction measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Ecological intercepting ditch</td><td>m</td><td>670</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm2</td><td>15.54</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>1012</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>721</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>800</td><td>Existing</td></tr>
<tr><td>3.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">DN1000 HDPE diversion pipe</td><td>m</td><td>100</td><td>Existing, reusable</td></tr>
<tr><td>3</td><td colspan="2">DN600 HDPE diversion pipe</td><td>m</td><td>400</td><td>Additional, reusable</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>3652</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>2045</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>789</td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Grit chamber</td><td>Masonry grit chamber</td><td>Chamber</td><td>12</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>103</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>67</td><td></td></tr>
<tr><td>6</td><td colspan="2">Covering with compound geomembrane</td><td>hm2</td><td>15.54</td><td>Additional</td></tr>
<tr><td>7</td><td colspan="2">Baffle plate</td><td>Plate</td><td>3502</td><td>Additional</td></tr>
</table>

12.5.5 Qingshui Sub-region

Control area of Qingshui sub-region is 53.13hm^2, composed of pond control area, channel control area and other contaminated soil control areas.

The control area is mainly planned as Class 2. residential land, commercial facility land, Class 1. industrial land and etc, of which the soil of planned residential land is controlled by ex-situ control; the soil in the planned area of commercial land, road and utility land with P≥2 is controlled by ex-situ stabilization/solidification; the soil in other control areas is controlled by in-situ stabilization treatment or ecological restoration technology.

The area causing pollution to the mountain is controlled by ecological interception; ecological intercepting ditch mainly functions for collecting non-point source pollution runoff, and pretreatment of collected runoff.

Control area of pond by dredging of dry pond, and measures are taken to reduce disturbance to pond bed, pumped pond seeper is treated by mobile wastewater treatment equipment, after water quality is in compliance with Class III surface water after testing, it's discharged to Xiawangang.

Channel control area is 1.81hm2, the channels involved are old Xiawangang and Xinqiao low discharge channel downstream section; sectional cofferdam construction is adopted; after cofferdam construction, cofferdam upstream port water is pumped to downstream river course, and measures are taken to reduce disturbance to downstream riverbed; DN1000 HDPE pipe is used as temporary diversion pipe; it's 300m long and reusable.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). Ecological intercepting ditch is constructed around the area causing pollution to the mountain and at solid waste landfill;

b). During the control of channel sediment, DN1000 HDPE diversion pipe is used; it's 300 m long and reusable;

c). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

d). After ex-situ treatment of contaminated soil or displacement to solid waste landfill, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During contaminated soil construction by ex-situ control or displacement to solid waste landfill, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil or displacement to solid waste landfill, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

d). During the control of pond sediment, in order to solve the problem of channel or drain outlet along pond, each drain outlet is blocked with sandbag, surrounding channels converging to pond channel is diverted to downstream channel by pumping; DN1000 HDPE pipe is used as temporary diversion pipe; it's 600m long and reusable.

(2.) Control quantity

a). Construction measures

3291m ecological intercepting ditch is designed for main construction.

b). Planting measures

1068 dogbanes, 760 crape myrtles and 844 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 16.39hm^2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; together with 100m DN1000 HDPE diversion pipe and 500m DN1000 HDPE diversion pipe; the plan includes additional 4759m temporary masonry drainage ditch, 16 temporary masonry grit chambers, 16.39hm^2 compound geomembrane covering and 4317 baffle plates.

Table 12.5-5 Statistics of Water and Soil Conservation Measures for Qingshui Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Construction measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Ecological intercepting ditch</td><td>m</td><td>3291</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm2</td><td>16.39</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>1068</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>760</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>844</td><td>Existing</td></tr>
<tr><td>3.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">DN1000 HDPE diversion pipe</td><td>m</td><td>100</td><td>Existing, reusable</td></tr>
<tr><td>3</td><td colspan="2">DN600 HDPE diversion pipe</td><td>m</td><td>500</td><td>Additional, reusable</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>4759</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>2665</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>1028</td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Grit chamber</td><td>Masonry grit chamber</td><td>Chamber</td><td>16</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>137</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>89</td><td></td></tr>
<tr><td>6</td><td colspan="2">Covering with compound geomembrane</td><td>hm2</td><td>16.39</td><td>Additional</td></tr>
<tr><td>7</td><td colspan="2">Baffle plate</td><td>Plate</td><td>4317</td><td>Additional</td></tr>
</table>

12.5.6 Yingfeng Sub-region

Control area of Yingfeng sub-region is 26.17hm^2, composed of closed facilities control area and other contaminated soil control areas. The control areas are mainly planned as Class 1. industrial land, middle school and elementary school, Class 2. residential land, road and etc; of which the soil in the area of residential land and culture & education land with P≥1.5 is controlled by ex-situ stabilization/solidification or incineration; the soil in the area of planned residential land and culture & education land with 1<P≤1.5 is controlled by displacement to non-sensitive land or delivery to industrial solid waste landfill for landfilling; the soil in the area of planned industrial land with P≥2 is controlled by ex-situ stabilization/solidification; the soil in other control areas is controlled by in-situ stabilization treatment or ecological restoration technology.

The area causing pollution to the mountain is controlled by ecological interception; ecological intercepting ditch mainly functions for collecting non-point source pollution runoff, and pretreatment of collected runoff.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). Ecological intercepting ditch is constructed around the area causing pollution to the mountain;

b). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

c). After ex-situ treatment of contaminated soil or displacement to solid waste landfill, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During ex-situ treatment of contaminated soil, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

(II) Control quantity

a). Construction measures

1516m ecological intercepting ditch is designed for main construction.

b). Planting measures

357 dogbanes, 254 crape myrtles and 282 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 5.48hm^2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; the plan includes additional 1964m temporary masonry drainage ditch, 7 temporary masonry grit chambers, 5.48hm2 compound geomembrane covering and 3293 baffle plates.

Table 12.5-6 Statistics of Water and Soil Conservation Measures for Yingfeng Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Construction measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Ecological intercepting ditch</td><td>m</td><td>1516</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm2</td><td>5.48</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>357</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>254</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>282</td><td>Existing</td></tr>
<tr><td>3.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>1964</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>1100</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>424</td><td></td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Grit chamber</td><td>Masonry grit chamber</td><td>Chamber</td><td>7</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>60</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>39</td><td></td></tr>
<tr><td>4</td><td colspan="2">Covering with compound geomembrane</td><td>hm2</td><td>5.48</td><td>Additional</td></tr>
<tr><td>5</td><td colspan="2">Baffle plate</td><td>Plate</td><td>3293</td><td>Additional</td></tr>
</table>

12.5.7 Qingshuihu Sub-region

Control area of Qingshui Lake sub-region is 86.16hm^2, composed of channel control area and other contaminated soil control areas.

The control areas are mainly planned as Class II residential land, mixed commercial office building, greenbelt and urban road, of which the soil in the area of 域主要 planning 为 residential land and culture & education land is controlled by ex-situ treatment; the soil in the area of commercial land, road and utility land with P≥2 is controlled by ex-situ stabilization/solidification; the soil in the planned water area with P≥1.5 is controlled by ex-situ stabilization/solidification; the soil in the planned water area with 1<P≤1.5 is controlled by displacement to solid waste landfill for landfilling; the soil in other control areas is controlled by in-situ stabilization treatment or ecological restoration technology.

The area causing pollution to the mountain is controlled by ecological interception; ecological intercepting ditch mainly functions for collecting non-point source pollution runoff, and pretreatment of collected runoff.

Control area of pond control area is 4.16hm2, by dredging of dry pond, and measures are taken to reduce disturbance to pond bed, pumped pond seeper is treated by mobile wastewater treatment equipment, after water quality is in compliance with GB8978-1996 table4 after testing, it's discharged to Xiawangang.

(1.) Disposal of control measures

(1) Disposal of water and soil conservation listed and included in the plan

a). Ecological intercepting ditch is constructed around the area causing pollution to the mountain;

b). During the control of channel sediment, DN1000 HDPE diversion pipe is used; it's 300m long and reusable;

c). During construction preparation period, set up vehicle washing trough at the entry and exit of the project area to avoid transport vehicle carrying dirt;

d). After ex-situ treatment of contaminated soil of displacement to solid waste landfill, restore vegetation in the field by planting heavy-metal resistant dogbane, crape myrtle, cinnamomum camphora and the like.

(2) Disposal of additional water and soil conservation in the plan

a). During ex-situ treatment of contaminated soil or displacement to solid waste landfill, earth excavation and backfill will form a given amount of uncovered topsoil, which needs to be covered with compound geomembrane in rainy season to avoid direct erosion of bare slope by rainwater and resultant soil erosion.

b). After ex-situ treatment of contaminated soil or displacement to solid waste landfill, dispose temporary drainage ditch and grit chamber along excavated and backfilled slope crest and foot, treat rainwater with mobile wastewater treatment plant, and directly discharge rainwater to Xiawangang after standard treatment.

c). Block control area with circumferential baffle plate.

(II) Control quantity

a). Construction measures

284m ecological intercepting ditch is designed for main construction.

b). Planting measures

1719dogbanes, 1224 crape myrtles and 1359 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 26.39hm^2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed; together with 100m DN1000 HDPE diversion pipe; the plan includes additional 8473m temporary masonry drainage ditch, 28 temporary masonry grit chambers, 26.39hm2 compound geomembrane covering and 3495 baffle plates.

Table 12.5-7 Statistics of Water and Soil Conservation Measures for Qingshui Lake Sub-region

<table>
<tr><th>No.</th><th colspan="2">Measures and construction type</th><th>Unit</th><th>Quantity</th><th>Remark</th></tr>
<tr><td>1.</td><td colspan="2">Construction measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Ecological intercepting ditch</td><td>m</td><td>284</td><td>Existing</td></tr>
<tr><td>2.</td><td colspan="2">Planting measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Planting area</td><td>hm2</td><td>26.39</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">Dogbane</td><td>Tree</td><td>1719</td><td>Existing</td></tr>
<tr><td>3</td><td colspan="2">Crape myrtle</td><td>Tree</td><td>1224</td><td>Existing</td></tr>
<tr><td>4</td><td colspan="2">Cinnamomum camphora</td><td>Tree</td><td>1359</td><td>Existing</td></tr>
<tr><td>3.</td><td colspan="2">Temporary measures</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">Vehicle washing trough</td><td>Trough</td><td>2</td><td>Existing</td></tr>
<tr><td>2</td><td colspan="2">DN1000 HDPE diversion pipe</td><td>m</td><td>100</td><td>Existing, reusable</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Temporary drainage ditch</td><td>Masonry drainage ditch</td><td>m</td><td>8473</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>4745</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>1830</td><td></td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Grit chamber</td><td>Masonry grit chamber</td><td>Chamber</td><td>28</td><td>Additional</td></tr>
<tr><td>Earth excavation</td><td>m3</td><td>240</td><td></td></tr>
<tr><td>Shove joint brickwork</td><td>m3</td><td>156</td><td></td></tr>
<tr><td>5</td><td colspan="2">Covering with compound geomembrane</td><td>hm2</td><td>26.39</td><td>Additional</td></tr>
<tr><td>6</td><td colspan="2">Baffle plate</td><td>Plate</td><td>3495</td><td>Additional</td></tr>
</table>

12.5.8 Other Requirements for Water and Soil Conservation

All stones and gravels necessary for construction of the project are outsourced. Outsourced materials should be procured from legal quarry with approval formality of water and soil conservation project; purchase price includes soil erosion control cost and compensation cost; responsibility for soil erosion control should be defined in purchase contract; soil erosion control during mining is the responsibility of mining unit or individual, or local water and soil conservation department may collect soil erosion control cost from mining unit or individual according to Notice on Republish of Revenue from Administrative and Institutional Fees Project & Standard of Water Conservancy System in Hunan Province (Xiang Jia Fei No.[2009]62 号) collectively issued by Hunan Province Price Bureau and Department of Finance of Hunan Province, and local water administration is responsible for soil erosion control.

12.5.9 Collected Water and Soil Conservation Measures

Water and soil conservation measures for the projects are:

a). Construction measures

6438m ecological intercepting ditch is designed for main construction.

b). Planting measures

5953 dogbanes, 4238 crape myrtles and 4707 cinnamomum camphoras for resisting heavy metal are planted in rows, with planting area of 91.40hm^2.

c). Temporary measures

Before design and construction of main works, 2 vehicle washing trough are constructed, together with 300m DN1000 HDPE diversion pipe, the plan includes additional 1200m DN600 HDPE diversion pipe, additional 27195m temporary masonry drainage ditch, 93 temporary masonry grit chambers, 91.40hm2 compound geomembrane covering and 21583 baffle plates.

Table 12.5-8 Collected Water and Soil Conservation Measures

No.	Measures and construction type		Unit	Control sub-region							Total	Remark
				Xiangshiling sub-region	Qingshi sub-region	Tongtangwan sub-region	Tongxia sub-region	Qingshui sub-region	Yingfeng sub-region	Qingshui Lake sub-region		
1.	Construction measures											
1	Ecological intercepting ditch		m	0	0	677	670	3291	1516	284	6438	Existing
2.	Planting measures											
1	Planting area		hm^2	0.16	2.35	25.09	15.54	16.39	5.48	26.39	91.40	Existing
2	Dogbane		Tree	10	153	1634	1012	1068	357	1719	5953	Existing
3	Crape myrtle		Tree	7	109	1163	721	760	254	1224	4238	Existing
4	Cinnamomum camphora		Tree	8	121	1292	800	844	282	1359	4707	Existing
3.	Temporary measures											
1	Vehicle washing trough		Trough	2	2	2	2	2	2	2	14	Existing
2	DN1000 HDPE diversion pipe		m			100	100	100		100	400	Existing
3	DN600 HDPE diversion pipe		m			300	400	500			1200	Additional
4	Temporary drainage ditch	Masonry drainage ditch	m	182	1385	6780	3652	4759	1964	8473	27195	Additional
		Earth excavation	m3	102	776	3797	2045	2665	1100	4745	15229	
		Shove joint brickwork	m3	39	299	1464	789	1028	424	1830	5874	
5	Grit chamber	Masonry grit chamber	个	1	6	23	12	16	7	28	93	Additional
		Earth excavation	m3	9	51	197	103	137	60	240	796	
		Shove joint brickwork	m3	6	33	128	67	89	39	156	517	
6	Covering with compound geomembrane		hm2	0.16	2.35	25.09	15.54	16.39	5.48	26.39	91.40	Additional
7	Colored steel sheet		Sheet	559	945	5472	3502	4317	3293	3495	21583	Additional

12.6Analysis of Environmental Risks & Preventive Measures

12.6.1 Analysis of Environmental Risks

12.6.1.1 Risk of Surface Water Pollution by Heavy-metal Contained Soil after Rainstorm

Major causes of potential risk are: accidental discharge of contaminated soil as a result of construction in rainy day; as the project needs to excavate and deposit soil, construction in rainy day may lead to disturbed contaminated soil entering in surrounding water area with rainwater runoff, and consequential exceedance in local water area of Xiang River.

12.6.1.2 Risk of Accidental Discharge of Leaching at Landfill

1. Analysis of the causes of risky accidents:

The causes of risky accidents of accidental discharge of leaching at landfill mainly include the following aspects:

a). Direct discharge of leaching without treatment due to collapse/landslide of the dam;

b). Direct discharge of leaching without treatment due to overflow or leakage of leaching collecting system and equalization tank;

c). Groundwater pollution by infiltration of leaching due to improper bottom anti-seepage measures or breakdown of anti-seepage layer;

d). Failure of filtrate treatment system.

2. Analysis of risk severity

a). Analysis of the risk of collapse/landslide of the dam

The rolled earth fill dam is adopted as solid waste dam of the project; the dam is featured by stable foundation, safe cross section, and high bearing capacity of foundation and strong anti-sliding stability of dam body.

The project utilizes existing limestone mining pit landfill; outer slope is 1:4, crest slope is not less than 2%; further, environmental impact assessment necessitates anti-seismic requirements being met in design stage.

To sum up, landfill is safe in design, with minor risk of dambreak; as long as diversion and drainage of surface water around the dam body are strengthened in rainy season, the possibility of dam break is very low.

b). Analysis of the risk of overflow or leakage of leaching collecting system and equalization tank

The leaching drainage system of the project consists of diversion layer, seepage-diverting blind ditch and branch blind ditch; in order to collect leaching, leaching diversion layer is laid above anti-seepage layer to enable fast drainage of leaching out of the site and prevent groundwater pollution; intermediate liquid-diverting gravel blind ditch is constructed for each additional 30m high waste; DN200 UPVC conduit is laid in blind ditch, filled with 30～100mm gravels and covered with 150g/m^2 inverted geotextile; therefore, sharp increase of leaching discharge will not occur even in the case of rainstorm in May, June, July and August when rainfall is plentiful, collecting, diverting and draining system will not result in leaching overflow and pollution of water area due to failure in meeting the requirements.

Construction of 1×500m^3 equalizing pond will be change to act as emergency reaction tank for leaching equalization; according to calculations, project related leaching output is about 400m^3/d; consideration will be given to impossible leaching treatment in rainy season, when leaching will be stored in equalization tank for treatment until to dry season; the calculations indicate that leaching output in May, June, July, August and September exceeds treatment capacity of corresponding months, 500m^3 equalization tank can meet the requirements for temporary storage; in addition, main anti-seepage layer in the bottom of equalization tank and surrounding slopes is 2.0mm thick HDPE membrane, above which 600g/m^2 geotextile filament is paved as protective layer, thus anti-seepage effect is good.

To conclude above analysis that risk of overflow or leakage of leaching collecting system and equalization tank is very low.

c). Analysis of the risk of improper bottom anti-seepage measures or breakdown of anti-seepage layer

As for bottom anti-seepage treatment of the project, double anti-seepage structure is configured; anti-seepage measures are taken for anchoring shotcrete treatment of slope substrate; membrane rupture may occur during membrane laying construction, thus, environmental impact assessment requires that technical requirements are strictly observed during material section and membrane laying, and geomembrane rupture will not occur as far as these requirements are met.

Therefore, the environmental impact assessment requires the employer to strictly observe technical requirements during material selection, laying membrane on reservoir bottom, and laying anti-seepage membrane along the slope under construction supervision, and take groundwater monitoring measures at the same time.

To conclude, the risk of geomembrane rupture is low.

d). Analysis of failure of leaching treatment system

Immediately after failure of leaching treatment system, it makes alarm, the facility is shut down, the system in operation is closed in the shortest time to prevent discharging of wastewater, and untreated wastewater is temporarily stored in treatment tank; what’s more, the project is configured with equalization tank of sufficient volume for storage of leaching; after recovery of treatment system, wastewater is treated before standard discharge.

To conclude, the risk led by failure of leaching treatment system is low.

12.6.2 Preventive Measures for Environment Risks

12.6.2.1 Preventive Measures for the Risk of Surface Water Pollution by Heavy-metal Contaminated Soil after Rainstorm

(1) The construction contractor should conduct environmental supervision in as aspects in the process of construction, put into practice pollution preventive measures proposed in the report of environmental impact assessment and construction plan;

(2) The construction should be carried out by areas, wastewater emergency treatment chemicals like caustic soda flakes, sodium sulphide and PAM should be prepared during dredging and excavation construction for emergency use in case of accident; watcher should be assigned for 24h watch during construction period.

(3) Strengthen the contact with heavy metal control construction contractor during simultaneous construction, establish linkage mechanism; in case of failure of wastewater treatment equipment for any control construction, all construction should be suspended to avoid superposed pollution impact and overloaded pollution.

(4) In rainy season, one on-board mobile wastewater treatment equipment should be configured, which, in case of accident, pumps wastewater before treatment and discharging to Xiawangang or Qingshuitang industrial wastewater treatment plant.

(6) Rainwater intercepting equipments such as water pumps should be configured for one-operation-one-standby use to prevent failure of one equipment and waterlogging of rainwater in the pond.

(7) Maintenance of equipments should be strengthened to avoid failure.

12.6.2.2 Preventive Measures for the Risk of Leaching Seepage at Landfill

(1) Preventive and emergency response measures for collapse/landslide accident of dam body

The project should ensure uniform pavement quality and rolling frequency of incoming waste residue; waste residue landfilling should be carried out by areas; temporary drainage ditch should be constructed to divert surface runoff in the area not landfilled and closed area, to avoid surface runoff from entering in landfill reservoir area and increase of waste weight; construction management level should be improved, and landfilling disposal should be carried out strictly according to specification.

The environmental impact assessment requires construction of retaining wall, the wall type and wall body should be designed logically, not only paying attention to the cause of wall collapse, but also carefully calculate wall slope stability, wall anti-slide stability, wall anti-overturning stability and wall foundation stability, so as to ensure scientific and logic design of retaining wall; during operation of landfill, wall maintenance should be carried out on a regular basis, and ground rainwater and leaching diversion should be carried out timely to avoid impact of wall body by massive rainwater and waterlogging of wall foundation in accumulated rainwater or leaching, and ensure stable operation of retaining wall; in case of collapse accident of retaining wall, reinforcement and remedial measures should be taken as soon as possible to minimize pollution and loss.

Therefore, with proper drainage in the waste, ensuring landfill process quality and strengthening construction of retaining wall, it’s known from presentation in related documents and experience in completed domestic projects, the risk of geological hazard by collapse of project specific waste residue is very low, and the safety is ensured.

(2) Preventive and emergency response measures for overflow/leakage accident of leaching collecting system and equalization tank

The leaching output will sharply increase in rainy season and after downpour; if no measures are taken, it may result in direct discharge of leaching and contamination of surface water. To overcome this situation of the project, following measures are incorporated in construction design:

a). Waste landfilling should be carried out by areas; temporary drainage ditch should be constructed to divert surface runoff in the area without landfilling and closed area, so as to avoid waste from entering in leaching collecting system and effectively reduce the output of leaching;

b). Floodwater drain channel should be constructed surrounding landfill area to intercept rainwater out of landfill area;

c). The ground surface of sealed landfill area should be earthed and planted timely, 20% slope surface should be formed to divert rainwater out of the landfill area, avoid infiltration of rainwater in the waste and reduce the output of leaching;

d). Operation should be suspended in case of downpour, and bare working face should be protected by rainproof covering;

e). Strict anti-seepage measures should be taken at landfill;

⑥ In rainstorm season, leaching should be fully evaporate in equalization tank in advance; also, regulate cleaning and maintenance of flood intercepting trench is required to reduce the output of leaching.

To conclude, as long as anti-seepage measures are focused on, anti-seepage design and construction are carried out strictly according to specification, landfilling operation is carried out according to standard, the output of leaching can be reduced effectively, normal operation of sewage collecting facility and free flood discharge system are ensured, and the risk level of leaching leakage and pollution of surrounding surface water is low; in addition, the environmental impact assessment requires strengthened management and regular patrol and protection on a routine basis.

(3) Preventive and emergency response measures for improper bottom anti-seepage measures or anti-seepage breakdown accident

In case of damage of anti-seepage layer at waste residue site, it’s difficult to detect and repair by leaking stoppage, pouring and like means; preventive measures against damage of anti-seepage layer should strengthen supervision of construction quality during construction period, select anti-seepage material, cement, reinforcement and etc meeting the requirements of design code, engage construction group of high construction level, develop precise construction plan of anti-seepage layer, carry out construction exactly according to design requirements, so as to ensure laying quality of anti-seepage layer.

Care should be exercised in laying membrane of anti-seepage layer:

a). Membrane should be laid smoothly without wrinkle;

b). Splicing of membrane must allow minimal weld joint;

c). When laying anti-seepage membrane along the slope, maintain joint from top to bottom, horizontal joint on the slope is not allowed, so as to avoid stress concentration in weld joint;

d). Calculate slope stability before laying membrane along the slope, so as to prevent slide of membrane;

e). Do not make weld joint on the border of slope and bottom surface; weld joint should traverse across the border;

⑥ Direction of weld joint of foundation membrane should be in line with flowing direction of leaching;

⑦ Do not lay membrane on natural foundation; rather, it must be laid on smooth and stable finished layer, in other words, a scientific cushion foundation must be provided beneath anti-seepage membrane, generally of an artificial anti-seepage layer of natural anti-seepage material.

Laying quality should be improved by strict supervision of laying construction of anti-seepage layer, so as to prevent rupture after laying.

12.6.3 Emergency Response Plan on Environmental Risks

12.6.3.1 General Emergency Response System

(1) Accident rescue command and decision-making system: accident rescue command system is an accident rescue treatment system in response to emergency accident, which is essential for quick response after occurrence of accident, timely treatment of accident decisive decision-making and reduction of accident loss. The system consists of such contents as organizational system, communication liaison, victim rescue and etc; therefore, such emergency response plan should be developed during execution of the project.

a). Organizational system: emergency response rescue headquarters should be set up, dedicated staffs should be appointed to take charge of distribution of protection equipments and spot rescue; various functional departments should take respectively responsibilities for proper management of chemical toxicants and first aid after accident; b). communication liaison: free communication information should be ensured; the leader of emergency response and telephone number for contact should be specified in emergency response plan; telephone numbers of external liaison center and social rescue organizations, such as ambulance station, fire department and etc, should be indicated; communication liaison determines the capacity of quick response in case of accident; communication liaison should not only be fast and free at daytime, but also be available for fast liaison in late night and during festivals and holidays.

(2) In general, emergency response plan should include following contents:

Overview of construction project; major source of hazard screening and severity assessment; rescue command organization; emergency rescue group; emergency rescue procedure; post-accident spot treatment; emergency rescue installations & equipments; social rescue; communication network; simulation rehearsal of emergency rescue plan and etc.

12.6.3.2 Incident Emergency Response Plan

Due to inherent environmental risk of the project, and in the event of pollution accident, principal scope of impact is two downstream cities of Changsha and Xiangtan; in order to prevent excess wastewater of the project from causing accidental pollution of Xiang River, the environmental impact assessment suggests setup of an emergency leading group under the leadership of Department of Environmental Protection of Hunan Province, definition of the scope, principle, procedure and task of emergency response, as well as method of disposal and countermeasures after occurrence of pollution accident. Before commencement of construction, emergency response plan on environmental pollution accident should be prepared and reported to competent governmental organ for approval; during construction of the project, construction contractor should strictly implement various measures stated in construction plan and emergency response plan to ensure environmental safety.

Base on the analytical results of environmental risks, by making reference to incident emergency response plan developed by Zhuzhou Environmental Protection Bureau specially for integrated control project of Qingshuitang cadmium pollution, following outline of emergency response plan is developed for environmental risks of incidental accidents by the project, for the reference of project decision-maker.

The outline of emergency response plan:

1.. Organization

An environmental pollution accident emergency treatment leading group should be set up under the leadership of Zhuzhou Environmental Protection Bureau, which takes charge of origination and commanding of environmental pollution accident response treatment work; the leading group includes environment supervision emergency response team and environment monitoring emergency response team, led by Zhuzhou Environmental Protection Bureau.

2.. Task

(1) United origination and commanding of environment supervision and monitoring in case of incident of environmental pollution;

(2) Receiving the report on incident of environmental pollution, quick investigation and finding out of the cause of accident, property of pollution source as well as the course of accident;

(3) Timely report to Zhuzhou Municipal People's Government, Changsha Municipal Environmental Protection Bureau, Xiangtan Municipal Environmental Protection Bureau and Department of Environmental Protection of Hunan Province about the incident of environmental pollution within the scope of the project;

(4) Participating in related emergency rescue work organized by Department of Environmental Protection of Hunan Province;

(5) Guiding the public for emergency protection, assisting relevant authority to take effective measures for eliminating pollution;

(6) Publicizing information on the incident of environmental pollution within the scope of the project after such publication is approved by the superior.

3.. Emergency response procedure

(1.) Emergency response

1. Make quick notice and dispatch emergency response team

(1) Upon receiving related notice for emergency response

a). Upon receiving the report on pollution accident , emergency response leading group should act as emergency response headquarters, the leader of emergency response leading group to act as chief commander, and deputy leader to act as assistant commander;

b). Launch emergency response system, leading group should notify supervision emergency response team and monitoring emergency response team to arrive to the spot of accident;

c). Upon receiving the notice of emergency response, all emergency response operators and members of emergency response team should arrive to the location of emergency treatment within 20min, quickly make emergency preparation as required in emergency response notice, and take rescue action as soon as possible.

2. Analysis and judgment, definition of task, organizational guarantee

(1) Hear the report and opinion: emergency response team should actively make suggestions about emergency response work to emergency headquarters base on respective responsibilities, for reference of decision-making by emergency headquarters;

(2) Definition of task: in addition to hearing related suggestions, and after comprehensive analysis and judgment, emergency response leading group should define emergency response task, general objective of emergency response and intention of

emergency response.

(2.) Emergency treatment

1. During construction of the project, Zhuzhou Environmental Protection Center should trace and monitor water quality in various sections of Xiang River, and notify the monitoring results, if necessary;

2. In emergency rescue action, emergency response leading group and various emergency response teams should timely record the process of emergency response, so as make a solid basis for summary of experience and lesion from emergency response actions, as well as revision and supplementation of emergency response plan; recording should be fulfilled by dedicated staff, and the contents must be recorded are: (1) occurrence, evolution and termination of accident; (2) commanding procedure, scale and nature of rescue force; (3) working division and performance of task; (4) adaptability and ability of emergency organization, emergency staffs, emergency instruments and equipments for fulfilling emergency task; (5) major protective measures taken by the public and effect; (6) the impact of terrain and weather on hazard area and emergency action.

Various public statements, communiqués, notices, circular orders, messages and major instructions should be collected and archived. Records of all events must bear time, location, execution unit and leader of execution unit; such records should be submitted to emergency response leading group after termination of emergency event and archived by the personnel appointed for this purpose.

(3.) Termination of emergency

1. Condition for termination of emergency

(1) Accident spot is under control, accident condition is removed;

(2) Cadmium discharge from pollution source is reduced within stated limit;

(3) Hazard of accident is eradicated without the possibility of recurrence;

(4) Various special emergency treatment actions at accident spot are not necessary any longer;

(5) Necessary protective measures are taken to enable long-term aftereffect of accident to be a rational and as much low level.

2. Process for termination of emergency

Emergency response leading group should determine the time for termination of emergency base on treatment and monitoring feedback of accident spot, make notice on termination of emergency, and accident spot treatment operators should be evacuated in order.

3. Action after termination of emergency

(1) Assessment of emergency result

The emergency response leading group should organize assessment of emergency result; the basis for emergency result includes: a). records of emergency process; b). summary report submitted by various emergency response teams; c). other emergency information known by emergency response leading group; d). actual effect of emergency action and social influence; e). public feedback, and etc.

Major conclusion should include: a). severity of accident; 2.completion of general task and partial task of emergency action; 3.whether or not meeting general requirements for public protection and environmental protection; 4.whether or not major protective measures and methods applied is appropriate; whether scale of emergency force, use of instruments and equipments, 5. extent and rapidity of emergency are adapted to emergency task;⑥whether or not the relation of benefit and cost, risk and difficulty is scientific and rational during emergency treatment;⑦whether or not the published communiqué and public information is true in content, whether or not the time of notice is proper, and what kind of impact to public mentality;⑧typical case of success or failure; and ⑨other conclusions to be derived.

(2) Guide related department and accident unit to find the cause of accident and prevent recurrence of such problem;

(3) Prepare emergency summary report, and submit it within 2 weeks after termination of emergency for recording;

(4) Continue environmental supervision and monitoring;

(5) Revise emergency response plan based on practical experience and submit for approval by the superior;

(6) Guide emergency response team for maintenance and servicing of instruments and equipments, to maintain them in good technical condition at all times.

4.. Logistic guarantee

(1.) Material guarantee

Sufficient reserves of Na_2S chemicals and caustic soda flakes should be available to allow timely dosing in emergency.

(2.) Communication guarantee

(1) Communication guarantee after Initiation of emergency response

Combined wired communication, wireless communication and network transmission should be adopted, mainly by wired communication; emergency notice should be issued and received mainly by wired communication, which should be realized through office telephone;

contact with outgoing emergency operators should be realized mainly by wireless communication means such as mobile phone and the like to ensure quick release of emergency notice.

(2) Communication guarantee in the progress of emergency response

Release and receiving of emergency instruction, as well as notice and feedback of accident spot emergency information, should mainly be realized by wireless communication.

(3) Communication guarantee during emergency treatment

Combined wired communication, wireless communication and mobile communication should be adopted, mainly by wireless communication.

(3.) Traffic guarantee

Confirmation and dispatch of transport capacity should be organized by emergency response leading group, during routine period, all emergency vehicles should ensure oil reserves for transportation of more than 100km.

(4.) Medical guarantee

In case of poisoning or injury of personnel during emergency action, the poisoned or injured should be sent to the nearest hospital for medical treatment, or contact with medical unit to organize spot treatment, or send to the hospital or medical unit appointed by field headquarters; after termination of emergency, such personnel should be transferred to another hospital or continued medical treatment, as the case may be.

(5.) Living guarantee

The emergency response leading group should develop plan and organize implementation of plan; before taking action, various emergency response teams should make sufficient reserves of food and drinking water for one-day consumption, together with a given amount of cash.

(6.) Organization disciplinary guarantee: upon occurrence of incident, and after initiation of emergency response plan, related personnel must obey united command; upon receiving emergency notice, such personnel must be on duty regardless of holidays or leave, and the violator should be punished without remission.

12.7Mitigation Measures for Social & Environmental Impact

1. Before commencement of construction, all preparations should be made, detailed investigation and understanding of various aboveground and underground pipelines and pipings involving in road, power supply, communication, feedwater & drainage, gas and etc in

connection with the project, coordinate with related department to determine demolition, restructuring and relocation plan, properly perform various emergency works, ensure normal operation of various measures for prevention of disturbance of water, electricity, gas and communication facilities for the residents in Qingshuitang area during construction, so as to ensure social life in normal state.

2. Construction contractor must strictly comply with applicable laws and regulations, such as The Production Safety Law of People's Republic of China, Regulations of Hunan Province on Safe Production and etc; before commencement of construction, related responsible department of the company should disclose safe technology of key construction part to the project PMO, such technical disclosure should be documented; PMO manager should make construction organization technical disclosure to all construction management staffs, such technical disclosure should be documented; before commencement of each procedure (Subunit construction), PMO construction technology engineer must should make construction safety technical disclosure to all construction operators, tell them about risky factors in the workplace , preventive measures and emergency treatment measures for accident, and such disclosure should be recorded in detail.

Special measures and regulations should be established and supervised for construction site and special operation conditions such as dangerous operation, operation at height, operation is special weather, underground excavation construction; all packages interviewed during construction monitoring are able to observe regulations on construction safety management all the time, without occurrence of major safety accident.

3. During road construction, no access signs should be erected at the exit and entry of the road under construction, and vehicles should be guided to normal passage in the area nearest to from the road; in principle, road construction should be carried out without impairing normal operation of existing road traffic; during road construction, care should be exercised to avoid collision of foot passengers and prevent occurrence of traffic accident.

Warning signboard should be erected at construction site, indicating main construction works, construction time, asking for public understanding for inconvenience due to road construction, and the liaison, complaint hotline and like content.

4. Corresponding environmental planning in Environmental management plan should be observed to reduce social and environmental impact from the activities for implementation of the project.

5. In planning stage of the project, when it's necessary for plan optimization, full consideration should be given to local social and economic impact from project construction,

which should be taken as key factors for necessary plan optimization.

More efforts should be made to collect basic data, conduct in-depth analysis of local social and economic status and outlook of future development, develop feasible resettlement action plan in light of local actual situation, and ensure those affected by the project are not degraded in standard of living as a result of project construction.

Measure s for compensation standard and compensation method proposed in Action Plan on Resettlement of Affected Residents should be observed to mitigate the requisition and demolition impact against affected residents due to implementation of the project.

6. Construction operation should avoid rainy season, adequate drainage measures should be taken, and temporary buildings such as construction sidewalk, construction modular houses should be prepared properly.准备。

7. All-round safety and health education of construction personnel is required to improve their awareness of safety precaution for early report and prevention of risk, so as to avoid unnecessary loss.

8. In the stages of project design, execution, Post-management and operation, public supervision mechanism and information publicity mechanism should be executed strictly, so as to ensure prospective objectives and social benefits of the project be achieved.

In the process of design preparation of the project, social investigation is required for public participation of affected communities, and hearing of social public opinions about the project; once the red line of requisition and demolition of the project is defined, physical quantity affected by requisition and demolition should be publicized; PMO should establish special information publication channel and method, and publish the progress of project execution during implementation of the project; during implementation of the project, project design plan, resettlement plan, report of environmental impact assessment, report of social impact assessment and etc should be publicized through governmental information publicity platform for receiving public supervision, and ensure free feedback channel.

12.8Environmental Protection Investment Estimation

The project is a pollution control project. Here, only expenditures for prevention of secondary pollution are included in environmental protection investment, particular investment estimation is as shown in **Table 12.8-1**.

Table 12.8-1 Environmental Protection Investment Estimation

Item	Content of construction measures		Construction investment (RMB10,000)		
			Main construction listed	Additional	Total
Environment and water and soil conservation	Plant shrubs, sow grass seeds, drainage ditch, grit chamber, land improvement, plant shrubs, sow grass seeds, temporary earth drainage ditch, site restoration and greening		3594.86		3594.86
Acoustic environment	Construction period	Construction of noise reduction facilities such as temporary sound barrier	50		50
	Operation period	Reserved sound insulation measures	10		10
Air environment	Construction period	Dust suppression measures such as spraying water	50		50
		Spray inhibitor on organic contaminated soil, cover foundation pit with membrane for isolation		50	50
		Personal malodorous protection equipment for workers	5		5
	Operation period	Dust suppression by spraying water, cover with tarpaulin and etc	5		5
		Station greening		50	50
Surface water environment	Construction period	initial rainwater tanks of 6 closed facilities		30	30
		Machinery wash water and oil separation & sedimentation tank		5	5
		mobile water treatment equipment	200	0	200
		Pit seeper treatment tank	45		45
	Operation period	Initial rainwater tank in solidification/stabilization ground and dewatering site		50	50
		SBR treatment technology and membrane bioreactor of landfill		100	100
		Leaching treatment equipment of landfill	72	0	72
Groundwater environment	Construction period	Initial rainwater collecting tank, oil separation tank, sedimentation tank and chlorination reaction tank laid with geomembrane or tank hardened anti-seepage measures; buildings/structures washing sites of various closed facilities are hardened; temporary piling area at all stations are protected by rainproof or ground hardened anti-seepage measures		500	500
	Operation period	Construction of $75m^3$, $75m^3$, $100m^3$, $180m^3$initial rainwater collecting tank for anti-seepage treatment in Xinqiao solidification	137.66	50	187.66

		/stabilization plant, Xinqiao dewatering site, Xiawan dewatering site, temporary piling area			
		Sediment dewatering wastewater collecting tank facilities are protected by laying geomembrane or tank hardened anti-seepage measures	130.42		130.42
		For bottom anti-seepage treatment at landfill, double anti-seepage structure is configured, slope substrate is protected by anchoring shotcrete anti-seepage treatment	1513.31		1513.31
	Closing period	Regular monitoring of leaching at landfill	25	100	125
		Closing anti-seepage	335.44		335.44
	Post remediation	long term groundwater monitoirng	180		180
Solid waste	Construction period	Reclaiming and recycling of construction building wastes		50	50
		Reclaiming and recycling of reclaimable wastes of demolished buildings, non-recyclable construction wastes not containing residual heavy metal delivered to landfill for landfilling treatment, heavy-metal contaminated construction wastes washed before landfilling treatment		50	50
		Sludge from wastewater treatment delivered to solidification/stabilization ground for further treatment, and then delivered to landfill for landfilling treatment		5	5
	Operation period	Periodical clearing and removal of domestic waste by sanitation department	10		10
Environmental risk	Operation period	Mobile wastewater treatment equipment necessary for collecting sewage	/	/	/
Total			6363	1040	7403

13 Analysis of Cumulative Environmental Impact

13.1Introduction of Cumulative Impact

Comparing with environmental impact assessment of project level, with which only simple cause-and-effect relation, primary impact, immediate effect, a given environmental property and location are taken into consideration, the characteristic of cumulative impact is represented by environmental change upon combined action of comprehensive consideration of multiple projects, complex cause-and-effect relation, induction impact, interaction process, temporary and spatial covering and other factors. According to US Council of Environmental Quality (USCEQ) , increasing facts indicate that destructive environmental impact is not the outcome of direct or indirect effect, rather, it's a pressure by series of singular and minor impacts accumulating over the time. In USCEQ's 1978 statement about consideration of cumulative impact under National Environmental Policy Act (NEPA) , cumulative environmental impact is defined as "when an activity, in combination with another activity on the past, today and reasonably foreseeable future, the resultant cumulative environmental impact……cumulative impact is from the activities occurring in a given period of time, with minor singular impact, but tremendous impact when combined."

In this report, analysis of cumulative impact will be conducted on the basis of review of the construction history of Qingshuitang Industrial Zone and in terms of the impact from project construction as well as development planning in the future.

13.2Scope Definition & Source Identification of Cumulative Impact

Many major environmental problems as a result of project construction are defined in related sections of the report, as follows:

Discharge of fugitive dust and wastewater, soil erosion and other impact during construction period of the pollution control project; output of leaching, domestic sewage, discharge of experiment wastewater, fugitive dust at landfill, noise disturbance of various construction equipments and transport vehicles and other impact during pollution control of the project; different from the assessment of environmental impact by the project, assessment of cumulative impact requires expansion of geographic border and extension of duration to allow it including superposed impact of various resources, as well as superposed impact on ecosystem and human community. The first step of cumulative impact assessment of the project is definition of reasonably foreseeable activities as well as temporal and spatial scope of their cumulative impact.

In the level of whole project, factors having potential cumulative impact of the project include active enterprises in core area of whole Qingshuitang Industrial Zone, contaminations discharged by these enterprises may lead to certain cumulative effect in project related sub-regions.

According to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City (2012) , temporal and spatial scope of cumulative impact assessment is defined.

Short-term scope of assessment: about 15.17km^2 in core area of Qingshuitang Industrial Zone, assessment period to 2020;

Long-term scope of assessment: about 47km^2 in Zhuzhou Qingshui Lake new ecological city, assessment period to 2030.

13.3Review & Status Analysis of Project Area

13.3.1 Construction Status of Project Area

The range of project area is 8.48km^2, where there’re about 39 active enterprises, including 6 closed facilities; active enterprises are mainly in the chemical industry, smeltering industry and machinery industry, concentrated in the east of project area; construction area of enterprises in operation is about 1.32km^2, accounting for 15.6%

project area; area of residential land is about 0.32 km^2, accounting for 3.8% project area.

13.3.2 Situation about Discharge of Main Contaminations in Project Area

13.3.2.1 Situation about Discharge of Wastewater

The enterprises of the largest output of main wastewater, COD, emission of ammonia-nitrogen, heavy metal and cyanide are Hunan Zhuzhou Chemicals (Group) Co., Ltd, Hunan Zhuzhou Zhicheng Chemical Co., Ltd, Zhuzhou Smelter Group Co., Ltd, Zhuzhou Flotation Reagents Plant, Zhuzhou Tiancheng Chemical Co., Ltd, Hunan Haohua Chemical Co., Ltd, Zhuzhou Kinbin Glass Group Co., Ltd and etc; in 2013, 13 water contamination discharging enterprises in the project area are Zhuzhou Kangli Smelting Plant, CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd and etc, with wastewater emission up to 19549100t, accounting for 74.4% total emission of the whole area; COD emission is 2425.33t, accounting for 88.5% total emission of the whole area; ammonia-nitrogen emission is 500.091t, accounting for 92% total emission of the whole area; emission of heavy metals lead, arsenic, cadmium, Hg and cyanide contaminations are more than 90%, respectively.

Top-2 enterprise of COD emission in project area are Zhuzhou Kangli Smelting Plant and Hunan Zhuzhou Zhicheng Chemical Co., Ltd; Top-2 enterprise of ammonia-nitrogen emission in project area are Hunan Zhuzhou Zhicheng Chemical Co., Ltd and Zhuzhou Kangli Smelting Plant; enterprise discharging heavy metal, lead, arsenic, cadmium and Hg are Zhuzhou Kangli Smelting Plant and CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd.

At present, CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd and Zhuzhou Kinbin Glass Group Co., Ltd are shut down.

13.3.2.2 Situation about Emission of Exhaust Gas

In 2013, emission of sulfur dioxide in project area is 29499.86t (Including 14553.36t emission of sulfur dioxide in the process of fuel combustion, together with 14946.5t technical process emission) , 5080.49t soot, 25199.01t NOx, 1681.1t industrial dust and 3.12t fluorid.

Major discharging enterprises of SO_2, soot, NOx, industrial dust and fluorid in project area are Zhuzhou Huayin Thermal Power Generation Co Ltd, Zhuzhou Smelter Group Co., Ltd, Hunan Zhuzhou Chemicals (Group) Co., Ltd, Hunan Zhicheng Chemical Co., Ltd, Zhuzhou Kinbin Glass Group Co., Ltd, Zhuzhou Hongji Zinc Industry Co., Ltd, Zhuzhou Haili Fine Chemicals Co Ltd, Zhuzhou Zhongcheng Chemical Co Ltd and etc. SO_2 emission is 25127.9t, accounting for 85.2% total emission in project area; soot emission is 3656.24, accounting for 72% total emission in project area; NOx emission is 500.091t, accounting for 92% total emission in project area; emission of industrial dust is 1535.35t, accounting for 91.3% total emission in project area; fluorid emission is 2.92t, accounting for 93.6% total emission in project area.

Top-2 SO_2 discharging enterprise in project area are Zhuzhou Kangli Smelting Plant and Zhuzhou Huayin Thermal Power Generation Co Ltd; major soot discharging enterprises in project area are Zhuzhou Zhicheng Chemical Co Ltd and Zhuzhou Huayin Thermal Power Generation Co Ltd; major industrial dust discharging enterprises in project area are Zhuzhou Kangli Smelting Plant and CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd; major NOx discharging enterprises in project area are Zhuzhou Zhicheng Chemical Co Ltd and CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd; fluorid discharging enterprises are CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd and Zhuzhou Kinbin Glass Group Co., Ltd.

13.3.2.3 Output & Discharge of Solid Waste

(1) Output & discharge of general solid waste

As smeltering and chemical industries prevail in the project area, industrial waste residues are in large volume and complex ingredient; at present, there're 42 producers of general solid waste in project area, with 2389950t output of solid waste per year (See **Table 10.2-13**) , composed of coal dust, slag, nonferrous metallurgical slag, chemical waste residue and etc, including 844797t coal dust, accounting for 35.3%; 616783t other waste residues, accounting for 25.8%; 348602t smeltering waste residue, accounting for

14.6%; yearly recycling amount is 2350951t, 98.4% utilization; waste residues can basically be recycled, of which utilization of smeltering waste residues is more than output, and stock is decreased.

(2) Output & discharge of hazardous wastes

In 2013, there're 9 producers of hazardous wastes in Qingshuitang area, including 11 types of hazardous wastes to an amount of 19952t (See **Table 10.2-14**) , mainly composed of nonferrous metallurgic smeltering waste residue, rectifying (Distilling) residues, organic solvent and etc, including 11994t nonferrous metallurgic smeltering residues, accounting for 60.1%; 3480t rectifying (Distilling) residue, accounting for 17.4%; 2566t zinc-contained wastes, accounting for 12.9%.

Yearly recycling of hazardous wastes is 10195t, 为 51.1% utilization, stock is 8474t, stock cumulates on a year-on-year basis, which will impose an environmental problem.

13.3.3 Review Assessment of Environmental Quality in Project Area

1. Air Environment

1h average value and 24h average value of TSP, SO_2 and NO_2 at all monitoring points in the project area meet the requirements of Ambient Air Quality Standard (GB3095-2012) , Class 2.; PM10 at monitoring points G2, G3, G5 and G6 fails the requirements of Ambient Air Quality Standard (GB3095-2012) , Class 2.; 8h average value of TVOC at all monitoring points meets the requirements of Indoor Air Quality Standard(GB/T18883-2002); concentration of fluorid, Hg, lead & lead compound, arsenide, chrome ($^{6+}$) , manganese & manganese compound, hydroxybenzene and ammonia at all monitoring points meets the requirements of Sanitary Standard for the Design of Industrial Enterprise (TJ36-79).

According to annual report of ambient air quality monitoring by Zhuzhou Environmental Protection Center, monitoring points of the hospital of Zhuzhou Kangli Smelting Plant,年度 sulfur dioxide and PM_{10} are exceeded during 2010-2013; except for 2012, NO_2 is exceeded in all other years; CO concentration is within standard limit in all years.

2. Surface Water Environment

On the monitoring sections of Xiang River, Xinqiao low discharge channel, new Xiawangang and old Xiawangang in the project area, monitored values of pH, SS, cyanide, volatile hydroxybenzene, Cd, Hg, Zn, Pb, As, Ni, Cr^{6+} and Cu meet the requirements of Environmental Quality Standard for Surface Water (GB3838—2002) for corresponding standard of water quality; total phosphorus at the intake section of Xiang River No. 3 Water Plant fails the requirements of Environmental Quality Standard for Surface Water (GB3838—2002) , Class Ⅱ water quality, maximum excess multiple is 0.20; COD at opening section of Xinqiao low discharge channel to Xiang River fails the requirements of Environmental Quality Standard for Surface Water (GB3838—2002) , Class Ⅴwater quality, maximum excess multiple is 0.37; ammonia-nitrogen and total phosphorus in the section of new Xiawangang to project area, opening section of new Xiawangang to Xiang River, opening section of old Xiawangang to Xiang River fail the requirements of Environmental Quality Standard for Surface Water (GB3838—2002) , Class Ⅴwater quality, maximum excess multiple of ammonia-nitrogen is 0.25, 1.04 and 0.56, respectively; maximum excess multiple of total phosphorus is 0.55, 0.77 and 0.51, respectively

According to monitored data on water quality of Zhuzhou City during 2012-2014 (Zhuzhou Environmental Protection Center) and monitored results of water quality at sewage outfall of No.3 Water Plant, in recent years, except for total nitrogen, all other factors monitored in the intake section of No.3 Water Plant comply with Environmental Quality Standard for Surface Water (GB3838-2002) , Class Ⅲ water quality.

According to Annual Report on Monitoring of Water Quality in Zhuzhou Section of Xiang River during 2010-2013 submitted by Zhuzhou Environmental Protection Center, in 2010, ammonia-nitrogen in Xiawan section is exceeded; coliform is exceeded in 2010 and 2011; total nitrogen is exceeded during 2010-2013.

3. Groundwater Environment

At monitoring points of Zhuzhou Hehua Cement Plant within assessment scope of the project, ammonia-nitrogen, chloride, sulfate, nitrite nitrogen, TDS, nickel, Hg and total hardness exceed Groundwater Quality Standard (GB/T14848-93) , Class Ⅲ; at monitoring points ZK1, ZK8 and ZK11, iron exceeds Class Ⅲ; at monitoring points ZK14, ZK15 and ZK20, sulfate exceeds Class Ⅲ; at monitoring point ZK21, nitrate nitrogen exceeds Class Ⅲ; at monitoring points ZK2, ZK3, ZK4, ZK7, ZK8, ZK11, ZK15, ZK17 and ZK19-21, nitrite nitrogen exceeds Class Ⅲ; at monitoring points ZK14 and ZK20, TDS exceeds Class Ⅲ; at monitoring points ZK4, ZK15, ZK16 and ZK18-20, manganese exceeds Class Ⅲ; at monitoring points ZK1, ZK3, ZK6-10, ZK12 and ZK16-22, Be exceeds Class Ⅲ.

4. Sediment

According to Annual Report on Monitoring of Water Quality in Zhuzhou Section of Xiang River during 2010-2013 submitted by Zhuzhou Environmental Protection Center, in the sediment in Xiawan section of Xiang River, total arsenic, total Hg, total copper, total lead, total cadmium and total Zn during 2010-2011 decrease on a yearly basis, except increase of total chrome.

5. Noise

The noise level at all monitoring points comply with the standard, acoustic environment is good in construction area of the project.

6. Soil

(1) The soil in Yingfeng sub-region is featured by unusually enriched topsoil contamination of 48mg/kg arsenic maximum, 37.5mg/kg cadmium, 1430mg/kg Zn, 2.41mg/kg Hg, 1.4 mg/kg Se, 3.4mg/kg silver; main contaminations in the investigation of the impact of artificial factors on sub-region solid are cadmium, lead, Zn, Sb, Hg, arsenic and silver; roughly estimated depth of soil contamination is about 40cm, exceeding 60cm in some positions.

(2) The soil in Qingshui Lake sub-region is featured by unusually enriched topsoil contamination of 19.4 mg/kg cadmium maximum, 576mg/kg lead maximum, 907mg/kg Zn, 10.9mg/kg Sb, 2mg/kg silver, 58.3 mg/kg arsenic; main contaminations in the investigation of the impact of artificial factors on sub-region solid are cadmium, lead, Zn, Sb, Hg, arsenic and silver; roughly estimated depth of soil contamination is about 60cm, exceeding 60cm in some positions.

(3) The soil in Qingshui sub-region is generally contaminated by heavy metal,

featured by unusually enriched topsoil contamination of 3400mg/kg lead maximum, 400mg/kg arsenic, 73.7mg/kg cadmium, 11200mg/kg Zn, 150mg/kg nickel, 350mg/kg copper, 550mg/kg cobalt; main contaminations affected by artificial factors in Qingshui sub-region are Pb, As, Cd and Zn; roughly estimated depth of soil contamination in Qingshui sub-region is about 20cm-40cm, exceeding 60cm in some positions.

(4) The soil in Tongxia sub-region is generally contaminated by heavy metal, featured by unusually enriched topsoil contamination of 3726mg/kg lead maximum, 450mg/kg arsenic, 250mg/kg cadmium, 9701mg/kg Zn, 150mg/kg nickel, 2119mg/kg copper, 500mg/kg cobalt; main contaminations affected by artificial factors in Tongxia sub-region are Pb, Cd, As, Zn and Co; roughly estimated depth of soil contamination in Tongxia sub-region is up to 50cm, exceeding 60cm in some positions.

(5) The soil in Tongtangwan sub-region is generally contaminated by heavy metal, featured by unusually enriched topsoil contamination of 1240mg/kg lead maximum, 671mg/kg arsenic, 353mg/kg cadmium, 2620mg/kg Zn, 237mg/kg copper; main contaminations affected by artificial factors in Tongtangwan sub-region are Pb, Cd, As and Zn; roughly estimated depth of soil contamination in Tongxia sub-region is up to 50cm, exceeding 60cm in some positions.

(6) The soil in Qingshi sub-region is generally contaminated by heavy metal, featured by unusually enriched topsoil contamination of 951mg/kg lead maximum, 65.1mg/kg arsenic, 1200mg/kg Zn; main contaminations affected by artificial factors in Qingshi sub-region are Pb, As and Zn; roughly estimated depth of soil contamination in Qingshi sub-region is up to 50cm, exceeding 60cm in some positions.

(7) Xiangshiling sub-region is generally contaminated by heavy metal, featured by unusually enriched topsoil contamination of 661mg/kg lead maximum, 122mg/kg arsenic, 444mg/kg Zn; main contaminations affected by artificial factors in Xiangshiling sub-region are Pb, As and Zn; roughly estimated depth of soil contamination in Xiangshiling sub-region is up to 50cm, exceeding 60cm in some positions.

13.4Environmental Impact in Core Area of Qingshuitang Ecotype New City (2015-2020)

13.4.1 Planning of Zhuzhou Core Area of Qingshuitang Ecotype New City

The contents of Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City (2012) are followed, **Figure6.9-1** is the planning map:

1. Scope of Planning:

The scope of planning includes Qingshui Road- south area of North Jianshe Road, east area of Xiangyun Road, north area of Xiang River and west area of Shifegn Park, including total planning land area of about 15.17km^2.

2. Functional Orientation:

Functionally, planning area is oriented to be the core area of Qingshuitang ecotype new industrial city, which mainly bears four functions in the future, as follows:

(1) CBD: construction of Qingshui Lake waterfront featured business center and Qingshui Square urban commercial subcenter;

(2) Industrial highland: construction of industrial park of environmental protection (Rail) equipments and metropolis type industrial park by upgrading of traditional industrial formats and introduction of advanced manufacturing, so as to develop industrial highland of cluster of emerging industries in Qingshuitang ecotype new industrial city.

(3) Logistic hub: formation of comprehensive logistic center and hub oriented to Zhuzhou City and radiating to Changsha, Zhuzhou and Xiangtan cities by construction of comprehensive bonded logistic park.

(4) New residential district: achievement of the objectives of industry-city integration and job-housing balance, and formation of Qingshuitang ecotype new industrial city by the development of featured residential communities surrounding Qingshui Lake as well as construction of supporting comprehensive residential

community in the east of Xiawan Park.

3. Functional Layout:

(1) Layout of industrial space: one center and three parks: “one center” means headquarters based R&D center; “three parks”“ include industrial park of environmental protection (Rail) equipments, metropolis type industrial park (Spatially composed of metropolis type industrial park in the north and creation industrial park in the south) , comprehensive bonded logistic park (Spatially composed of metal logistic city of Xiang River, Changsha, Zhuzhou and Xiangtan intercity railway logistic zone and Tongtangwan Port) .

(3) Commercial spatial layout: three centers: including Qingshui Lake waterfront featured commerce & business center, Qingshui Square urban commercial subcenter and Xiangshi Square CBD.

(4) Ecological spatial layout: one belt, two parks and multiple corridors: “one belt” means the greenbelt along Xiang River; “two parks” mean Qingshui Lake ecotype sports and leisure park and Xiawan Park; “multiple corridors” mean green corridors to be formed along both banks of multiple channels in this area.

4. Composition of Land Use:

Total land area in planning area is 1517.40ha, including 1397.31ha construction land, accounting for 92.09% total land area; 120.09ha non-construction land, accounting for 7.91% total land area.

Of construction land, land area of local traffic facility (Class H2) accounts for 3.17% total land area; of urban construction land, residential land (Class R) accounts for 18.67%, land area of public management and public service (Class A) accounts for 4.75%, land area of commercial service facility (Class B) accounts for 6.97%, industrial land area (Class M) (Class I) accounts for 4.24%, logistic & warehousing land area (Class W) accounts for 2.03%, land area of road and traffic facility (Class S) accounts for 18.66%, land area for public facility (Class U) accounts for 1.69%, and land area of greenbelt and squares (Class G) accounts for 18.06%。

Of non-construction land, water area (Class E1) accounts for 3.55% total land area; land area of agriculture and forestry (Class E2) accounts for 4.36% total land area.

5. Planning of Ecological Restoration & Environmental Protection

(1) Planning of Soil Contamination Control

a). Construction of contaminated soil stabilization plant for stabilization treatment of heavy-metal contaminated soil in Qingshui sub-region; stabilization treatment of all soils exceeding Standard of Soil Quality Assessment for Exhibition Sites (Provisional) (HJ350-2007), Class B.

b). Handle stabilizes soil back to original site to mix with intermediate soil to allow total heavy metal in the soil complying with Standard of Soil Quality Assessment for Exhibition Sites (Provisional) (HJ350-2007), Class B.

c). Treatment of mixed soil according to planned property of land use: in the area planned for park landscaping, the 0.5m subsoil beneath mixed soil is displaced to above stabilized soil to prevent district contact of soil and human body as well as absorption of heavy metal in the soil by plants; in the area planned for construction of road and square, mixed soil is hardened; in the area planned for commercial and industrial use, mixed soil is directly reused.

(2) Planning of water pollution control

a). Control of soil contamination in pond, port and channel

The quality of effluent wastewater after treatment at wastewater treatment station should comply with Discharge Standard of Contaminations for Municipal Wastewater Treatment Plant (GB18918-2002) , Class IB.

b). Sediment pollution control

One additional heavy-metal pollution control plant will be constructed for treatment of heavy-metal contaminated pond sediment and soil; after treatment of contaminated sediment, lixivium index should comply with following standard:

Table 13.4-1 Water Pollution Control Standard

Item (mg/L)	Cadmium	Lead	Arsenic	Hg
Leaching value of undisturbed sediment (Max.)	1.1431	2.1516	0.114	0.001
Design leaching value	0.4	2.0	0.1	0.001
Control limit of influent hazardous wastes for landfilling treatment	0.50	5.0	2.5	0.25
Identification Standard for Hazardous Wastes(GB5085-2007)	＜1	＜5	＜5	＜0.1

c). Control of soil contamination along the sections of pond, port and channel

Sludge+stabilizer+cement-based stabilization of heavy-metal contaminated soil along the sections of pond, port and channel is applied; content of heavy metal in stabilized soil 后土壤 heavy metal should be less than Standard of Soil Quality Assessment for Exhibition Sites (Provisional) (HJ350-2007), Class B.

(3) Planning of waste residue pollution control

Different control methods are applied to different types of waste residue. For mixed waste residues, backfilling after special stabilizer treatment is advisable; in order to prevent direct exposure of waste residue to the environment after backfilling that could cause secondary pollution, earthing of landfill site is required, together with planting of corresponding heavy metal remediation trees; for identifiable industrial waste residue, recycling method is applicable.

(4) Planning of air pollution control

After air pollution control, air and acoustic environmental quality in planning area should comply with the standard for function zoning in all aspects; air environmental quality should be better than national air environmental quality standard, Class 2., API≤80; environmental noise should comply with national acoustic environmental quality standard, Class 2.

13.4.2 Forecast of Environmental Impact

1. Forecast of Air Pollution Source

According to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, industrial land area in the planning area is only 4.24%, mainly of Class I industrial land in the industrial park of environmental protection (Rail) equipments, which has minor pollution impact, thus no particular forecast is made here.

2. Forecast of Water Pollution Source

The output of wastewater in planning area mainly includes domestic sewage, office wastewater and etc; by the year of 2020, 核心区日 daily average water consumption in core area is about 91000m^3/d, including 81350m^3/d comprehensive domestic water consumption and etc, 9650m^3/d industrial water consumption; annual water consumption is 33210000m^3, drainage is about 26570000m^3.

3. Forecast of Output of Solid Wastes

(1) Forecast of output of domestic wastes

The population in core area is expected to reach 175000 by the year of 2020, to calculate by per capita output of 1.0kg domestic waste per day, total output of domestic waste is 17.5t/d and 6387t/a.

(2) Forecast of production of general industrial solid wastes and hazardous solid waste

Formula for forecast: $V_{\mathrm{I}} = S_1 \times M$

V_{I} : production of solid wastes (t/a)

S_1: discharge coefficient for industrial solid wastes (t/ha/a)

M : industrial land area (ha)

From analog investigation, discharge coefficient for general industrial solid wastes and hazardous solid wastes, and base on planned land area, production of general industrial solid wastes and hazardous solid wastes in the demonstration park is forecast, as shown in **Table 13.4-2**.

Table 13.4-2 Forecast of Production of Industrial Solid Wastes

Industrial land area (ha)	General industrial solid waste		Hazardous solid waste	
	Discharge coefficient (t/ha/a)	Production (t/a)	Discharge coefficient (t/ha/a)	Production (t/a)
64.38	12	772	0.2	13

General industrial solid wastes in assessed area are mainly recycled; domestic wastes are delivered to waste landfill for treatment; hazardous solid wastes are delivered to qualified unit for further treatment.

4. Change of property of land use

At present, construction area of core area of Qingshuitang ecotype new city in Zhuzhou City is 951.39ha, including 429.64ha industrial land area; following replanning and construction of this area by the year of 2020, construction area will be 1397ha, which only includes 64.38ha industrial land area, 365.26ha (-85%) less than current industrial land area, of which most part of land area is planned for construction of residential land, greenbelt, commercial district and etc.

13.5Forecast of Environmental Impact by Prospective Planning & Development of Qingshuitang Industrial Zone (2021-2030)

13.5.1 Introduction of Planning

According to Conceptual Planning of Zhuzhou Qingshui Lake Ecotype New City:

1. Scope of Planning: The scope of extension is to Baishi Port in the east, Fahua Mountain in the west, Xiang River in the south and Beijing-Guangzhou Railway in the north, including an area of 47 square kilometers.

2. Objective of Planning:

1) Industrial transformation

Firstly, facilitate upgrading, transformation and green relocation of stock industries in planning area, proper settlement of reemployment of the employers of the enterprises; profound technical transformation and reduction of contamination emission of enterprises represented by Zhuzhou Kangli Smelting Plant for industrial transformation and upgrading; secondly, introduction of incremental industries of potential development, and formation of industrialization by clustering of competitive industries; thirdly, focusing on the development of alternative industries by advantageous geography.

2) Ecological restoration

Firstly, starting with pollution control to remove the barrier and make a solid basis for subsequent construction in other cities; secondly, in addition to integration of related findings about pollution control, make full consideration in the control of soil, water area and waste residue, logic arrangement of time sequence for alternate control of soil, water area and waste residue; thirdly, take pollution control of Xiawangang, Tongtang Port and etc as an opportunity, learn from German experience in Rhine water pollution control, introduce rainwater collection and eco-purification technologies to improve water environment; fourthly, construct ecological greening system and realize ecological restoration by means of ecological background of the base.

3) Quality upgrading

Firstly, strengthen the development of tertiary industry, promote fictional upgrading of the format of tertiary industry, and highlight the percentage of tertiary industry; relying on sub-region development and relocation and reconstruction of enterprises, construct featured CBD and urban subcenter respectively; secondly, develop all-around urban public service system; thirdly, construct city parks, river and port landscaping zones, tidy up waterfront green roads and revitalize ecotype new city.

3. Development Orientation:

According to this objective, the general structure of “circular industrial park” (Industrial transformation) , ecological Xiawangang (Pollution control) , beautiful Qingshui Lake (Quality buildup) will be established in the ecotype new city at the end of planning period. Qingshui Lake ecotype new city will become a national “pioneer of resource-conserving and environment-friendly social, sample of industrial transformation, model of ecotype new city and representative of industry-city integration.”

4. Planning of land use:

Industrial land: industrial land is mainly located in industrial park of environmental protection rail, metropolis type industrial park and creation industrial park, including total industrial land area of 199.9ha.

Residential land: the area of planned residential land is 796.25ha, mainly of Class II residential land (Class R2) , with small area of Class I residential land (Class R1) ; facility improvement and environmental control and reconstruction of existing staffs dormitory will be conducted to reach Class II residential level.

Park greenbelts: the area of planned park greenbelts is 642ha, accounting for 21% urban construction land area; planned layout for the development of “one zone, one corridor, one base; three parks, multiple zones, multiple scattered parcels” structure.

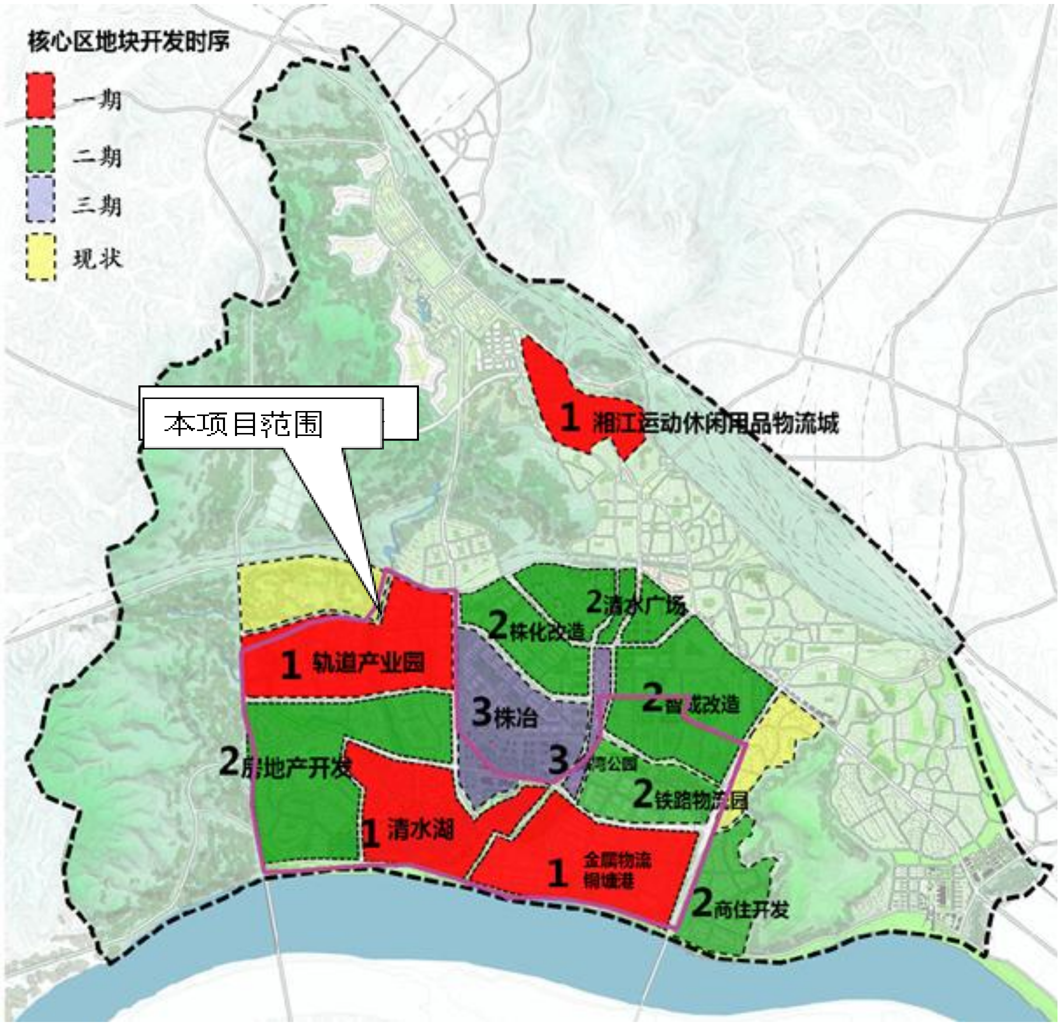
5. Stage Planning:

The planning is made with 5 years as a cycle, and the development of planning area is divided into three stages.

First stage of development consists of “Qingshui Lake Park, block of commercial housing surrounding Qingshui Lake, metal logistic city of Xiang River, industrial park of environmental protection rail and Xiang River logistic park of sports and fitness goods”, of which development and construction of Qingshui Lake Park will become key project in first stage of development, the catalytic effect will be developed to drive upgrading of surrounding environmental quality by shaping of high-quality environment; as for industry, industrial park of environmental protection rail in the west will be developed, and metal logistic city will be constructed by introducing logistic enterprises; as for urban construction, featured commercial district will be constructed around the block of Qingshui Lake.

Second stage of development consists of development of commercial housing black at the site of Zhuzhou Kinbin Glass Group Co., Ltd, as well as development of commercial housing area on the replacement plots of the enterprises for easy demolition work and ground leveling (Development of commercial housing plots at the site of Hunan Zhuzhou Zhicheng Chemical Co., Ltd) ; as for industry, after relocation of enterprises such as CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd and Hunan Zhuzhou Zhicheng Chemical Co., Ltd, multifunctional industrial buildings will be developed on the demolished plots; as for urban construction, the value of surrounding land will be increased by focusing on construction of Qingshui Square urban commercial subcenter, developing catalytic effect of Qingshui Square, and through construction of Qingshui Square CBD.

Third stage of development consists of construction of headquarters office buildings and buildings for creation industry on the demolished plots of enterprises such as Zhuzhou Kangli Smelting Plant; in addition, development of south section of Xiawan Park will be completed, and office environmental quality will be upgraded by overflow effect of landscape; as for industry, regional service function of this sub-region will be driven by the development of high-end productive service industry.



Time sequence for the development of plots in core area: first stage; second stage; third stage; current situation; 1-Xiang River logistic city of sports and leisure goods; 1-industrial park of environmental protection rail; 2-restructuring of CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd; 2-Dishui Square; 2-restructuring of Zhuzhou Zhicheng Chemical Co., Ltd; 2-real estate development; 3-Zhuzhou Smelter Group Co., Ltd; 1-Qingshui Lake; metal logistic city in Tonggang Port; 2-development of commercial housing

Figure13.5-1Time sequence for the Development of Zhuzhou Qingshui Lake Ecotype New City

6. Spatial Structure of Industries

General objective: creation of "one center, four parks" spatial structure of industries.

"One center" means headquarters based R&D center in the section of Qingshui Lake, which is located on the plots in the south of the road to Zhuzhou Kangli Smelting Plant (Under planning) , north of Qingshui Lake Park (Under planning) and west of Xiawan Road (Under planning) (Currently the plot of Zhuzhou Kangli Smelting Plant Kivcet plant area) , with total land area about 850-mu; general orientation is an integrated headquarters based business office center of market management, R&D, after-service and head offices.

"Four parks" include industrial park of environmental protection rail, metropolis type industrial park, Qingshui Lake modern logistic park and Xiang River logistic park of sports and fitness goods.

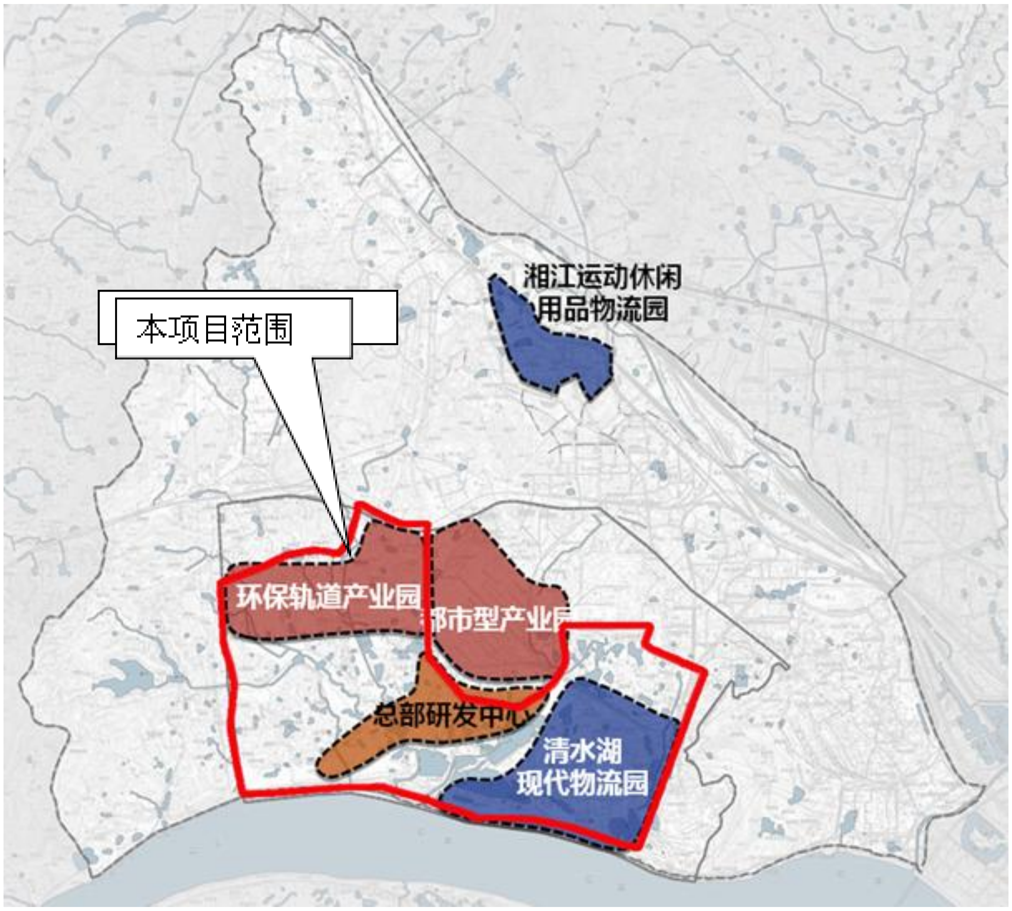
Industrial park of environmental protection rail: mainly of incremental industrial land in the west of Zhuzhou Kangli Smelting Plant; total area of construction land is about 1500-mu; in the east is environmental protection industry project for the control of environment pollution in this area, including environmental protection project of Hunan Bossco Environmental Protection Technology Co., Ltd and Beijing torch furnace project; the planning recommends construction of environmental protection industrial park by internal requirement and highlighting the features; in the west is current farmland, with which the planning recommends taking over spilled industry of rail technology city in the future, and development of rail equipment industry; planned property of land use is Class I industrial land.

Metropolis type industrial park: mainly of the plots after relocation of Zhuzhou Kangli Smelting Plant, CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd plant area; total construction area of land is 2000-mu; after relocation of CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd, the vacated plot will be planned for development of metropolis industries in terms of high-end manufacturing, light industry and like nonpolluting and environment-friendly metropolis industries. After relocation of Zhuzhou Kangli Smelting Plant, the vacated plot will be planned for development of creation industrial park in the future.

Qingshui Lake modern logistic park: it's the plots located in the south of Yujiaping freight yard, east of Xiawangang, west of Shifeng Avenue and north of Xiang River; total land area is about 4000-mu; general orientation is "freight transfer terminal serving Changsha, Zhuzhou and Xiangtan cities, integrated logistic hub oriented to Zhuzhou City". Prospective objective is creation of the largest integrated logistic hub for Changsha, Zhuzhou and Xiangtan cities.

Xiang River logistic park of sports and fitness goods: it's located in the south of intersection of Qingshi Road-Times Avenue, north of Zhuyi Road; total land area is about

1300-mu; general orientation is construction of professional logistic base prevailed by sports and fitness land.



Xiang River logistic park of sports and fitness goods; industrial park of environmental protection rail; metropolis type industrial park; headquarters based R&D center; Qingshui Lake modern logistic park

Figure13.5-2Spatial Structure of Industries in Zhuzhou Qingshui Lake Ecotype New City

13.5.2 Forecast of Environmental Impact

1. Forecast of Air Pollution Source

According to Conceptual Planning of Zhuzhou Qingshui Lake Ecotype New City, industrial land in planning area only accounts for 4.26% total land area, mainly of industrial park of environmental protection (Rail) equipments (Class I industrial land) , non-polluting metropolis type industrial park, Qingshui Lake modern logistic park and Xiang River logistic park of sports and fitness goods, which have minor pollution impact; thus, no particular forecast is made here.

2. Forecast of Water Pollution Source

Main wastewater in the planning area includes domestic sewage, office wastewater, industrial wastewater and etc; by the year of 2030, daily average water consumption is about 270000m^3/d, including 240000m^3/d comprehensive domestic water consumption and etc, 30000m^3/d industrial water consumption; annual water consumption is 98550000m^3, drainage is about 78840000m^3.

3. . Forecast of Production of Solid Wastes

(1) Forecast of domestic wastes

A population of 300000 is expected in the area by the year of 2030; to calculate by per capita 1.0kg domestic waste per day, production of domestic waste is 30t/d and 10950t/a.

(2) Forecast of production of general industrial solid wastes and hazardous solid wastes

Formula for forecast: $V_{\text{I}} = S_1 \times M$

V_{I} : production of solid waste (t/a)

S_1:discharge coefficient for industrial solid waste (t/ha/a)

M :industrial land area (ha)

By analog investigation, discharge coefficient for general industrial solid wastes and hazardous solid wastes, comprehensive planning land area, production of general industrial solid wastes and hazardous solid wastes by the industrial park is forecast, as shown in **Table 13.5-1**.

Table 13.5-1 Forecast of Production of Industrial Solid Wastes

Industrial land area (ha)	general industrial solid wastes		Hazardous solid wastes	
	Discharge coefficient (t/ha/a)	Production (t/a)	Discharge coefficient (t/ha/a)	Production (t/a)
199.9	12	2399	0.2	40

General industrial solid wastes in assessed area are mainly recycled; domestic wastes are delivered to waste landfill, hazardous solid wastes are delivered to qualified unit for further treatment.

4. Change of property of land use

At present, current industrial land area of Zhuzhou Qingshui Lake ecotype new city is 839.57ha; after replanning and construction of this area by the year of 2030, industrial land will only be 199.9ha, 639.67ha (-76%) than current industrial land area, and the industries will be changed from current smeltering, chemical, building materials of high energy consumption and high pollution to industries without pollution and minor pollution; most of remaining plots are planned for construction of residential land, greenbelt, commercial district and etc.

13.6Potential Problems Regarding Inductive & Cumulative Impact and Measures Thereof

13.6.1 Impact of Construction of Qingshuitang Ecotype New Industrial City on the Greenbelt in Planning Area

1. Impact of construction of Qingshuitang Industrial Zone on the greenbelt

Base on the investigation of current situation about planning area and according to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, the area of current greenbelt (Including cropland, woodland and etc) in project area is 2.45km^2; upon completion f the project, the area of greenbelt will be decreased to 1.19 km^2; future development and construction will encroach the greenbelt in project area, leading to loss of woodland, grassland and greenbelt.

2. Mitigation measures

(1) During road construction, design road greening construction to create urban linear landscaping zone; during factory construction, take greening construction as hard-and-fast rules for factory construction;, so as to replenish the loss of biomass and area due to construction of industrial zone and beautify urban landscapes.

(2) In developing planning, consideration should be given in the planning of greenbelt system, and following aspects should be stated in Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City:

With favorable condition of the mountains surrounding planning area, greenbelt planning should emphasize the interrelation of peripheral Fahua Mountain and Shifeng

Park to establish the structure of greenbelt system with “one belt, two parks, seven corridors, multiple scattered parcels”.

“One belt” means Xiang River waterfront greenbelt, including some plots along Xiang River and Shugang Avenue and Xiangwan Road, greenbelt width to be controlled within 10m-120m.

“Two parks” mean Qingshui Lake eco-sports & leisure park and Xiawan Park.

“Seven corridors” mean ecological settings of two scenic areas of Fahua Mountain and Shifeng Park surrounding project area; in addition, seven green space corridors will be constructed in line with ports, channels and planar shelter greenbelts and strip parks in project area.

“Multiple scattered parcels” mean clustered mass of large greenbelt park, ecological woodland and shelter greenbelt in project area.

Construction of green system will compensate reduction of vegetation in area and quantity as a result of construction of development zone, thus this act is necessary.

(3) Planning and setting of urban slow greenway system, including independent greenway and auxiliary greenway.

Independent greenway mainly includes special channels located in the areas surrounding Qingshui Lake eco-sports & leisure park-Xiawan Park, on both sides of river course and inside greenbelt, which are specially configured for walking and bicycle driving of citizens.

Auxiliary greenway main integrates citizen walking channel configured along sidewalk on both sides of trunk road, secondary road and branch road in the city, of which auxiliary greenway on both sides of trunk road and branch road should focus on spatial human-friendliness of the streets within additional facilities such as rest chairs, street furniture and the like, control of building interface should emphasize understructure functions and interaction with the foot passengers; auxiliary greenway on both sides of trunk road should focus on relation with public traffic in layout’ moreover, ground signs should be erected on road surface, and driving speed on branch road should be controlled to not exceeding 20km/h at most.

Slow driving traffic system is green, environment-friendly and healthy without environmental pollution, and it’s helpful for physical exercise; in addition, slow driving traffic underlies the concepts of fairness, harmony, human-centering and sustainable development, which works with private motorized traffic and public traffic to constitute urban traffic system.

13.6.2 Impact of Construction of Qingshuitang Ecotype New Industrial City on the Environment in Planning Area

Certain water, air, noise pollution is unavoidable during construction of industrial zone. It’s obvious from analysis of resource bearing capacity and environmental bearing capacity, that resources and the environment are bearing force for basic existence and development of residents in project area as well as important embodiment of sustainable development.

13.6.2.1 Analysis of Resource Bearing Capacity

(1) Analysis of water resource bearing capacity

Environmental water demand of core sections of Xiang River is 46000000m^3/a, including total amount of reclaimable water resource of 31000000m^3/a; according to planning of core area, with implementation of the planning of circular economy industrial core area, increase of utilization of industrial water and reclaimed water, water consumption in core area will be reduced by the year of 2020, and current water supply capacity of core area meets the requirement for water supply.

(2) Analysis of land resource bearing capacity

Total area of construction land in core area is about 15.17km^2, including 13.97km^2 urban construction land and 1.20km^2 non-construction land; of urban construction land, the area of residential land accounts for 18.67%; land area of public management and public service accounts for 72.03%; land area of commercial service facility accounts for 6.97%; the area of industrial land accounts for 4.24%; land area of logistic and warehousing accounts for 2.03%; land area of road and traffic facility accounts for 18.66%; land area of greenbelts and squares accounts for 18.06%; land area of public facility accounts for 1.69%; the area of industrial land is reduced from current 429.64ha to 64.38ha; the soil after remediation will comply with corresponding requirements for development and utilization, and this area is able to bear the requirements for planned development land.

13.6.2.2 Analysis of Environmental Bearing Capacity

Excerpted assessment contents in the Report on Environmental Impact of Qingshuitang Circular Economy Industrial Core Area:

(1) Analysis of water environment bearing capacity

Base on current characteristic of water environment and sewage discharging characteristic, COD and NH_3-N are taken as total control factors to calculate water environment capacity of assessed section of Xiang River.

Standard water quality of upstream functional area is applied to influent wastewater quality. During dry season, monthly average flow of Xiang River is 290m^3/s, annual average flow rate of Xiang River in Zhuzhou section is 0.25m/s, flow rate is 0.15m/s in dry season; according to hydrological characteristic of Xiang River, calculated water environmental capacity of COD and ammonia-nitrogen in the effluent of Xiang River in dry season are 5112t/a and741.2t/a, respectively; during normal flow period, water environmental capacity of COD and ammonia-nitrogen is 30495t/a and 4422t/a, respectively.

According to above-mentioned calculation, after planning of core area, drainage volume is about 26570000m^3/a; according to Discharge Standard of Contaminations for Municipal Wastewater Treatment Plant (GB18918－2002) Class I B, calculated total COD and ammonia-nitrogen are 1594t/a and 398.55t/a, respectively; total discharge of COD and ammonia-nitrogen in water contaminations is less than environmental capacity, indicating sufficient bearing capacity of water environment.

(2) Analysis of air environmental bearing capacity

Multi-source model and A-P value method are applied respectively for the assessment, environmental capacity of soot, dust and SO_2 in assessed area is calculated; the minimum value of calculation results is taken as final value, statistic results are as shown in **Table 13.6-1**:

Table 13.6-1 Schedule of Calculation Results of Air Environmental Capacity

Unit: t/a

Indicator	Calculation method	Total environmental capacity
SO_2	Calculation by standard annual concentration	11032
Soot & dust		14569

According to forecast in the preceding section, after implementation of the planning, Class I industrial projects will settle, with minor pollution impact, and regional air environmental bearing capacity is sufficient.

13.6.2.3 Mitigation Measures

■ Mitigation measures for air environmental impact

(1) Logic layout of settled projects strictly according to planned key industries and industrial land composition;

(2) Strengthen industrial exhaust gas pollution control , including following five aspects: a). promote clean production ;b). optimize energy utilization structure, prioritize use of natural gas; ensure effective control of various types of process exhaust gas of enterprises;d). improve environmental management and supervision;e). improve emergency mechanism of accidental discharge;

(3) Regularly monitor the enterprises possibly producing contamination in the development zone, so as to ensure normal operation of exhaust gas treatment measures of such enterprises , and ensure standard exhaust emission;

(4) Strengthen the control of air environment, impose strict examination and approval, limit construction of industrial project of high energy consumption and serious pollution, continuously reduce energy consumption for unit production value and contamination discharge index, and encourage development and use of clean energy;

(5) Ban small enterprises of excess air pollution discharge, as well as industrial projects listed in outdated, backward productivity, technology and product directory; take initiative to promote clean production among enterprises, facilitate certification of ISO14000 environmental management system to enable transformation from extensive energy use to intensive energy use;

(6) Strengthen civilized construction management, practice commercialization of

concrete in the construction of urban buildings, take measures such as closed operation, closed running, clean vehicles, dust suppression by spraying water and etc, so as to control fugitive dust from construction.

- surface water environmental impact mitigation measures

(1) Practice water-sewage separation and rainwater-sewage separation mechanism;

(2) Promote clean production process;

(3) Promote sewage drainage declaration and license system;

(4) Sewage produced by the enterprises in project area should be pretreated according to Integrated Wastewater Discharge Standard, Class 3. before discharging to wastewater treatment plant for treatment, so as to realize standard discharge;

(5) Strengthen water environmental protection of rivers and channels in project area;

(6) Make proper emergency response plan for accidental discharge of wastewater treatment plant;

(7) Long-term treatment capacity of wastewater treatment plant can be adjusted according to actual situation of enterprises settled in the industrial park, so as to ensure wastewater treatment plant is able to take over the drainage of production wastewater and domestic sewage in development zone, and avoid water pollution of Xiang River;

(8) Complete construction of auxiliary sewage intercepting pipe network project for existing wastewater treatment plant, accelerate construction of wastewater treatment facility and auxiliary facility, reconstruct municipal wastewater treatment system, implement rainwater-sewage separation, improve municipal sewage collecting ratio; set up wastewater treatment plant in the sub-region, and establish local sewage collection, treatment and drainage system.

- Mitigation measures for groundwater environmental impact

(1) Depending upon the contaminations involved in respective production, the enterprises settled in development zone should take corresponding surface water anti-seepage measures, general principle is: in the area of serious pollution and high accident probability, anti-seepage level is higher, and surface water filtration coefficient is lower;

(2) The wastewater produced by all enterprises should firstly be treated by auxiliary wastewater treatment plant according to takeover requirements of wastewater treatment plant, and then delivered to wastewater treatment plant for further treatment before

standard discharge, unapproved discharge is prohibited; accidental discharge wastewater and fire fighting wastewater should be discharged to wastewater accident pool of the enterprises, and then delivered to auxiliary wastewater treatment plant of the enterprises for treatment according to takeover requirements of wastewater treatment plant, and finally discharged to wastewater treatment plant for further treatment before standard discharge;

(3) Strengthen maintenance and management of wastewater treatment plant, ensure long-term and stable standard discharge of wastewater after centralized treatment, so as to avoid serious impact of wastewater accidental discharge on surface water and groundwater;

(4) During construction in planning area, strict quality control is required, strengthen anti-seepage treatment of pipelines and structures during design and construction, so as to ensure project construction and pipe network construction to be completed qualitatively and quantitatively according to design requirements.

- Noise control measures

(1) Industrial noise control measures: logic layout and standard boundary;

(2) Construction noise control measures: logic arrangement of construction time;

(3) Traffic noise control measures: care should be exercised to avoid planning for construction of noise-sensitive residential houses, schools and similar buildings within 30m from both sides of main traffic trunk road in planning area; 20～50m wide greenbelt should be constructed, so as to reduce the impact of traffic noise by means of distance attenuation and greening noise reduction;

(4) Social life noise control measures.

- Solid waste management and disposal measures

(1) Strengthen the management of general industrial solid wastes, realize recycling of waste and used materials, expand the approach for recycling, strengthen industrial disposal and swap management of solid waste, establish industrial solid waste production, liquidity, storage, disposal and trading information system, and encourage waste recycling and reclamation among production enterprise in the project area;

(2) Implement production, declaration and registration system of hazardous wastes, as well as operation license system of hazardous waste storage, collection, disposal and

recycling facilities; implement whole-process management of hazardous wastes from the aspects of collection, handling, storage, recycling, treatment, disposal and etc;

(3) Establish waste collection system, waste storage system, waste handling system and waste treatment system, so as to realize harmless treatment of domestic wastes.

13.6.3 Impact of Construction of Qingshuitang Ecotype New Industrial City on Natural Drainage in Planning Area

1. Environmental impact

Land development does not encroach in river course and will not change natural width, flow direction and width of river course; before commencement of land development, land leveling is necessary; land leveling will cause certain change of terrain and relief of the county seat, which will cause certain impact on natural runoff in the county seat; rainwater-sewage separation system is adopted for all planned construction of pipe networks; road rainwater runoff in the industrial park is collected by storm sewer network for sedimentation and finally discharged in river course; sewage is collected in wastewater treatment plant for standard treatment before discharging in natural water area; therefore, the construction of development zone has limited impact on the volume of natural water area.

Construction of road and factory enterprises will change the ground in industrial park from natural soil to impermeable area such as concrete pavement, asphalt pavement and the like; hardened ground reduces penetrability of natural soil and prevents atmospheric precipitation from directly replenishment of underground aquifer.

2. Mitigation measures

Due to change of ground from natural soil to impermeable area such as concrete pavement, asphalt pavement and the like, hardened ground reduces penetrability of natural soil and prevents atmospheric precipitation from directly replenishment of underground aquifer; therefore, full consideration should be given to the relation of infrastructure construction and natural drainage and groundwater replenishment during the progress of construction work.

Therefore, in considering construction of development zone, consideration may be given to improve filterable greenbelt, permeable ground and municipal drainage capacity to increase natural drainage ratio of the city.

Filterable greenbelt: during urban construction, maintain higher level of greenbelts near factories and roads than that of road and factory plane; by taking such measures, rainwater runoff on surrounding hard ground flows in greenbelt by gravity to replenish groundwater volume.

Permeable ground: consideration should be given to construct permeable asphalt pavement during road construction, and permeable road surface tiles can be used in sidewalk construction, reconstruct impermeable road surface in waterlogging area, use porous materials in lieu of fully hardened ground (Such as parking lot, court ground and surrounding area), so as to increase rainwater infiltration and replenish groundwater volume.

Urban drainage: considering actual situation in project area, the planning recommends the value of rainfall recurrence period as follows: for general residential area and road, design rainfall recurrence period P＝2-3 years; for downtown area, trunk road and square, design rainfall recurrence period P＝3-5 years; for the area of special importance, design rainfall recurrence period P＝10 years. In the planning design, full consideration should be given to the impact of rainstorm on the city, so as to ensure urban drainage capacity.

13.6.4 Impact of Construction of Qingshuitang Ecotype New Industrial City on the Environment in Planning Area

Favorable ecological system is established in Qingshui Lake ecological wetland, which continuously enables the objective of reducing contaminations in planning area, with remarkable ecological benefit: construction of Qingshui Lake ecological wetland changes existing structure of vegetation, enriches the species and quantity of plants, having positive impact on terrestrial vegetation; most birds can find habitable space for existence and living; some other animals will also migrate to wetland for reproduction and existence; upon construction of wetland, some fish will be introduced, zooplankton, Crustacea, aquatic insect and other wild life will reproduce gradually to constitute wetland aquatic ecosystem; landscape diversity will also be increased; construction of ecological wetland may further improve water quality of influent water in Xiang River from Qingshuitang area, which will play an active role in improving water quality of Xiang River.

13.6.5 Impact of Construction of Qingshuitang Ecotype New Industrial City on Social Life in Planning Area

According to Particular Planning for the Control of Core Area of Zhuzhou Qingshui Lake Ecotype New Industrial City (Compiled in 2012) , the objectives for control, development and construction of Qingshuitang Industrial Zone are oriented as ecotype new city; by integrated environmental control, a low-carbon environment-friendly, scenic, habitable and commerce-suitable ecotype new city will basically be constructed in about 10 years, so as to make Qingshuitang Industrial Zone a national model of integrated heavy-metal pollution control, national sample of industry restructuring and upgrading of old industrial base, as well as construction and new urbanization model of "resource-conserving and environment-friendly society" in Changsha, Zhuzhou and Xiangtan cities. Thus, it has notable social benefit.

However, remediation of contaminated soils and the construction is concurrently carried out, and permanent land acquisition will cause the original inhabitants to loss the land and move out of their homes, thus their short-term life quality may be decreased. According to the No.748 Letter sent by the Ministry of Land and Resources in November 2008, the contaminated land in Qingshuitang area is not suitable for crop planting, and it is required to change land classification, and the members in the collective economic organization in the land shall be correspondingly relocated and compensated. According to the document published by the Ministry of Land and Resources in 2009, the agricultural land within the range of 6.7 square kilometers in the core zone of Qingshuitang area shall be transformed into construction land in one time, the residents in the communities and villages governed by Tongtangwan Office shall be changed into urban residents and be brought into the network of urban resident employment and social security, and the land contracted by the original economic organization hasn't been the income source of the residents in the area. Land requisition and relocation will follow polices issued by people's government of Hunan Province or Zhuzhou City. Meanwhile, with the implementation of the emplacement policy, the living or working environment of relocated residents will be improved.

Besides, the construction may temporarily cut off the existing rural roads, irrigation canals, power supply, communications and so on, which will bring some impact on the normal life of the residents. However, with the advance of regional construction and demolition work, these effects will be eliminated.

13.6.6 Impact of Loss of Farmland from Construction of Qingshuitang Ecotype New Industrial City

1. Mode of impact

Farmland is the planning area is not suitable for farming, however, farmers in planning area plant some crops; construction of development zone will encroach some farmland in this area; according to Environment Survey Report on The World Bank-China Proposed Zhuzhou Brownfield Remediation Project, Hunan Province, land use in this area is planned as "other grassland", including an area of 1.15km^2.

According to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City, after construction of this planning area, there's no cropland, and it's changed to urban construction area; former farmland will disappear with the progress of urban development and be replaced by factories, enterprises and densely populated residents' resettlement communities and etc.

Investigation indicates that major source of income of the residents in project area is non-farming income from migrant work, other income stands for small percentage, indicating affected families are lowly dependent on the land; overall impact from loss of farmland is limited, however, its impact on local area and some agricultural population should be fully recognized.

2. Mitigation measures

Economic compensation for occupied houses and farmland: construction of local enterprises provides job opportunities and increases the income of local workers; moreover, infrastructure reconstruction in project area may attract settlement of many enterprises, and the development of such enterprises necessitates employment of a lot of migrant workers, so as to provide numerous job opportunities, and provide local low-income group, vulnerable group and women with job opportunities, provide job opportunities for land-lost farmers, increase their income level, and ultimately improve the standard of living for the good of local residents.

13.6.7 Implementation of Countermeasures for Cumulative Environmental Impact

13.6.7.1 Short-term Pollution Control of Enterprises in Operation

According to Planning of Zhuzhou City for Environmental Improvement & Protection for the Period of the 12th Five-year Plan, during “the 12th Five-year Plan”, Zhuzhou Kangli Smelting Plant will launch sintering-blast furnace lead smelting process replacing Kivcet lead direct smelting process project, integrated heavy-metal gas pollution control project, Qingshuitang area sediment heavy metal control project and etc, so as to gradually eliminate potential risk of heavy metal pollution, and ensure environmental safety.

According to Planning of Zhuzhou City for Reduction of Total Emission of Main Contaminations for the Period of the 12th Five-year Plan: during “the 11th Five-year Plan”, many representative environmental protection projects are constructed by key industrial enterprises in Zhuzhou City, for instance, control of fume sulfur dioxide of 1-3 ＃volatilizing kilns of Zhuzhou Smelter Group Co., Ltd, zero discharge of heavy-metal contaminated wastewater and control of heavy-metal fume of Zhuzhou Kangli Smelting Plant, total wastewater treatment and reclaimed water recycling of Hunan Zhuzhou Zhicheng Chemical Co., Ltd, removal of ferrous ion in wastewater of CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd, treatment of ammonia-nitrogen wastewater of Zhuzhou Zhicheng Chemical Co Ltd, total wastewater control of Zhuzhou Haida Chemical Co., Ltd; standard discharge of key pollution sources is realized, total discharge of main contaminations is reduced substantially; during “the 12th Five-year Plan”, kiln fume control, including 4# and 5# volatilizing kilns FGD treatment of Zhuzhou Smelter Group Co., Ltd, with expected 4160t reduction of sulfur dioxide; unit desulfurization of Zhuzhou Zhicheng Chemical Co., Ltd, with expected 467t sulfur dioxide.

According to 2013 communiqué of Zhuzhou Smelter Group Co., Ltd, some FGD facility, total wastewater treatment system and spoil ground of the enterprise were upgraded and technically transformed in 2013.

To sum up, measures are taken in Zhuzhou City to strengthen contamination discharge control of key polluting enterprise, so as to reduce local output and cumulative volume of contamination.

13.6.7.2 Long-term Relocation Measures

According to Detailed Planning on the Controllability of Core Area in Zhuzhou Qingshuitang Ecotype New Industrial City (2012) :

For the control of enterprises as pollution source, the principles of industrial transformation of core enterprise, relocation and upgrading of pillar enterprise, closing of small-and-medium enterprises are applicable to the implementation of control projects under planning for short term.

There’s one core enterprise, namely, Zhuzhou Kangli Smelting Plant, which will shut down polluting production line, eliminate rough processing smelting production line of high pollution and high discharge, so as to realize the objective of transformation to fine smelting.

For pillar enterprises including“ Zhuzhou Mingzhu Concentration Plant, Zhuzhou Ironworks, Hunan Haohua Chemical Co., Ltd, Hunan Haili Chemical Industry Co., Ltd, CNSIC Zhuzhou Chemical Plant, CNSIC Hunan Zhuzhou Chemical Industry Group Co., Ltd, Liuzhou (Zhongcheng) Chemical Industry Co., Ltd, Liuzhou (Zhicheng) Chemical Industry Co., Ltd”, the headquarters of key pillar enterprises of important supporting role for industrial development will be reversed in current industrial zone in the short term for the development of headquarters economy and industrial transformation, and production lines of pillar enterprises will be moved to other places step by step.

For small-and-medium enterprises, 175 small-and-medium enterprises in project area will be treated by closing and shutdown under governmental guidance, social supervision, enterprise independence and supporting policy, so as to reduce pollution sources effectively.

The land after relocation will be remediated for replanning, so as to eliminate cumulative impact of local contaminations from the source.

13.6.7.3 Environmental Management Measures

Control of local environmental impact from local development is the control from the source and an important aspect; for instance, rigorous approval and limit of construction of industrial project of high energy consumption and serious pollution as well as industrial project discharging heavy metal contamination, shutdown of all small enterprises of excess air pollution discharge, and the project listed for outdated, backward productivity, process and product directory, standard discharge of sewage after pretreatment by the enterprises in industrial park, standard discharge of air contamination, proper disposal of industrial solid wastes, strengthening of civilized construction management and similar environmental monitoring and supervision means, all are unachievable without strong support from local environmental protection department.

More than 100 participants from Zhuzhou Environmental Protection Bureau, Zhuzhou Shifeng District, Zhuzhou Environmental Protection Bureau, including Environmental Protection Center and Environment Supervision Brigade for implementation of environmental management measures. Construction of Environmental Protection Center complies with national standardization construction, Class 2.; Construction of environment Monitoring Enforcement Brigade complies with national standardization construction, Class 2.

Zhuzhou City has a large domain; at present, construction of environmental management group of Zhuzhou Environmental Protection Bureau suffices present requirements; however, with the development of Zhuzhou City, and in order to further adapt to the requirements of environmental protection work in the new situation, continuously improve environmental supervision capacity, promote sound development of environmental protection work in Zhuzhou City, establishment of environment monitoring stations for Environmental Protection Bureau in various districts is envisaged.

13.6.7.4 Implementation of Environmental Protection Measures

In the course of urban development, environmental impact should be kept under control, and implementation and management of various environmental protection measures are required.

(1) In urban planning or planning adjustment , the planning department should take full consideration of the percentage of urban greenbelt to overall planning; in the planning of land use, high-yield farmland should be avoided to include in the scope of planning as possible; during construction and development of Zhuzhou City, Zhuzhou Municipal Bureau of Housing and Urban-Rural Development may implement construction of greenbelt project as designed by planning department;

(2) Zhuzhou Municipal Water Supplies Bureau should timely adjust treatment capacity of wastewater treatment plant based on demand of the enterprises settled in Zhuzhou City 市 enterprise to allow effective collection and treatment of sewage in the industrial park;

(3) Zhuzhou Municipal Bureau of Housing and Urban-Rural Development should pay attention to construction progress of municipal sewage, rainwater, water supply and drainage pipe networks to allow effective collection of sewage in all sub-regions of Zhuzhou City, and easy delivery to wastewater treatment plant for further and effective treatment; also, consideration should be given to rainfall recurrence period of Zhuzhou City to allow storm sewer network with sufficient drainage capacity, and reduce urban impact from rainstorm;

(4) During implementation of road construction, Zhuzhou Municipal Bureau of Housing and Urban-Rural Development may establish filterable greenbelt, use of new materials such as permeable asphalt pavement, colored permeable surface tiles and the like as compulsory condition for road construction project, so as to reduce the impact from hardened road surface and natural drainage;

(5) Zhuzhou Municipal Sanitation Bureau should establish waste collection system, waste storage system, waste handling system and waste treatment system, pay attention to capacity of waste landfill plant, so as to ensure harmless treatment of general industrial wastes and domestic wastes.

Main capital sources are self-financing and loan.

13.6.8 Detailed Guidelines for Cumulative Environmental Impact Assessment

In the preparation for project specific environmental impact assessment, inductive and cumulative environmental impact assessment is performed based on available data. However, in view of insufficient data with current stage, and various urban and industrial development planning of Zhuzhou City to be improved, current reductive and cumulative environmental impact assessment is only preliminary. On the other hand, pressure and impact on the environment, resources and the society as a whole as a result of rapid urbanization and industrialization should not be dismissed for the expedience's sake. Therefore, technical assistance part of the project incorporates an activity of cumulative environmental impact assessment in the second stage; more data should be collected for this activity on the basis of preliminary assessment, study and consultation should be carried out, and detailed cumulative environmental impact assessment should be performed in the implementation stage of the project. As this assessment work will be closed related to various planning works of Zhuzhou City, and comprehensive consideration of environmental and social factors is necessary, thus it's deemed as strategic environmental and social impact assessment, the guidelines of assessment should include following tasks:

Key Points of Compiling the Guidelines for Strategic Environmental and Social Impact Assessment
The method of fast assessment is adopted by incorporating other factors having impact on assessment and technical assistance projects, particularly compiling of strategic township planning; the assessment should be performed in following steps: 1. Project Overview & Background: Description of the project, its background and other projects and activities with potential cumulative effect; the consulting advisor will apply environmental assessment report and other, for instance: General Planning of Zhuzhou City (Planning Shifeng District) , General Planning and Detailed Planning for the Control of Qingshuitang

Industrial Zone, documents regarding planning on the protection of related environmental functional zones, resource recycling, historic and cultural sites, cultural relics and etc; inductive and cumulative impact assessment (CIA) needs to determine the sequence of planned construction of the project, sequence of ancillary and local infrastructure construction, determination of type of industry of potential development as well as the context of development; discrimination of potential impact of important environmental factors, geographic information (Including administrative border or watershed) essential for cumulative impact assessment, spatial and temporal boundary of assessment to be provided by the advisor.

Following aspects need to be introduced in the project overview:

(1) Known project

Completed projects in the assessment area of World Bank financed project and other areas; presentation of stage scale, overview and expected time for execution; presentation of World Bank funded project in such area and summary of construction area in such period of time; presentation of municipal infrastructure in connection with known project, including road, power transmission line, gas transmission line and etc to be constructed; identification of environmental sensitive areas, major shareholders and affected residents in the project area.

(2) Past, present and prospective projects

After determination on the scope of assessment and environmental impact of the project, analyze past, present and prospective projects as well as activities within special temporal and spatial framework; following aspects should be considered in the assessment of other projects and activities:

- Assessment of all completed projects and projects under planning for construction in assessed area;
- Determination of time phase of past, present and prospective projects;
- Content of assessment should include approved projects, projects to be approved, projects to be constructed and projects under designing in cumulative impact assessment area;
- Assessment of the type of potential industrial development and potential pollution load of such type of industry in cumulative impact assessment area;

- Assessment of reasonably foreseeable environmental factors having cumulative environmental and social impact, in particular, projects having immediate impact on water resource, land resource and biological diversity, and plotting of basic maps present and prospective projects as well as prospective development of extended area.

(3) Identification of important environmental and social problems

Identification of cumulative impact of urban expansion on critical resources in the scope of assessment, for instance, impact on groundwater, biological diversity and the life of local people; generally, these are called valuable ecological constituents (VECs) ; these projects need to be identified after consulting with potential affected group, local governmental authority, NGO and experts and scholars, so as to identify valuable ecological constituents to be measured by relevant indexes; potential valuable ecological constituents and indexes may include:

Damage of urban greenbelt and natural habitat by urban expansion;

Emission of car exhaust discharge and noise impact of running vehicles due to urban road construction and increased number of vehicles; impact of ambient air quality and acoustic environmental quality due to construction of factories in industrial zone;

Before development and construction, ground surface of the area is natural soil of high permeability; however, urban construction will harden the ground surface, and hardened ground surface reduces penetrability of natural soil stratum; permeability of concrete is poor, which will prevent atmospheric precipitation from directly replenishing underground aquifer;

Urban expansion will deprive local residents of the farmland they living on; loss of land may cause certain impact on their source of income and livelihood.

Urban expansion and infrastructure construction impose impact on material and cultural resources.

(4) Baseline map

Mark selected VECs on baseline map with geological information system or other tools; planning on necessary indexes for each VECs state, environmental bearing capacity, historic development trend of the city and urban expansion in a given time frame.

2. Impact Assessment

Assessment of the extent of inductive and cumulative impact; assessment of the extent of inductive and cumulative impact is conducted with similar method for environmental impact assessment, expect the difference of the former involving in assessment of the projects in special temporal and spatial framework, in addition to other projects and activities.

Assessment includes the impact in implementation stage as well planned progress stage of the project; assessment of each environmental factor and cumulative impact should consider typical composition of environmental assessment, namely, extent, frequency, duration, magnitude, uncertainty and possibility. The assessment method should be qualitatively analyzed and proved by quantitative data; quantitative data can be fulfilled by information collection or analogy; in the assessment, map overlay analysis is applicable to analysis of prospective scenario of industrial development and additional load of environmental system (e.g. wastewater treatment plant) .

3. Determination of Extent or Scope of Impact

Determination of extent and scope of cumulative impact; determination of qualitative assessment according to set threshold value, law rules or policy or professional judgment and consultation, so as to determine is extent of impact, and extent or scope of cumulative impact must be justifiable.

Assessment advisor is required to define scope and extent of impact, and continuously apply it to past, present and prospective projects; in the projects in past, present and prospective stages, extent or scope of impact of each VECs should be assessed, in addition to assessment of cumulative impact from inductive evolution.

4. Establishment of Impact Mitigation Measures

Analysis of rational and feasible method for mitigation or avoidance of inductive and cumulative impact; make corresponding action plan (Inc. time, organizational responsibility and budget) based on analysis conclusion, specify mitigation measures and mitigation measures to be included in environmental management plan; for example, urban regional development or development and construction of industrial zone construction; measures for mitigation of environmental impact are:

- Take into full consideration of greening area in the boundary and planting of greenbelt around industrial zone in the construction of factories and enterprises;

- Construct waterside parks along major river course in Zhuzhou City; take into full consideration of construction of greenbelt and downtown greenbelt in the design of urban road, so as to form many green corridors in Zhuzhou City for the benefit of urban environment and landscape;
- Protection or avoidance of high-yield farmland is required in the planning and expansion of urban and economic development zones;
- Take into full consideration of construction of wastewater treatment plant by stages; wastewater treatment capacity of wastewater treatment plant should be adjusted in terms of population expansion and settlement of enterprises in Zhuzhou City to meet the requirements of urban expansion;
- New materials should be used in road construction(e.g. permeable asphalt road surface) as possible; filterable greenbelt (The level of greenbelt is lower than that of road surface in plant area and ground level of road) should be fully considered in the construction of road and factory; permeable road surface tiles should be used in the construction of sidewalk; porous materials should be used in lieu of fully harden road surface in waterlogging area; by taking such measures, the possible impact of atmospheric precipitation replenishing groundwater is reduced;
- Local environmental protection department should establish complete, standard and more stringent requirements for water contamination and air contamination discharge for factories and enterprises in the development zone;
- Local environmental protection department should strengthen supervision of drainage and gas emission by the enterprises in the development zone, make environmental monitoring plan, and understand more about sewage discharge in the development zone;
- Development of other traffic systems, for example, establishment of slow drive traffic, consider construction of special bicycle lane and sidewalk;

The suggestion should also include management method having impact on adaptability, uncertainty of impact or insufficient assessment due to lack of information.

13.7Conclusion

Base on the comprehensive analysis of above guidelines, summary and consideration of general planning of the city, planning on environmental impact assessment, investigation of current situation, preliminary assessment of inductive and cumulative environmental impact of the project is conducted, and major factors having inductive and cumulative environmental impact are selected; it's obvious that, during the period of 2020-2030. Qingshuitang Industrial Zone will have notable cumulative impact on the project. Due to limited information, detailed and comprehensive data and information on environment and social impact from the development of infrastructure, industry and commerce in Qingshuitang Industrial Zone are unavailable, making it difficult to conduct certain and quantitative analysis; therefore, further assessment is necessary in terms of actual development situation and basic information of these areas during implementation of the project.

14 Information Publicity & Public Consultation

14.1Purpose and Significance

During project construction, major problems of interest with local farmers and villagers, such as land occupation, demolition of civil houses and the like, will arise; as an important part of environmental impact report, public participation is crucial to considerate decision-making, and which directly reflects public opinion about project construction, allows decision-making department to find any problems, revise and complete design scheme, and solve the problems put forth by the public, all in a timely manner; in addition, public participation enables perfect and logic construction plan of the project for achieving coordinated economic benefit, environmental benefit and social benefit. Moreover, public awareness of construction project as well as public utterance of attitude and opinion about construction project not only lead to public understanding and support of construction project, but also improvement of public awareness of environmental protection, supervision of environmental protection, protection of environment, so as to en sure implementation of sustainability strategy; according to applicable requirements of Provisional Regulations on Public Participation In Environmental Impact Assessment (Huan Fa Circular No. [2006]28) issued by State Environmental Protection Administration and the requirements of OP/BP4.01“Environmental Assessment” of World Bank’s ten safety guarantee policies, as part of procedures for environmental impact assessment, two rounds of public consultation will be organized for the project specific environmental impact assessment in the forms of combined media statement, poster of public notice, release of questionnaire for public participation and holding of public symposium.

Collections of environmental impact assessment information publicity of “World Bank financed Hunan Zhuzhou Qingshuitang area heavy-metal pollution environmental improvement construction project” are as shown in **Table 14.1-1**.

Table 14.1-1 Collections of Environmental Impact Assessment Information Publicity of "World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project"

<table>
<tr><th colspan="6">First round of information publicity</th></tr>
<tr><th colspan="2">Form</th><th>Time</th><th>Method of public participation</th><th>Participants</th><th>Organizer</th></tr>
<tr><td rowspan="2">A</td><td>Internet media statement</td><td>July 28, 2014</td><td>Official website of Zhuzhou Municipal People's Government (www.zhuzhou.gov.cn)</td><td rowspan="2">/</td><td rowspan="2">ZREIDC
Nanjing Guohuan Environmental Science & Technology Development Co., Ltd</td></tr>
<tr><td>Public notice</td><td>Oct 28, 2014</td><td>Village affairs information billboard of Qingshuitang community, Tongtangwan Community, Zhushan Community, Dingshan Community, Yingfeng Community, Jianshe Village, Qingxia Community, New Xiawan Village</td></tr>
<tr><td colspan="2" rowspan="2">B. Questionnaire</td><td rowspan="2">Sep 2014</td><td>Completion of project questionnaire for public participation (Individual)</td><td>Groups of residents, officials, workers and farmers of different social standings and professions in project area</td><td rowspan="2">ZREIDC
Nanjing Guohuan Environmental Science & Technology Development Co., Ltd</td></tr>
<tr><td>Completion of project questionnaire for public participation (Group)</td><td>Qingshuitang Community, Tongtangwan Community, Zhushan Community, Dingshan Community, Yingfeng Community, Jianshe Village, Qingxia Community, New Xiawan Village Community</td></tr>
<tr><td colspan="2">C . Public participating in symposium</td><td>Oct 27, 2014</td><td>Residents' representatives from affected communities (Inc. requisition and house-demolished communities) attending public participation symposium</td><td>Representatives from Zhuzhou Urban-Rural Construction Bureau, Zhuzhou Rural Works Bureau, Zhuzhou Land and Resources Bureau, Zhuzhou Planning Bureau, Zhuzhou Environmental Protection Bureau, Tongtangwan Subdistrict Office and residents' representatives</td><td>ZREIDC
Nanjing Guohuan Environmental Science & Technology Development Co., Ltd</td></tr>
<tr><td colspan="6">Second round of information publicity</td></tr>
<tr><td colspan="2">Form</td><td>Time</td><td>Method of public participation</td><td>Participants</td><td>Organizer</td></tr>
<tr><td>A</td><td>Internet media</td><td>April 2015</td><td>Official website of Zhuzhou</td><td>/</td><td>ZREIDC</td></tr>
</table>

statement		Municipal People’s Government (www.zhuzhou.gov.cn)		Nanjing Guohuan Environmental Science & Technology Development Co., Ltd
B．Questionnaire	May 2015	Completion of project questionnaire for public participation (Individual)	Groups of residents, officials, workers and farmers of different social standings and professions in project area	ZREIDC Nanjing Guohuan Environmental Science & Technology Development Co., Ltd
		Completion of project questionnaire for public participation (Group)	Zhuzhou association for promotion of construction of resource-conserving and environment-friendly society, closed facilities and the enterprises in operation	
C．Interview	May 2015	Interviewing in affected communities (Inc. requisition and house-demolished communities)	Residents from Qingshuitang Community, Tongtangwan Community and etc	ZREIDC Nanjing Guohuan Environmental Science & Technology Development Co., Ltd

14.2First Public Participation

14.2.1 Scope of Inquiry

According to the requirements of the Environmental Protection Law of the People's Republic of China, on the principle of fair, open, authentic and objective inquiry, massive inquiry of public opinions about sensitive points, institutional units, business owners, schools, residential areas in connection with project construction are collected.

14.2.2 Method of Inquiry

14.2.2.1 Questionnaire

(1.) Individual inquiry

The scope of inquiry of public participation include villages, business and institutional units, some CCP and governmental bodies in project area and surrounding areas, and the objects of inquiry include groups of residents, officials, workers and farmers in different social standings and professions in planning area. A total of 80 questionnaires are issued; 78 valid questionnaires are called back, valid callback ratio is 97.5%.

Particular content of individual inquiry for public participation is listed in **Table 14.2-1**.

Statistic compositions of public inquiry objects are listed in **Table 14.2-2**.

Statistic findings of inquiry are listed in **Table 14.2-3**.

Table 14.2-1 World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project Questionnaire for Public Participation of Environmental Impact Assessment (Individual)

<table>
<tr><td>Name</td><td></td><td>Sex</td><td></td><td>Age</td><td></td><td>Nationality</td><td></td></tr>
<tr><td>Education</td><td></td><td>Telephone number</td><td></td><td>Residence</td><td colspan="3"></td></tr>
<tr><td colspan="2">Profession</td><td colspan="6">A-worker; B-farmer; C-serviceman; D-student; E-science-education-culture-health professional; F-governmental official; G-enterprise & commerce employee; H-retirees; I-private owners; J-other_____</td></tr>
<tr><td colspan="2">Construction contractor</td><td colspan="3">ZREIDC</td><td>Liaison</td><td colspan="2">WANG Lili, 15115350161</td></tr>
<tr><td colspan="2">Organization for environmental impact assessment</td><td colspan="3">Nanjing Guohuan Environmental Science & Technology Development Co., Ltd</td><td>Liaison</td><td colspan="2">SHEN Mingxia, 13451890345</td></tr>
<tr><td>Project overview</td><td colspan="7">“Qingshuitang heavy-metal contaminated area environmental improvement construction project”, in Zhuzhou Qingshuitang Industrial Zone, includes land area of 8.48km^2, consisting of Xiangshiling sub-region, Qingshi sub-region, Tongtangwan sub-region, Tongxia sub-region, Qingshui sub-region, Yingfeng sub-region and Qingshui Lake sub-region; the contents of pollution control relating to the project include all solid wastes such as local soil, soil of closed facilities, waste residue, channel and pond sediment and construction waste, to a total volume of 2020700m^3; contaminated water area to be controlled is 345400m^3. control plan of contaminated area includes main construction works of: (1) clearing and leveling of the ground in project area; (2) control of contaminated soil and demolished site of closed facilities in project area; (3) control of water and sediment in contaminated channels and ponds in project area; (4) control of left waste residues in project area; (5) construction of one industrial solid waste landfill; (6) construction of landfill.</td></tr>
<tr><td>No.</td><td colspan="3">Question</td><td colspan="4">Option (Please tick the number you selected)</td></tr>
<tr><td>1</td><td colspan="3">Do you known the project?</td><td colspan="4">A-Yes; B-hear; C-No</td></tr>
<tr><td>2</td><td colspan="3">From which way do you know the project?</td><td colspan="4">A-newspaper; B-TV; C-internet; D-told by others</td></tr>
<tr><td>3</td><td colspan="3">What’s your opinion on the benefit of project construction to local economic development?</td><td colspan="4">A-favorable; B-adverse; C-have no idea</td></tr>
<tr><td>4</td><td colspan="3">What’s your opinion on the benefit of project construction to improving standard of living of local people?</td><td colspan="4">A-favorable; B-adverse; C-have no idea</td></tr>
<tr><td>5</td><td colspan="3">What about the environmental condition in the area you live?</td><td colspan="4">A-good; B-moderate; C-poor</td></tr>
<tr><td>6</td><td colspan="3">What are the major environmental problems in the area you live?</td><td colspan="4">A-surface water pollution; B-groundwater pollution; C-air pollution; D-ecological damage; E-soil contamination; F-noise</td></tr>
<tr><td>7</td><td colspan="3">What’s your opinion on potential major pollution impact of project construction on surrounding environments?</td><td colspan="4">A-wastewater pollution; B-exhaust gas pollution; C-noise; D-solid waste pollution; E-risky accident</td></tr>
<tr><td>8</td><td colspan="3">What do you concern about implementation of the project?</td><td colspan="4">A-economic benefit; B-environment betterment; C-industrial sustainability; D-</td></tr>
</table>

		job opportunity
9	What is the impact of the project on you and your family life?	A-very favorable; B-moderate impact; C-minor impact; D-adverse impact
10	What is the impact on your health after implementation of the project?	A-very favorable; B-moderate impact; C-minor impact; D-adverse impact
11	Do you agree to demolish your house during project construction?	A-support; B-conditional support; C-not support; D-reject
12	From the perspective of environmental protection, what is your attitude toward the project? (If you do not support, please briefly describe the cause)	A-support; B-not support; C- indifferent
In addition to above questions, what's your opinion or suggestion about project construction and environmental protection work?		

Table 14.2-2 Basic Composition of Public Participation Objects

Item		Number of persons	Percentage	Total
Nationality	Han	198	99.50%	100%
	other	1	0.50%	
Gender	male	122	61.31%	100%
	female	77	38.69%	
Age (years)	<20	0	0.00%	100%
	20-45	98	49.25%	
	46-60	65	32.66%	
	>60	24	12.06%	
	Other	12	6.03%	
Education	Above college	58	29.15%	100%
	Senior high school	32	16.08%	
	Junior high school	70	35.18%	
	Elementary school and below	7	3.52%	
	Other	32	16.08%	

Table 14.2-3 Statistic Findings of Public Participation

No.	Survey	Options						
1	What do you know about the project?	Newspaper	TV	Internet	Told by others	No opinion		
		32.66%	24.62%	11.56%	40.20%	2.01%		
2	What do you think about your living environment?	Good	Moderate	Poor	No opinion			
		2.51%	14.07%	80.90%	2.51%			
3	What are the environmental issues in the area where you live?	Surface water pollution	Groundwater pollution	Air pollution	Ecological damage	Soil contamination	Noise	No opinion
		49.25%	33.17%	82.41%	39.20%	50.25%	32.66%	1.51%
4	Do you know that this area's topsoil is contaminated by Cd,As, Pb, and other heavy metals?	Yes	No	uncertain	No opinion			
		73.87%	13.07%	10.05%	3.02%			
5	What do you think is the purpose of implementing this project?	Improve living environment, restore land's value	Treat contaminated soil, develop a platform for demonstrating environmental protection technology	unfamiliar	No opinions			
		80.40%	46.73%	8.54%	2.01%			
6	Do you know that this project is based on protecting human health and remediating soil contaminants such as heavy metals to a target value?	yes	No	uncertain	No opinion			
		49.75%	17.09%	27.14%	6.03%			

7	What are the positive effects that this project has made and you have paid attention to?	Treat contaminated soil	Improve living environment	Improve the area's investment environment	Promote the area's industrial transformation	Develop and utilize land resources	Promote development of environmental protection industry	Introduce advanced technology to the area	No opinion	
		72.86%	71.36%	40.70%	27.14%	23.12%	22.11%	14.07%	1.51%	
8	What do you think are the short-term impacts that this project may bring about on the environment?	Mechanical noise, vehicle noise	Dust, stench, and exhaust emissions	Soil erosion	Land used for construction	Congestion of existing road by construction vehicles	Increased number of migrant construction workers causing safety risk	Surface water pollution	Groundwater pollution	No opinion
		79.40%	67.34%	19.60%	34.67%	23.62%	26.13%	17.59%	15.58%	3.02%
9	What is your attitude toward the effects caused by the implementation of the project?	Understandable	Understandable but mitigation measures must be taken	No opinion	Unable to understand	No opinion				
		34.17%	55.78%	4.52%	5.03%	2.01%				
10	If this project is to have an impact on your living environment, what measures do you wish to be taken	Take control measures	Optimize engineering plan	Economic compensation or resettlement	Logical planning and layout	Plant greenbelt	Other	No opinion		
		57.79%	33.67%	63.82%	14.57%	12.56%	4.02%	2.01%		
11	If your home needs to be demolished, what do you think about it?	Monetary compensation	Compensation of demolished house with new house	Reasonable economic compensation	Improve housing condition	Other	No opinion			
		55.28%	17.09%	40.70%	12.06%	2.51%	3.52%			

12	From the perspective of environmental protection, what's your attitude toward the project?	Support	Do not support	Indifferent	No opinion	
		89.95%	1.51%	7.04%	1.51%	

Conclusion from and advice on surveys in which the public participated: Following conclusions are made according to statistic findings and analysis:

1. Most residents learn about the project from being told by others, and from newspapers and TV while 11.56 percent of the residents learn about the project online；

2. 80.9 percent of residents believe the area’s environmental quality is poor, concern about local air pollution, water pollution and soil contamination, and long for betterment of environment and resettlement.

3. The public believes the area’s main pollutions are air pollution, soil contamination, and surface water pollution.

4. 73.87 percent of survey respondents know that the area’s surface soil has been contaminated by Cd, As, Pb, and other heavy metals:

5. 80.4 percent of respondents believe that the project is aimed at improving living environment and restoring the land’s value; 46.73 percent of respondents believe that the project is aimed at treating contaminated soil and developing a platform for demonstrating environmental protection；

6. 49.75 percent of respondents know that the project is based on protecting human health and remediating soil contaminants such as heavy metals to a target value; 17.09 percent and 27.14 percent of respondents are either uncertain or having no idea; 6.03 percent of respondents have not voiced their opinions；

7. The positive impacts that this project has brought about and the public has paid attention to are treating contaminated soil, improving living environment, and improving the area’s investment environment；

8. With regard to the short-term impacts of implementation of the project on the environment, the public are concerned about mechanical noise, vehicle noise, dust, stench, and land used for construction；

9. With regard to the impacts caused by the implementation of the project, 55.78 percent of respondents believe the impacts are understandable but mitigation measures must be taken; 34.17 percent of respondents say the impacts are understandable; 4.52 percent of respondents withhold their opinions; and 5.03 percent of respondents believe the impacts are not understandable；

10. With regard to the impacts of the project's construction on the environment, 63.82 percent of respondents wish there are options of either monetary compensation or relocation; 57.79 percent of respondents want treatment measures to be taken; 33.67 percent of respondents want the engineering plan to be optimized；

11. With regard to housing demolition, 55.28 percent of respondents want monetary compensation; 40.7 percent of respondents want their housing conditions to be improved; 2.51 percent of respondents have other opinions; 3.52 percent of respondents withhold their opinions；

12. 89.95 percent of respondents favor the project's construction, 7.04 percent of respondents say they are indifferent to it, 1.51 percent of respondents withhold their opinions, and 3 respondents (1.51 percent of respondents) were against it. These three respondents were against it because they believed that land treatment alone would not help much and that residents would still suffer from groundwater, air and other types of pollutions; they instread favored the idea that treatment should be implemented after residents are relocated altogether. The EPA, the construction organization, and residents communicated with each other. Given financial resources at this time, collective relocation will be difficult to carry out. Currently, it is advised to restore contaminated soil in the area. Land designated as residential land can be restored to a target value; concentrated resettlement communities are being constructed in the area; and in the future, residents will be relocated gradually based on the usage of land.

(2.) Public participation by social group

Communities and civil NGOs in the project area are consulted for opinions and suggestions in the form of interview; the format of questionnaire is as shown in **Table 14.2-4**.

Table 14.2-4 World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project Questionnaire for Public Participation of Environmental Impact Assessment (Group)

Entity (Seal):	
Address:	
Property: Contact:	
Project overview	"Qingshuitang heavy-metal contaminated area environmental improvement construction project", in Zhuzhou Qingshuitang Industrial Zone, includes land area of 8.48km^2, consisting of Xiangshiling sub-region, Qingshi sub-region, Tongtangwan sub-region, Tongxia sub-region, Qingshui sub-region, Yingfeng sub-region and Qingshui Lake sub-region; the contents of pollution control relating to the project include all solid wastes such as local soil, soil of closed facilities, waste residue, channel and pond sediment and construction waste, to a total volume of 2020700m^3; contaminated water area to be controlled is 345400m^3. control plan of contaminated area includes main construction works of: (1) clearing and leveling of the ground in project area; (2) control of contaminated soil and demolished site of closed facilities in project area; (3) control of water and sediment in contaminated channels and ponds in project area; (4) control of left waste residues in project area; (5) construction of one industrial solid waste landfill; (6) construction of landfill.
Content of inquiry (Please tick in the blank)	
Are you satisfactory to current environmental quality in your area? (If NO, please describe the cause) □very satisfactory; □satisfactory; □unsatisfactory; □absolutely unsatisfactory	
Do you know/understand the project to be constructed in your area? □know very well; □yes; □no	
From which channel do you know the information on the project? □newspaper; □TV & broadcast; □billboard; □civil information	
With the information available to you, what is the adverse impact of the project on environmental quality? □minor; □moderate; □major; □unknown	
With the information available to you, what is the betterment of local environmental quality after implementation of the project? □minor; □moderate; □major; □unknown	
With the information available to you, what is the impact on the health of local residents after implementation of the project? □very favorable; □moderate; □minor; □adverse	
From the perspective of environmental protection, what's your attitude toward the project? And please briefly describe the cause □absolutely reject; □reject; □conditional support (Describe the cause) ______________________	
What's your suggestions and requirements with regard to environmental protection of the project?	
What's your suggestions and requirements for approval of the project by environmental protection department?	

Statistic findings are as shown in **Table 14.2-5**.

Table 14.2-5 Statistic Findings of Public Participation by Groups

No.	Entity	Contact	Attitude
1	Yingfeng Community of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	28314821	Support
2	Tongtangwan Subdistrict Community of Shifeng District of Zhuzhou City	22797162	Support
3	Qingxia Community of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	28314225	Conditional support
4	Jianshe Village of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	28314819	Support
5	New Xiawan Village of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	22610753	Conditional support
6	Zhushan Community of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	28632318	Conditional support
7	Dingshan Community of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	28589877	Support
8	Qingshuitang Community of Tongtangwan Subdistrict of Shifeng District of Zhuzhou City	18773367877	Support

Conclusion and Suggestion for the Inquiry of Public Participation:

Following conclusions are made according to statistic findings and analysis:

All groups support project construction, with 100% support ratio; however, requirements and suggestions are made by all communities: thorough control of sub-regions is suggested for the good of villagers; overall demolition and resettlement are desired.

14.2.2.2 Public Participation Symposium

To hear more ideas and suggestions of affected people, subject team of environmental impact assessment organizes public participation symposium of residents' representatives from all affected communities in project area, attendants are officials from Zhuzhou Urban-Rural Construction Bureau, Zhuzhou Rural Works Bureau, Zhuzhou Land and Resources Bureau, Zhuzhou Planning Bureau, Zhuzhou Environmental Protection Bureau and Tongtangwan Subdistrict Office and residents' representatives (Attached are list of attendants) ; **Figure14.2-1** is the picture of symposium; the minutes of symposium are included in the attachment.

Figure14.2-1 First Public Participation Symposium

At the symposium, the delegates are given a presentation of project profile by construction contractor, evaluate the purpose of respective units to the symposium, potential environmental impact of the project and etc; the attendants utter their own opinions and suggestions about the project.

To conclude the results of public participation, overall attitude, treatment and reply regarding the project are as shown in **Table 14.2-6**:

Table 14.2-6 Collections of Public Opinions & Reply at Symposium

No.	Public opinions		Reply to public opinion
1	Shifeng Environmental Protection Bureau	a). The organization for environmental impact assessment is proposed to make wide public inquiry;b). take effective environmental protection measures during construction period to prevent secondary pollution; take effective environmental protection measures during the period of pollution control to avoid unnecessary trouble;	According to domestic and World Bank's requirements for public participation in environmental impact assessment, the organization for environmental impact assessment organizes twice public consultations in the forms of media statement, questionnaire, poster of public notice and field interview; the report of environmental impact assessment includes strict environmental protection measures and environmental supervision requirements during project construction and pollution control, so as to avoid secondary pollution.
2	Zhuzhou Planning Bureau	Actively support environmental improvement work of the project; call for pollution control construction of the project, for instance, site selection and environmental impact assessment to be completed before construction of landfill;	Plan on site selection of landfill and landfill environmental is compared in impact assessment and feasibility study, however, this work should be carried out according to applicable national regulatory requirements during actual construction.
3	Zhuzhou Land and Resources Bureau	It's proposed to handle land approval formality as required during pollution control by sub-regions;	The employer promises to handle land approval procedure as required in actual sub-region control.
4	Zhuzhou Rural Works Bureau	Call for proper cropland control	All land plots in the project area are unsuitable fro farming; contaminated soil will not be used as cropland after remediation in the future.
5	Opinions of residents' representatives	Jianshe Village: Dahu spoil ground of the project is located in Jianshe Village, local residents are unknown about the type of waste residue, waste residues to be treated or not to be treated, so they expect to be informed in this respect, please explain clearly;	The employer has considered erection of conspicuous signboard in waste residue staging area, indicating the types of hazardous wastes.
6		Qingxia Community: Xinqiao spoil ground is located in the community, overall resettlement, overall control and planning are required for thorough control; this sub-region suffers the most serious environmental pollution among 7 sub-regions in terms of noxious fume, toxic gas and noxious water pollution, the health of affected residents is endangered, they wish resettlement, and they support the project construction even id such resettlement is impractical in current stage;	According to the planning of ecotype new city, on the contaminated soil in this sub-region, residential district will be construction by replanning after remediation; in the future, the residents will be resettled in terms of remediation progress of contaminated soil; in current stage, environmental protection department will strengthen supervision of settled enterprises in accordance with revised Environmental Protection Law of the People's Republic of China, so as to ensure standard discharge of three wastes;
7		Zhushan Community: the villagers reflect major problems of noxious fume and toxic gas, the residents' vegetable field and cropland are seriously	

		polluted; their appeal includes two aspects: (1)resettlement of them; and (2)relocation of mining operators as pollution source;	relocation plan is made for polluting enterprises, which will be relocated step by step.
8		Tongtangwan Community: there're many old communities (Such as some residential areas in plant area) , with poor planning environment, it's proposed to include reconstruction of this community in the pollution control project;	
9		Yingfeng Community: local residents have the impression of worse air pollution than soil contamination; air pollution is the source of soil contamination should be controlled;	
10		World Bank is acknowledged for concerning about environmental pollution in Qingshuitang area; local residents strongly support "major and minor control of environmental pollution", and they're absolute advocators and supporters of environmental improvement！	

14.2.2.3 Media Statement

According to the requirements of Provisional Regulations on Public Participation In Environmental Impact Assessment, on July 14, 2014, a statement for first public participation in environmental impact assessment about "World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project" was published on official website of Zhuzhou Municipal People's Government (www.zhuzhou.gov.cn) (See **Figure14.2-2**); the period of statement is 10 days, to inform the public of more information on main contents of the project, as well as potential environmental impact after implementation of the project, so as to hear public opinions.

Figure14.2-2 First Online Statement of Project Information

14.2.2.4 Poster of Public Notice

To allow the public in the project area understanding main contents of the project from more channels, and consult for hearing more public opinions, construction contractor and organization for environmental impact assessment poster project information on village affairs billboards of various communities, see **Figure14.2-3**.

1. Jianshe Village

2. Yingfeng Comm

3. Tongtangwan Community

4. Zhushan Comm

5. Dingshan Community	6. Qingshuitang Com
	
7. Qingxia Community	8. New Xiawan Vi

Figure14.2-3Photos of First Public Participation

14.3Second Public Participation

14.3.1 Scope of Inquiry

According to the requirements of Environmental Protection Law of the People's Republic of China, on the principle of fair, open, authentic and objective inquiry, second inquiry for public opinions after finishing first draft of the project.

14.3.2 Method of Inquiry

14.3.2.1 Questionnaire

(1.) Individual inquiry

The scope of inquiry of public participation include villages, business and institutional units, some CCP and governmental bodies in project area and surrounding areas, and the objects of inquiry include groups of residents, officials, workers and farmers in different social standings and professions in planning area. A total of 200 questionnaires are issued; 199 valid questionnaires are called back, valid callback ratio is 99.5%.

Particular content of individual inquiry for public participation is listed in **Table 14.3-1**.

Statistic compositions of public inquiry objects are listed in **Table 14.3-2**.

Statistic findings of inquiry are listed in **Table 14.3-3**.

Table 14.3-1 World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project Questionnaire for Second Public Participation of Environmental Impact Assessment (Individual)

<table>
<tr><td>Name</td><td></td><td>Sex</td><td></td><td>Age</td><td></td><td>Nationality</td><td></td></tr>
<tr><td>Education</td><td></td><td>Telephone number</td><td></td><td>Residence</td><td colspan="3"></td></tr>
<tr><td colspan="2">Profession</td><td colspan="6">A-worker; B-farmer; C-serviceman; D-student; E-science-education-culture-health professional; F-official; G-enterprise & business staff; H-retiree; I-private owner; J-other_____</td></tr>
<tr><td colspan="2">Construction contractor</td><td colspan="3">ZREIDC</td><td>Liaison</td><td colspan="2">WANG Lili, 15115350161</td></tr>
<tr><td colspan="2">Organization for environmental impact assessment</td><td colspan="3">Nanjing Guohuan Environmental Science & Technology Development Co., Ltd</td><td>Liaison</td><td colspan="2">SHEN Mingxia, (025)85287024 13451890345</td></tr>
<tr><td>Project overview</td><td colspan="7">1.. Summary of Project:
“Qingshuitang heavy-metal contaminated area environmental improvement project”, in Zhuzhou Qingshuitang Industrial Zone, includes land area of 8.48km^2, total control area in project area is 2.75km2; the actions to be taken include five aspects:
(1) Soil clearing and remediation:
a). Soil clearing: the area of soil clearing is 2.30km^2; removal of 45843m^3 construction wastes; demolition of 6 closed facilities, including Zhuzhou Yongfa Metal Refining Co., Ltd, Zhuzhou Brothers Industry Co., Ltd, Zhuzhou Kangli Smelting Plant, Zhuzhou Tiancheng Chemical Co., Ltd, Zhuzhou Xinda Smelting Co., Ltd and Zhuzhou Hehua Cement Plant.
Removal of residential areas: houses of 167 families need to be demolished, including 665 affected residents, mainly from New Xiawan Village, Yingfeng Community, Qingxia Community and Jianshe Village.
b). replacement and backfill of uncovered soil: replacement and backfill of uncovered soil in neighboring residential areas in Xiangshiling sub-region, Qingshi sub-region and Tongtangwan sub-region, as well as residential areas surrounding demolished facilities.
c). Soil remediation at contaminated sites:
Treatment of heavy-metal contaminated soil: in addition to make references to applicable domestic and foreign standards, the framework of Super fund Program of United States Environmental Protection Agency (USEPA) is referred for selected soil remediation technology for the project; finalized methods for soil remediation are in-situ stabilization+separation, in-situ stabilization+ecological restoration, ex-situ solidification/stabilization, displacement to planned industrial land, ecological restoration and ecological interception technology.
Treatment of organic contaminated soil: handled to Sinoma (Zhuzhou) Cement Co., Ltd outside project area for incineration treatment.
d). Treatment of waste residue: waste residue staging areas in the project area are residue dump in Tongxia sub-region, waste residue in the plant area of Zhuzhou Hongji Zinc Industry Co., Ltd and scattered waste residue along low discharge channel, all of which are dredged and directly delivered to stabilized/solidification plant for treatment, and then delivered to solid waste landfill for landfilling.
(2) Treatment of channel and pond water and sediment
Total area of 26 ponds for pollution control is 0.17km^2, the area for pollution control in old Xiawangang and Xinqiao low discharge channel is 0.08km^2; dry port dredging is adopted, after dewatering of contaminated sediment, it’s delivered to stabilized/solidification plant for further treatment.
(3) Construction of soil remediation utilities
Xinqiao waste residue ground is leased as solidification/stabilization plant and Xiawangang dewatering site;
New dewatering site: land area is about 4200m^2.
Temporary piling area: temporary piling area is arranged beside solidification/stabilization plant, to an area of 10000m^2, for temporary storage of about</td></tr>
</table>

	150000m^3 solid wastes. Solid waste landfill: construction of landfill on unused limestone mine of Zhuzhou Hehua Cement Plant, land area is about 38265m2; available total capacity of the mine is 2000000m^3. Temporary road: reconstruction of 13832m village road, construction of 1802m temporary road; Tongxia Road, Qingxia Road, old Tongxia Road and Huanbao Avenue under construction are designed as main handling roads, other village roads as auxiliary handling roads; earth will be handled by making use of existing roads, reconstruction of village roads as appropriate and construction of some temporary roads. (4) Construction of Qingshui Lake ecological wetland Total land area of Qingshui Lake ecological wetland is about 64ha (23ha in east Qingshui Lake, 41ha in west Qingshui Lake) , the area of reclaimed water is 23ha. (5) Construction of landfill: construction area is 12800m^2, including the complex of landfill, environmental protection museum, rooms for services, and land for project tests (Demonstration base). Construction period of the project is Oct 2015～Oct 2022. 2.. Site investigation & Risk Assessment During 2011-2014, experts from Institute of Soil Science, Chinese Academy of Sciences and Nanjing Institute of Environmental Sciences(NIES) of Ministry of Environmental Protection (MEP) conducted detailed site investigation and risk assessment of project area; the conclusions are: local soil is generally contaminated by heavy metal, topsoil is featured by serious enrichment; major contaminations in the risk assessment are cadmium, arsenic and lead; according to Guidelines for Risk Assessment of Contaminated Sites published in 2014 and with software, models and parameters for risk assessment by foreign authoritative organizations, objective values for remediation of contaminated sites are determined as follows: in case of residential land, objective values for recommended removal of arsenic, cadmium and lead are 30mg/kg, 10mg/kg and 400mg/kg, respectively; in case of nonresidential land, objective values for recommended removal of arsenic, cadmium and lead are 60mg/kg, 30mg/kg and 600mg/kg, respectively; these objective values for soil remediation are approved by Zhuzhou Environmental Protection Bureau. 3.. Determination of Remediation Areas On the basis of the conclusions of risk assessment, according to objective values for removal of contaminations, and considering the progress of implementation of current projects as well as production of the enterprises in the area, organization for feasibility study reviewed the risk assessment report, and divided the project area into controllable risk sub-region, acceptable risk sub-region and sub-region requiring remediation. The area of sub-region requiring remediation is 2.75km^2, which is control area of the project. Total area of controllable risk sub-region and acceptable risk sub-region is 5.73km^2, where there's no activity to be implemented for the project, but belonging to part of project area; if any remediation activity is required in the future, similar environmental and social standards should be observed. 4.. Division of Assessment Period Construction period: including coil clearing in the project area (Oct 2015～Dec 2019); construction of dewatering site (Nov 2015～April 2016); construction of temporary piling area (Oct 2015～April 2017); construction of landfill (Sep 2016～Sep 2018); construction of landfill (June 2016～Dec 2017); excavation of soil for remediation, interception, diversion and dredging process of ports, channels and ponds, construction process of Qingshuitang ecological wetland (Jan 2016～Dec 2021). Operation period: dewatering and solidification/stabilization works of ex-situ remediation soil, waste residue and sediment (Jan 2016～Dec 2021); landfilling work of landfill (Landfilling works of solid waste of the project during June 2018～Dec 2021; final service period to Dec 2026). Closing period: closing period of landfill (Dec 2026～June 2027). 5.. Social, Economic & Environment Benefits The project is an integrated environmental protection and environmental improvement of urban industrial zone project. Implementation of the project allows

	harmless treatment of the soil in Qingshuitang heavy-metal contaminated area, avoids heavy-metal contained soil from potential risk to Xiang River, and improves water quality of Xiang River, with remarkable social, economic and environmental benefits. Implementation of the project allows harmless treatment of heavy metal contaminations such as cadmium, lead, arsenic and etc in contaminated soil and sediment, eliminates heavy metal internal pollution in Qingshuitang Industrial Zone, eliminates potential risk of heavy-metal pollution, helps improving downstream water quality of Xiang River, water environmental quality of Xiang River will become better, thus the project has remarkable ecological & environmental benefits. Implementation of the project will bring great social benefit: technical elimination of pollution source benefits the people, construction of habitable ecotype city; in line with general planning of Zhuzhou City, the project will improve local investment environment, drive local economic development, boost economic restructuring, develop and utilize resources, expand urban space, tap historic and cultural resources, inherit historic context of Zhuzhou, establish scientific research demonstration project, facilitate development of environmental protection industry, expand capital source supporting project construction, and accelerate application of introduced technology. 6.. Negative Environmental Impact during Project Construction Generally, the project has positive social, economic and environmental benefits, however, certain environmental impact will be unavoidable during construction and operation of the project. Exhaust gas: fugitive dust, exhaust gas of oil-fueled machinery and construction vehicles, and sediment malodor. Wastewater: domestic sewage of construction personnel, initial rainwater from demolition of closed facilities, wash water of vehicles and machinery, heavy-metal contained wastewater from washing buildings/structures during demolition of enterprise premises, dredging tail water from dry dredging of port, channel and pond, sediment dewatering wastewater, seeper of landfill quarry and leaching of landfill. Groundwater :initial rainwater collecting tank, oil separation tank, sedimentation tank and chlorination reaction tank, leaching of landfill, ecological wetland catchment and etc may cause impact on groundwater. Main source of impact on groundwater level during construction period is ecological wetland catchment. The intake area and bottom of constructed wetland of the project are designed with anti-seepage layer, which allows constructed wetland system to constitute a relatively independent hydraulic system, and no notable hydraulic relation of purified water and adjacent groundwater in vertical and horizontal directions. Therefore, ecological wetland catchment has minor impact on local groundwater level. Noise: noise of construction machinery, and noise of vehicles during transportation. Solid waste: construction waste, sludge as the product of wastewater treatment, domestic waste and the like. Ecological impact: damage of trees, greenbelt and like vegetation as a result of construction, and soil erosion impact. After taking proper measures, standard emission/discharge of exhaust gas, wastewater and noise as well as zero discharge of solid waste are achievable; after taking anti-seepage measures, the project has minor impact on groundwater. 6.. Conclusion of Environmental Impact Assessment From environmental impact analysis, construction of the project complies with national industrial policy, conforms to local urban planning, general planning and other development planning, and aligns with local environment functional zoning; negative impact on surrounding environment is acceptable before and after construction of the project, positive social, economic and environmental benefits prevail; implementation of the project will drive local sustainable development and improve local environmental quality. Therefore, environmental impact assessment of the project suggests that as long as World Bank's requirements of applicable environmental policy and domestic "three simultaneousness" system are implemented during construction and production periods of the project, ensure simultaneous design, construction and putting into operation of pollution control measures and main construction, minimize negative impact of the project, perfectly

	integrate economic benefit, social benefit and environmental benefit, so as to realize economic, social and environment sustainability. Discharge of contaminations by the enterprises in and out of project area threatens soil environmental quality after pollution control of the project; these enterprises are required for standard discharge of contaminations before relocation, and actively taking measures to reduce the output and discharge of contaminations; moreover, these enterprises should be called for faster progress of relocation and industrial transformation. After taking above measures, and from the perspective of environmental protection, construction of "World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project" is feasible in terms of environmental protection.	
No.	Question	Option (Please tick the number you selected)
1	How do you know about the project?	A-newspaper; B-TV; C-internet; D-told by others
2	How do you think about the status of your living environment?	A-good; B-moderate; C-poor
3	Which environmental problems are unsolved in your living area? (Multiple options)	A-surface water pollution; B-groundwater pollution; C-air pollution; D-ecological damage; E-soil contamination; F-noise
4	Do you know topsoil in your living area is contaminated by heavy metals such as cadmium, arsenic and lead?	A-yes; B-no; C-unsure
5	Do you know main purpose for implementation of the project? (Multiple options)	A-improvement of habitable environment, restoration of land use value; B-treatment of contaminated soil, construction of environmental protection demonstration technical platform; C-have no idea
6	Do you know the project is based on protection of human health and remediation of heavy metal contaminations in contaminated soil to given objective values?	A-yes; B-no; C-unsure
7	What positive impact of the project do you concern most? (Multiple options)	A-remediation of contaminated soil; B-improvement of living environment; C-improvement of local investment environment; D; promote local industrial transformation; E-development and utilization of land resource; F-facilitate development of environmental protection industry; G-introduction of advanced technology
8	What environmental impact will occur during implementation of the project tin the short term? (Multiple options)	A-machinery noise, vehicle noise; B-fugitive dust, malodor and like exhaust pollution; C-soil erosion; D-construction land occupation; E-congestion of existing road by construction vehicle; F-increased number of migrant construction workers causing safety risk; G-surface water pollution; H-groundwater pollution
9	What's your attitude toward the impact during implementation of the project?	A-understandable; B- understandable by taking mitigation measures; C-no opinion; D-not understandable
10	If project construction has certain impact on your living environment, what measures will be taken in your opinion? (Multiple options)	A-take control measures; B-optimize construction plan; C-economic compensation or resettlement; D-logical planning and layout; E-plant greenbelt; F-other
11	If it's necessary to demolish your house, what's your opinion?	A-monetary compensation; B-compensation of demolished house with new house; C-fair economic compensation; D-improve housing condition; D-other

12	From the perspective of environmental protection, what’s your attitude toward the project？ (Single option, if you do not support, please describe the cause)	A-support; B-do not support; C-indifferent
In addition to above questions, what’s your opinions or suggestions for construction and environmental protection of the project？		

Note: after this round of public consultation, the project activities were modified. The Qingshui Lake Constructed Wetland is dropped from the project. The two channels, i.e. Old Xiawanggang and Xinqiao Low Discharge Channel had to start earlier hence not financed by the project.

Table 14.3-2 Basic Composition of Public Participation Objects

Item		Number of participants	Percentage in effective responses	Total
Ethnicity	Han	198	99.50%	100%
	Left blank	1	0.50%	
Gender	Male	122	61.31%	100%
	Female	77	38.69%	
Age	< 20	0	0.00%	100%
	20-45	98	49.25%	
	46-60	65	32.66%	
	>60	24	12.06%	
	Left blank	12	6.03%	
Educational level	College and above	58	29.15%	100%
	Senior high school	32	16.08%	
	Junior high school	70	35.18%	
	Primary school or below	7	3.52%	
	Left blank	32	16.08%	

Table 14.3-3 Statistic Findings of Public Participation

No.	Investigation item	Options								
1	How did you know about this project?	Newspaper	TV	Internet	From others	Left blank				
		32.66%	24.62%	11.56%	40.20%	2.01%				
2	How do you think about your current living environment?	Good	So so	Poor	Left blank					
		2.51%	14.07%	80.90%	2.51%					
3	Whate are the major environmental issues in the region where you live?	Surface water contamination	Groundwater contamination	Air pollution	Ecological damage	Soil contamination	Noise	Left blank		
		49.25%	33.17%	82.41%	39.20%	50.25%	32.66%	1.51%		
4	Do you know that the topsoil of the area has been contaminated by heavy metals such as cadmium, arsenic and lead?	Yes	No	Not sure	Left blank					
		73.87%	13.07%	10.05%	3.02%					
5	Do you know what is the main objective of this project?	Improve living environment and restore the utilization value of land	Remediate contaminated soil and establish an environmental protection demonstration platform	I don't know about it	Left blank					
		80.40%	46.73%	8.54%	2.01%					
6	Do you know that this project is aimed at safeguarding human health and restoring the content of contaminant heavy metals to a certain target value?	Yes	No	Not sure	Left blank					
		49.75%	17.09%	27.14%	6.03%					
7	The main positive effects of the project that you concern are:	Remediating contaminated soil	Improving living environment	Improving regional investment environment	Promoting industrial transformation of the region	Developing and utilizing land resources	Promoting deveopment of environmental protection industry	Introducing in advanced technologies	Left blank	

No.	Investigation item	Options								
		72.86%	71.36%	40.70%	27.14%	23.12%	22.11%	14.07%	1.51 %	
8	What do you think are the possible short-term environmental impacts of the project in the implementation phase?	Noises from machines and transport vehicles	Air pollution cuased by dusts, stench and the like	Wate and soil loss	Land occupied for construction	Roads become crowded due to construction vehicles	More non-native construction workers may cause security matters	Surface water contamina tion	Grou ndwa ter conta minat ion	Le ft bla nk
		79.40%	67.34%	19.60%	34.67%	23.62%	26.13%	17.59%	15.58 %	3.0 2%
9	What is your opinion about the impacts of the project in the implementation phase?	Acceptable	Acceptable but necessary mitigation measures should be taken	No opinion	Unacceptable	Left blank				
		34.17%	55.78%	4.52%	5.03%	2.01%				
10	If the construction of the project has a certain impact on your living environment, what measures do you expect to be taken?	Taking remediation measures	Optimizing project plan	Financial compensati on or relocation	Reasonalbe planning	Greenbelt	Other	Left blank		
		57.79%	33.67%	63.82%	14.57%	12.56%	4.02%	2.01%		
11	What is your opinion if your house need to be demolished?	Monetary compensation	House replacement	Reasonable financial compensati on	Improving living environment	Other	Left blank			
		55.28%	17.09%	40.70%	12.06%	2.51%	3.52%			
12	From the perspective of environmental protection, what attitude do you hold towards this project?	Favorable	Unfavorable	I don't care	Left blank					
		89.95%	1.51%	7.04%	1.51%					

Conclusion and Suggestion for the Inquiry of Public Participation:

Following conclusions are made according to statistic findings and analysis:

1、Most of the the residents get project information through other people, newspaper or television, 11.56% of the residents learn the project information through the internet.

2、80.9% of the public believe the regional environmental quality is poor, they also express worries about the regional air pollution, water pollution and soil pollution, and long for betterment of environment and resettlement.

3、The public believes main local pollutions are air pollution, soil contamination, surface water pollution .

4、73.87% of the public believe the regional surface soil is polluted by heavy metals such as cadmium, arsenic,Pb.,etc;

5、80.4% of the public believe the project purpose is to improve the habitable environment and restore the value of land-use, 46.73% of the public think the project aims to remediate the contaminated soil and establish the environmental protection demonstration platform;

6、49.75% of the public know the project is based on the protection of human health, aiming to remediate the polluted soil till the heavy metal pollutants reduced to a certain target, while 17.09% and 27.14% of the public is not sure or not clear about it, another 6.03% of the public express no comment;

7、The positive impact of project implementation that the public most concern is the remediation of polluted soil, improvement of local environmental quality and investment situation;

8、As for the short-term impact on the environment during project implementation, What the public most concern is the vehicles noise, mechanical noise, dust, stench, construction land occupation, etc.;

9、If the project construction causes certain impact, 55.78% of the public express their understanding but requiring to take mitigation measures, 4.52% of the public express no comments, and 5.03% of the public will not forgive;

10、For the certain impact that project construction may have on living environment, 63.82% people expects economic compensation or resettlement, 57.79% people expect taking remediation measures, while 33.67% people expect to optimize project scheme;

11、For house demolition, 55.28% of the public expect monetary compensation, 40.7% of the public want reasonable economic compensation, 17.09% of the public wish to relocated the demolished house, 12.06% of the public expect to improve their living conditions, and 2.51% people choose other opinions, 3.52% of the public make no comment;

89.95% of the public support the project construction, and 7.04% expresses their carelessness, 1.51% people make no comment, and 1.51% (3 people) will not support the project construction, mainly because they suppose that merely remediate the soil make small effect, resident are still subject to groundwater pollution, air pollution,etc., they are expecting to relocate as a whole. According to the result of survey, what the public generally asked for is to implement the remediation after relocation as a whole. After communicating and coordinating with the residents, and combine with the actual situation of capital, the EIA consultant and construction unit consider it's hard to relocate as a whole. For current,it's planned to conduct brownfield remediation, aiming to remediate the planned residential land to the proposed target; Besides, the local government is constructing centralized resettlement community , and will complete the relocation of residents step by step, based on the future land use.

(2.) Public participation by social group

Communities and civil NGOs in the project area are consulted for opinions and suggestions in the form of interview; the format of questionnaire is as shown in **Table 14.3-4**.

Table 14.3-4 World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project Questionnaire for Second Public Participation of Environmental Impact Assessment (Group)

<table>
<tr><td colspan="2">Entity (Seal):</td></tr>
<tr><td colspan="2">Address:</td></tr>
<tr><td colspan="2">Property: Contact:</td></tr>
<tr><td>Project overview</td><td>“Qingshuitang heavy-metal contaminated area environmental improvement project”, in Zhuzhou Qingshuitang Industrial Zone, includes land area of8.48km², sub-regions are Xiangshiling sub-region, Qingshi sub-region, Tongtangwan sub-region, Tongxia sub-region, Qingshui sub-region, Yingfeng sub-region and Qingshui Lake sub-region; total area of sub-regions to be controlled is 2.75 km², including 2.19 km² soil, 0.29 km² remaining field of closed facilities, 0.28 km² water area of ports and channels, 0.04km² remaining waste residue staging area, 1.80m³ construction waste for treatment by demolition; total volume of sub-region soil, soil of closed facilities, waste residue, channel and pond sediment and construction waste is 2020700m³; contaminated water area for environmental improvement is 345400m³.
Major construction contents of the project include: (1) ground clearing and leveling in project area; (2) remediation of contaminated soil and treatment of remaining field of closed facilities in project area; (3) treatment of sediment in contaminated channels, ponds and water area in project area; (4) treatment of remaining waste residue in project area; (5) construction of one industrial solid waste landfill ; (6) construction of landfill; (7) construction of Qingshui Lake ecological wetland.
Water contamination in pollution control process includes: (1) wastewater from heavy-metal contaminated sediment treatment construction, including wastewater from pond water, sludge dredging tail water and sediment dewatering; (2) initial rainwater in solidification/stabilization plant; (3) leaching of landfill; (4) domestic sewage; (5) experimental wastewater from construction technical research center; main sources of air pollution are dust from mixing and screening during stabilization treatment, fugitive dust from excavation and handling of heavy-metal contained soil, as well as malodor from sediment dredging, soil stabilization depositing reaction, and fugitive dust of landfill; main noise sources are various wastewater lift pumps, mixing stations, excavators, bulldozers and like equipments, as well as noise of transporting vehicles; main sources of solid waste are soil after stabilization treatment and domestic waste of construction personnel.
Measure for disposal of various contaminations: wastewater: (1) construction waste washing wastewater treatment system, after sedimentation, supernatant is used in water recycling for dilution of solidification/stabilization treatment system; (2) wastewater from heavy-metal contaminated sediment treatment construction, including pond water, sludge dredging tail water and sediment dewatering wastewater; pond water will be connected to Tongxia Road municipal sewage pipe, treated at Xiawan wastewater treatment plant before standard discharge; dredging tail water will be treated by 4 sets of mobile water treatment equipment according to Integrated Wastewater Discharge Standard, Class I, before direct standard discharge; sediment dewatering wastewater will be pretreated treatment according to the requirements of Qingshuitang industrial wastewater treatment plant for influent wastewater quality, and then discharged to Qingshuitang industrial wastewater treatment plant for further treatment; (3) leaching produced by landfill will be treated by wastewater treatment unit; treatment process adopts neutralization-aeration –dewatering process, treated leaching complies with Integrated Wastewater Discharge Standard (GB8978), Table 1 and Table 4, Class 2.before standard discharge. exhaust gas: (1) malodor : cover plate or protective greenbelt will be erected in concentrated area of odor source of the project to reduce the environmental impact of malodor; (2) mixing and screening dust: ensure water content of soil, sediment, waste residue and aggregate; automatic discharge is adopted for solidification mixing; mixed materials are stored in closed workshop; reclaimed water is added by circumferential ejecting from mixing tank during solidification batching; (3) fugitive dust: spray water to suppress dust, spray water for 4-5 times per day to reduce about 70％ fugitive dust. noise: if construction area is close to densely populated residential area, temporary sound insulating wall should be constructed near the residential area; the height of sound insulating</td></tr>
</table>

	wall should not be less than 2.5m. solid waste: all soil after stabilization treatment should be backfilled in original position, waste residue after treatment should be treated by landfilling at landfill, which has minor environmental impact; domestic waste should be collected, cleaned and carried away by urban sanitation department in a timely manner. The implementation of the project may: (1)remove heavy metal contaminations of cadmium, lead, Hg and Zn in sediment; (2) eliminate key heavy metal internal pollution of Qingshuitang Industrial Zone, and eliminate potential risk of heavy-metal pollution; (3) improve downstream water quality of Xiang River; (4) improve air quality in suburb of Zhuzhou City; thus, the project has favorable environmental benefit; in addition, implementation of the project will bring great social benefit, improve drinking water quality for downstream citizens, protect physical health of downstream citizens; soil remediation will increase local land productivity, leading to notable economic benefit; (3) enhance comprehensive value in Xiang River downstream section, especially after construction of landscape zone in Changsha, Zhuzhou and Xiangtan cities, cultural and tourism values will increase continuously.
Content of inquiry (Please tick in the blank)	
Are you satisfactory to current environmental quality in your area? (If NO, please describe the cause) □very satisfactory; □satisfactory; □unsatisfactory; □absolutely unsatisfactory	
Do you know/understand the project to be constructed in your area? □know very well; □yes; □no	
From which channel do you know the information on the project? □newspaper; □TV & broadcast; □billboard; □civil information	
With the information available to you, what is the adverse impact of the project on environmental quality? □minor; □moderate; □major; □unknown	
With the information available to you, what is the betterment of local environmental quality after implementation of the project? □minor; □moderate; □major; □unknown	
With the information available to you, what is the impact on the health of local residents after implementation of the project? □very favorable; □moderate; □minor; □adverse	
From the perspective of environmental protection, what's your attitude toward the project? And please briefly describe the cause □absolutely reject; □reject; □conditional support (Describe the cause) __________________	
What's your suggestions and requirements with regard to environmental protection of the project?	
What's your suggestions and requirements with regard topsoil of the project by environmental protection department?	

Statistic findings are as shown in **Table 14.3-5**.

Table 14.3-5 Statistic Findings of Public Participation by Groups

No.	Entity	Contact	Attitude
1	Zhuzhou association for construction of resource-conserving and environment-friendly society	28686862	Support
2	Zhuzhou Xinda Smelting Co., Ltd	13762308491	Absolute support
3	Zhuzhou Kangli Smelting Plant	0731-28317229	Absolute support
4	Zhuzhou Hehua Cement Plant	0731-28631013	Absolute support
5	Zhuzhou Tianyuan Textile Co., Ltd, Degumming Plant	13789087265	Absolute support
6	Hunan Hongguan Real Estate Development Co., Ltd	0731-28916600	Absolute support
7	Zhuzhou Hongji Zinc Industry Co., Ltd	13973305221	Conditional support

Conclusion and Suggestion for the Inquiry of Public Participation:

Following conclusions are made according to statistic findings and analysis:

All groups support project construction, with 100% support ratio; however, requirements and suggestions are made by all communities: during pollution control, consideration should be given to the affected enterprises and employees.

14.3.2.2 Interview

In the field work, environmental impact assessment staffs interviewed local residents from several communities, they introduced to the interviewees about basic information on the content of project construction, as well as environmental impact of the project during construction period and operation period.

Figure14.3-1 Photo of Inquiry & Interview for Second Public Participation

The interviewed residents expressed following opinions and suggestions for the project:

1. How will the land currently not included for remediation be disposed in case of risk in the future?

2. Local residents should not be disturbed to the minimum extent during construction process, how will this principle be reflected in the conceptual design?

3. For the land plot of Qingshui Lake close to Xiang River, where excess heavy metal is tested from vegetable and soil, how will the farmland in this area be disposed?

For above questions, technicians from the organizations for environmental impact assessment and feasibility study communicated with the residents and replied as follows:

1. According to the results of environmental research for many times, large parcels of ground surface in of residential areas are hardened without soil contamination; moreover, the organization for feasibility study has surveyed small parcel of uncovered topsoil surrounding residential area according to the requirements of World Bank; for uncovered soil of heavy-metal contamination, soil replacement will be adopted for soil remediation.

2. Major impact on the residents during construction includes construction fugitive dust, sediment dredging malodor and construction noise.

The construction contractor is required to take following measures to suppress construction fugitive dust: setup of not less than 2m high enclosure facility conforming to applicable specification around construction site; setup of special deposit field for earth storage at construction site; strengthen construction management, carry out civilized construction; spray water to suppress dust on construction site and construction road; restore vegetation after use of temporary land; it's suggested that river course dredging work to be conducted in dry season and construction by sections; after construction proceeding to a given section, construction contractor must notify surrounding residents to close their windows; mechanical dredging will be adopted, dredged sediment will be handled to dewatering site immediately after dredging work instead of dumping on the spot; construction workers will be protected with personal protective articles; closed tank car will be used to handle sediment; transportation will avoid downtown area and densely populated residential area.

Low-noise mechanical equipments will be used; applicable provisions of Emission Standard of Environment Noise for Boundary of Construction Site (GB12523－2011) will be executed strictly; operation time generating noise pollution will be controlled; construction of high-noise equipments at nighttime (22:00-6:00) should be banned; construction activity generating noise should be avoided at noon (12:00-14:00) and nighttime (19:00-22:00) ; the area with access to construction vehicles or soil handling vehicles passing in and out of soil solidification site and other construction sites should be kept far from sensitive points as possible; vehicles should be driven slowly and honking is forbidden; construction machinery and construction intensity should be arranged logically.

3. For Qingshui Lake area, according to the route of pollution control, pollution exists in this area, where contaminated soil will be removed and replaced.

14.3.2.3 Media Dislcosure

According to the requirements of Provisional Regulations on Public Participation In Environmental Impact Assessment, on April 27, 2015, a statement was made on official website of Zhuzhou Municipal People's Government (http://www.zhuzhou.gov.cn/gk/zwdt/xsqdt/313229.htm) for second public participation in the environmental impact assessment with regard to "World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project" (See **Figure14.3-2**); full text of Environmental Impact Report of World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project was linked to this website to publicize information on project overview, environmental impact, environmental protection measures and conclusion of preliminary assessment.

Figure14.3-2Second Online Disclosure of Project Information

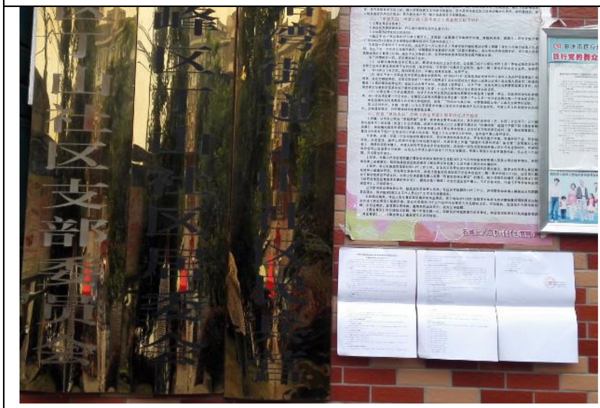
14.3.2.4 Bulletin board at communities

After the disclosre of full draft EA, the project owner and EA consutant posted porject and EA information at porject area communities and inform where to get the full EA.。

	
1、建设村	**2、映峰社区**

3、铜塘湾社区

4、竹山社区



5、丁山社区

6、铜塘湾街道办事处

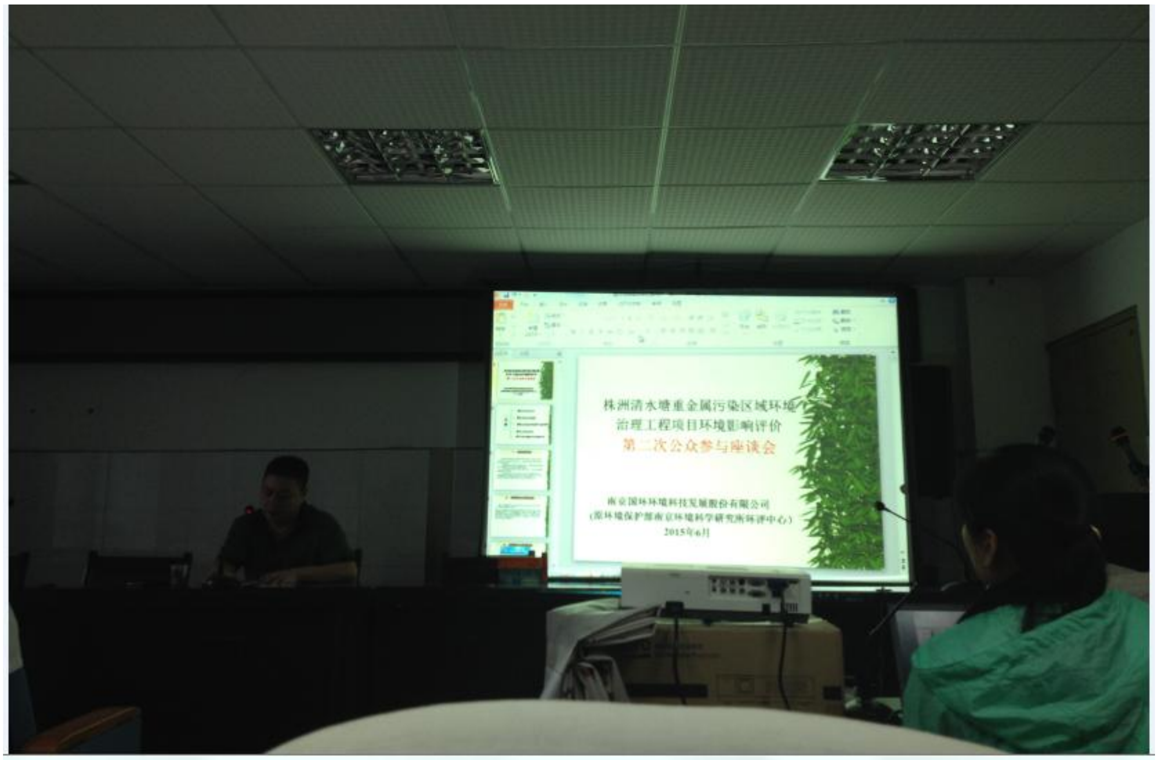
7、清霞社区

8、霞湾新村

FigureError! Use the Home tab to apply 标题 2 to the text that you want to appear here.**-3 Second round disclosure through bulletin boards at communities**

14.3.2.5 Group meetings

After the disclousre of full EAreort, community representatives were invited to held a second round group meetings.。



FigureError! Use the Home tab to apply 标题 2 to the text that you want to appear here.**-4 Group meetings during the second round consultation**

After hearing about the project and EA，most participants said it was a good project and they would support the project.

They also voiced their own opinions and advice: they demanded environmental treatment be implemented after they relocate; they pointed out that some of the excavated soil involved in the project had been backfilled without treatment; they pointed out that sediment at the Xiawangang channel and at the estuary that the Xinqiao low discharge channel discharges into has been severely contaminated; they pointed out that excessive lead levels had been found in children's blood.

At the symposium, the EPA explained these issues and used the opportunity to communicate to relevant residents that given financial resources at this time, collective relocation will be difficult to carry out. Currently, it is advised to restore contaminated soil in the area. Land designated as residential land can be restored to a target value; concentrated resettlement communities are being constructed in the area; and in the future, residents will be relocated gradually based on the usage of land. Environmental monitoring and management will be applied to this project and soil restoration will undergo acceptance tests according to national regulatory requirements so as to ensure that contaminated soil is restored to its target value. In this remediation plan, sediment in the Xinqiao low discharge channel and at the old Xiawangang channel which has been contaminated by heavy metals will be dredged and stabilized/solidified after the port is dry. Excessive lead levels in blood are caused by long-term industrial pollution in the area. To lower lead levels in blood, the following efforts should be made: the project should restore soil that has been contaminated in the area; the EPA should intensify its supervision over active facilities to prevent excessive emissions/discharge; in the future, active facilities will be gradually relocated; and regular medical check-ups should be conducted on children whose blood has been identified as having excessive lead levels with deleading reagents being provided to the children to be taken orally

15 Environmental Management and Monitoring

The implementation of the project will cause certain impact on local social, economic and natural environment. Therefore, environmental management should be strengthened during construction period and operation period to ensure effective operation of various pollution control measures, and allow integration of economic benefit, social benefit and environmental benefit from construction of the project.

15.1Purpose

The project will cause certain impact on local social environment, natural environment, social & economic environment and life quality of the public during construction and operation period; in order to take timely and effective environmental protection measures to mitigate or eliminate adverse impact, necessary environmental protection management and monitoring plan should be developed during construction period, operation period and closing period.

Main purpose: determine the role and duty for environmental management; establish appropriate mitigation measures; establish supervision and monitoring procedures; ensure sufficient budget for effective execution of environmental management plan.

15.2 Proposal on Environmental Management

In order to avoid adverse impact of project construction on the environment, strengthen environmental management work during construction period, ensure implementation of “three-simultaneousness” system and various environmental protection countermeasures and measures, according to Technical Guidelines for Site Soil Remediation (HJ 25.4-2014) and Guide for Site Environmental Survey, Assessment and Remediation of Industrial Enterprises (Provisional) , project specific environmental management system should be established and improved.

15.3 Objective of environmental Management

By developing systematic and scientific environmental management plan to allow construction and operation of World Bank Financed Hunan Zhuzhou Qingshuitang Area Heavy-Metal Pollution Environmental Improvement Construction Project conforming to basic guidelines of “three-simultaneousness” of design, construction and handover for acceptance of environmental protection project and main construction, so as to make a solid basis for designed implementation of environmental protection measures and supervision by local environmental protection department.

With environmental management plan, adverse environmental impact of the planned construction will be minimized to realize harmonious, continuous and stable development of social & economic benefits and environmental benefit from project construction.

15.4 Environmental Management

15.4.1 Management Organization and Responsibility

Execution of environmental management plan necessitates participation of multiple organizations and departments, of which each organization should play a different but critical role to ensure effective environmental management of the project.

Two groups of organization are involved in the process of environmental management: one group of organizations in charge of organization or implementation of environmental management plan, and another group of organizations in charge of execution of standards, laws and regulations as well as supervision of implementation of environmental management plan and general environmental performance during construction period, operation period and closing period of the project. The framework of environmental management and supervision organizations of the project is as shown in **Figure15.4-1**.

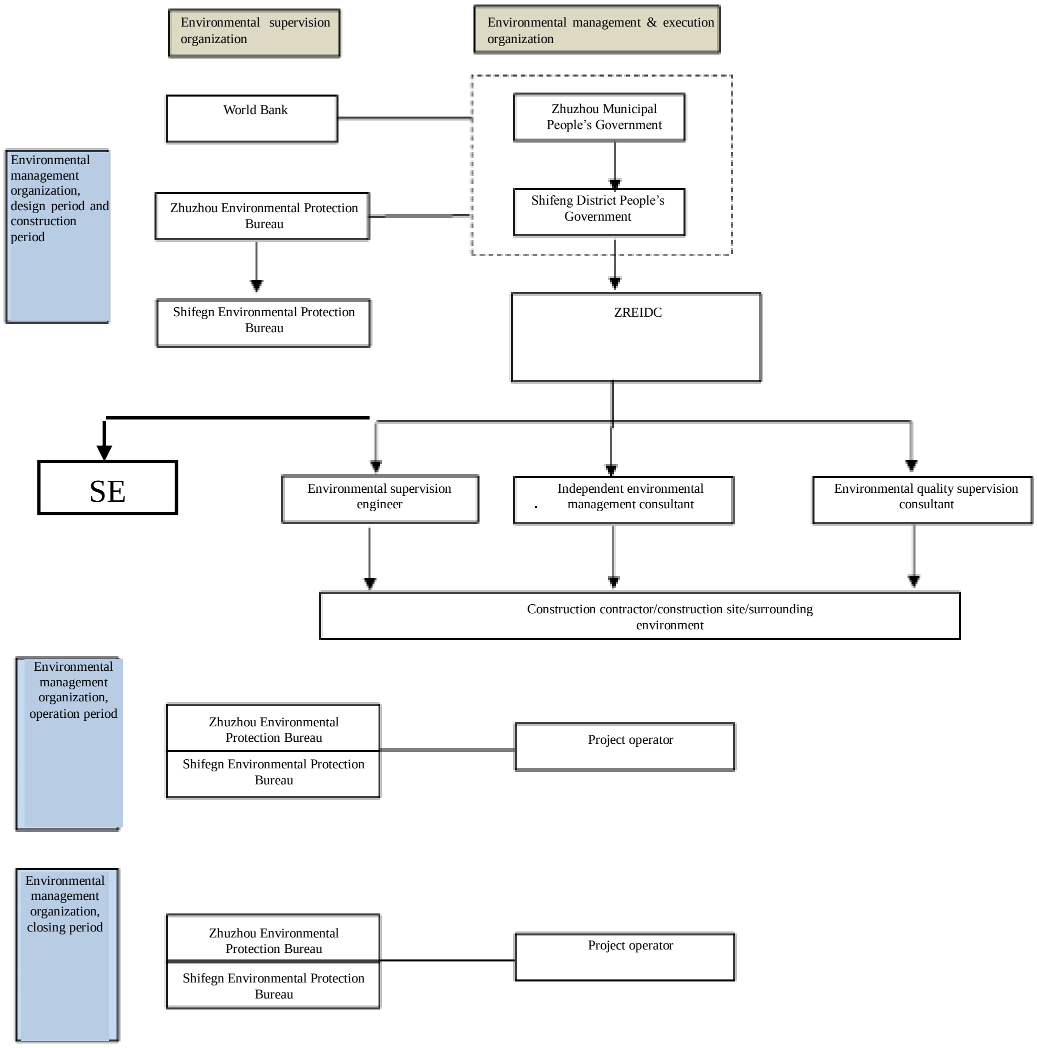


Figure15.4-1Framework of Environmental Management & Supervision Organizations of the Project

15.4.2 Responsibility of Environmental Management Organizations

Major environmental management responsibilities of various environmental management organizations are listed in **Table 15.4-1**:

Table 15.4-1 Schedule of Environmental Supervision & Management Responsibilities

No.	Organization/unit	Responsibility
1	Zhuzhou Municipal People's Government (World Bank PMO)	Take charge general environmental management works of the project, including effective execution of mitigation measures, supervision and monitoring, budget safety and report to World Bank and local environmental protection bureau; Ensure incorporating the measures of environmental management plan in bidding documents and construction contract; Supervise construction contractor in its implementation of pollution control measures, and timely notify construction contractor of any noncompliance; Ensure incorporating supervision contents executed by Zhuzhou Environmental Protection Bureau in bidding documents and the contract

		with environmental supervision engineer; supervise and participate in environmental supervision; Entrust environmental monitoring organization for environment monitoring during construction period; work with environmental monitoring organization for environment monitoring work during construction period; Organize environmental training for construction contractor and environmental supervision engineer.
2	Zhuzhou Environmental Protection Bureau, Shifeng District EPB	Zhuzhou Environmental Protection Bureau undertakes environmental management and supervision of the project; during construction period and operation period, Zhuzhou Environmental Protection Bureau performs environmental protection monitoring and supervision on behalf of Department of Environmental Protection of Hunan Province, together with investigation and treatment of complaints of public disturbance during construction period and operation period; ensure implementation of three-simultaneousness; ensure normal operation of environmental protection facility.
3	ZREIDC	ZREIDC will execute World Bank financed infrastructure construction project, including implementation and compliance of procurement, construction management and safety protection policies, as well as monitoring and reporting works.
4	Project operator	Ensure normal operation of environmental protection facility and environmental management and etc during operation period
5	The supervision engineer(SE)	Undertake the investment control, construction schedule control, engineering quality control, safety control of engineering construction, conduct the information management, construction contract management; And coordinate the working relationship between the relevant units, namely "four control, two management and one coordination".
6	Environmental supervision engineer (ESE)	Review and assessment of construction design according to the requirements of environmental impact assessment and environmental management plan, especially review and assessment of mitigation measures in site environmental management; Supervise site environmental management of construction contractor, and given proper guidance to construction contractor; Review execution of environmental management plan by construction contractor, verification and confirmation of environmental supervision procedures, parameters, monitoring sites, equipments and results; Report on the execution of environmental management plan; Approve the invoice or expenditure according to execution of environmental management plan.
7	Construction contractor	Formulate detailed environmental protection plan of construction contractor, which constitutes part of construction contract (Inc. construction land occupation land ensuring road access to communities or commercial stores) . Report to environmental supervision engineer about new environmental problem or cultural relics discovered during construction period; make continuous public consultation during construction.
8	Independent environmental management consultant (IEMC)	Independent environmental management consultant should be engaged by project owner; IEMC is independent from environmental supervision engineer and construction contractor; the task of independent environmental consultant is to assess implementation of environmental management plan during construction period, give management advise to project owner, and finally ensure the project conforming to the requirements of environmental management plan.
9	Environmental quality monitoring consultant (EQMC)	The environmental quality monitoring consultant means professional environmental quality monitoring organization according to environment monitoring plan included in environmental impact assessment report ; project owner will engage environmental quality monitoring consultant to implement monitoring plan.

15.5Environmental Management during Remediation Implementation

Remediation implementation includes remediation construction planning, preparation of construction site and site construction, the contents of environmental management in each aspect are as follows.

15.5.1 Remediation Construction Plan

Remediation construction plan should be developed according to construction site condition and applied construction process, updated and particularized construction site environmental management plan, including secondary pollution control measures, environmental accident emergency response plan, environment monitoring plan, safe and civilized construction, personal health and safety protection and etc.

15.5.2 Preparation of Construction Site

(1) Anti-seepage treatment of construction site should comply with construction plan and environmental management requirements, anti-seepage and diversion drainage setting should be available in the area apt to secondary pollution;

(2) Before entry, related construction personnel should be trained for construction safety and environmental protection.

15.5.3 Site Construction

In addition to ensure implementation of pollution control measures, communication should be strengthened with local environmental protection department and surrounding residents during construction for publicity and explanation, so as to ensure not jeopardizing the interest of surrounding residents; in case of major environmental pollution during soil remediation, construction contractor should make correction and rectification at he request of local environmental protection department, project owner and supervision organization, so as to ensure the process of soil remediation not disturbing surrounding residents and environment。

15.6 Environmental Supervision

15.6.1 Purpose of Environmental Supervision

The environment supervisor is entrusted by the responsible subject of contaminated site to deliver professional environmental protection consultation and technical service in the process of site remediation according to applicable environmental protection laws and regulations, documents regarding site environmental survey and assessment records, documents regarding site remediation plan records, environmental supervision contract and etc, assist and guide construction contractor for overall implementation of various environmental protection measures during site remediation, so as to realize minimum environmental damage and maximum environmental protection during site remediation.

15.6.2 Object of Environmental Supervision

Main objects of environmental supervision are environmental protection measures, risk preventive measures and affected external environmental protection and matters like that.

15.6.3 Content of Environmental Supervision

Contents of environmental supervision include supervision of remediation construction in compliance with the requireemtns for environmental protection, coordination of the relation between remediation construction and environmental protection, as well as the employer and all parties involced.

15.6.4 Mode of Environmental Supervision

Generally, three modes of environmental supervision are available:

Mode #1: inclusive environmental supervision mode; construction supervisor takes charge general environmental supervision; the merits are making full use of construction supervision system, direct linkage of environmental protection performance and quality progress cost, and precise execution; the imperfections are operators lack of knowledge about environmental protection and lack of targeted supervision.

Mode #2: independent environmental supervision mode; environmental supervisor and construction supervisor are independent from each other in terms of parallel relation; the merits are specialization of knowledge about environmental protection, strong coordination with responsible environmental protection department, and precise understanding of environmental protection requirements; the imperfections are environmental supervision staffs lack of information on implementation of the project, restriction against construction contractor, and insufficient guidance and execution.

Mode #3: combined environmental supervision mode; supervision contractor has internal environmental protection supervision department, environmental protection staffs undertake supervision work; the merits are sharing resources, real-time follow-up and make full use of professional knowledge; the imperfections are limitation by construction supervisor and loss of independence.

Due to remediation project belongs to environmental protection project, which demands supervision staffs with full knowledge in the field of environmental protection, any supervision mode applied should allow realizing the contents of environmental supervision, so as to ensure implementation of remediation project according to action plan.

15.6.5 Procedure of Environmental Supervision

Environmental supervision of remediation of contaminated site is mainly divided into three stages, namely, remediation design stage, remediation construction preparation stage and remediation construction stage; for particular procedures, see **Figure15.6-1**.

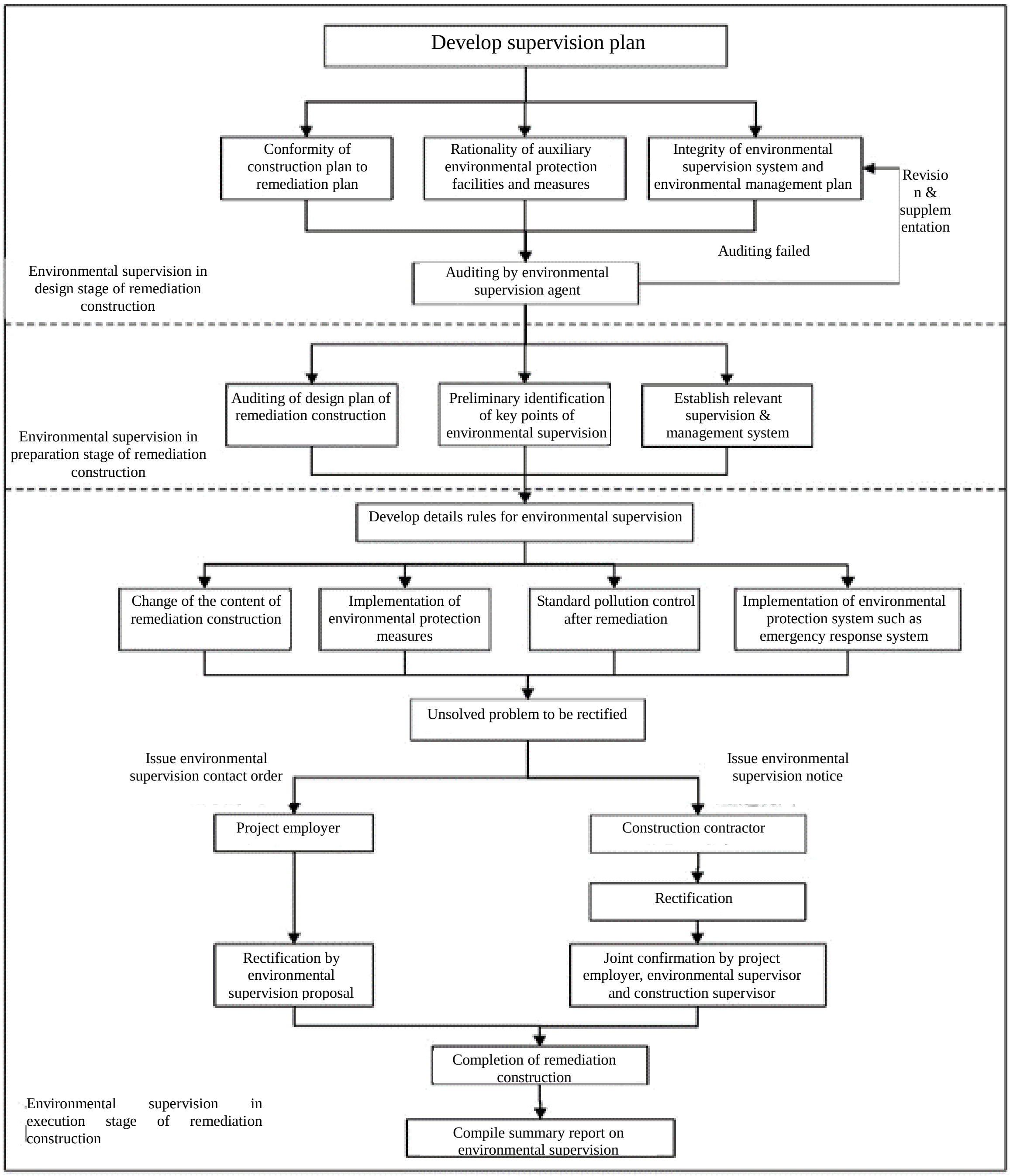


Figure15.6-1 procedures of Environmental Supervision Works

15.6.6 Contents of Environmental Supervision Works

15.6.6.1 Design Stage of Remediation Construction

The contents of environmental supervision in design stage include: collection of basic information on site survey & assessment, site pollution remediation plan, remediation construction design, construction organizational plan and etc, auditing of design document regarding environmental protection measures and environmental protection facilities to be sued in the process of remediation construction; pay attention to construction location and destination of ex-situ remediation soil of remediation construction; auditing of completeness of secondary pollution treatment measures for reclaimed water, air, noise, solid waste during remediation construction, rationality of treatment facilities, and consideration for necessary Post-management measures.

15.6.6.2 Preparation Stage of Remediation Construction

The contents of environmental supervision in preparation stage include: understanding of particular construction procedures and environmental protection objectives for various stages; participation in technical review of remediation construction design plan; determination of key works of environmental supervision; assisting the project owner in the supervision of sound environmental protection responsibility system; establishment of effective communication channels; compilation of detailed rules for site remediation environmental supervision.

15.6.6.3 Execution Stage of Remediation Construction

The contents of environmental supervision of remediation construction in execution stage include: verification of remediation construction conforming to remediation action plan, implementation of environmental protection facility, establishment of accident emergency response system and environmental management system; supervision of environmental protection construction and measures; supervision of environmental protection construction progress; inspection and monitoring of discharge of water, air, noise and waste residue during construction, construction affected area complying with standard environmental quality; environmental supervision of closure and handling process of vehicles handling contaminated soil and sewage; supervision and management of measures (e.g. water stoppage curtain, construction precipitation measures and etc) , pumping equipments and wastewater treatment relating to remediation construction; excavation and support of foundation pit according to applicable construction requirements during construction;

Implementation and monitoring of ground anti-seepage measures during ex-situ treatment process, including storage and treatment site; inspection of spoil ground of contaminated soil, completeness of exhaust discharge facility and monitoring facility for contamination treatment; confirmation of various conditions meeting environmental requirements; inspection of setup of long-term monitoring well for necessary Post-management; organization of environment monitoring in terms of the situation of construction environmental impact; exercise of power for environmental supervision; giving environmental supervision instructions to construction contractor, and inspection of execution of environmental supervision instructions; assisting construction contractor in the treatment of environmental incident and major environmental risk; preparation of monthly, biannual, annual environmental supervision reports and special environmental supervision report.

Particular procedures for execution stage of remediation construction are as shown in **Figure15.6-2**.

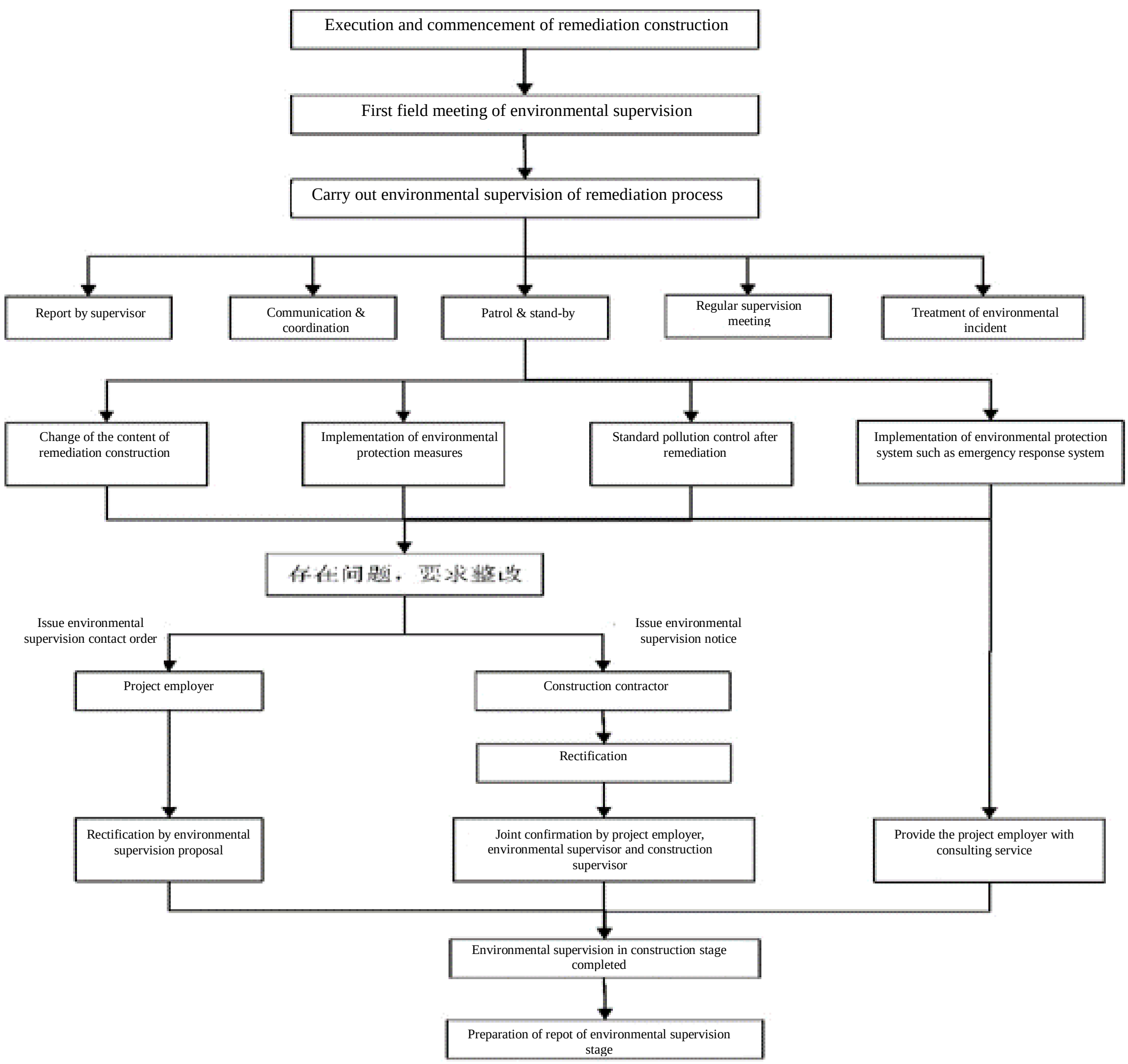


Figure15.6-2nvironmental Supervision Procedures for Contaminated Site Remediation Construction in Execution Stage

15.6.7 Key Points of Environmental Supervision

15.6.7.1 Soil Ex-situ Remediation Construction

For soil ex-situ remediation construction, it consists of dredging environmental supervision, remediation environmental supervision, backfill/removal environmental supervision, to be described in detail as follows:

(1) Dredging

Sample may be taken from the border, side wall or pit bottom in contaminated area; the border of dredging work should be determined based on testing data to avoid rework after finding of problem in remediation acceptance stage; layout of monitoring points should make reference to technical requirements for soil ex-situ remediation acceptance; odor diffusion of organic matters should be controlled strictly during dredging work; measures such as spraying odor inhibitor and the like should be taken to avoid impact of contaminated soil on surrounding environment; air monitoring points should be set around the dredging area for monitoring if air quality; supervise enclosure measures during handling of contaminated soil to avoid spill; supervise anti-seepage measures for dredged soil temporarily depositing on the ground; for organic contamination emitting malodor, inspect enclosure of storage facility, and set up monitoring points around storage facility for monitoring of odor; monitoring points should be distributed according to Technical Guidelines for Environmental Site Monitoring (HJ 25.2).

(2) Remediation

Heavy-metal contaminated soil remediation: supervise ground anti-seepage facility and measures; supervise the implementation of remediation construction according to technical parameters of construction plan; sampling of remediated soil, preliminary determination of remediation effect; supervise deposit of remediated soil for acceptance; sampling and testing in terms of batch treatment capacity of remediation construction; supervision and management of potential secondary pollution as a result of addition of chemicals during remediation.

(3) Backfill/removal

Supervision and management of backfilling process of remediated soil; supervise rational soil backfilling according to land use planning; supervise solidification/stabilization treated soil pit with complete anti-seepage measures and ground surface isolation measures.

15.6.7.2 Soil In-situ Remediation Construction

Strict supervision and management of the border of remediation area is required, sampling points should be set around remediation area to avoid remediation construction from disturbing surrounding soil and groundwater.

15.6.8 Working Methods for Environmental Supervision

Major working methods for environmental supervision include:

（1） Verification;

（2） Patrol;

（3） Stand-by;

（4） Follow-up inspection;

（5） Environmental monitoring;

（6） environmental supervision meeting;

（7） Information feedback;

（8） Recording and reporting.

15.6.9 Working System of Environmental Supervision

The organization for environmental supervision should establish series of working system to ensure normal and orderly environmental supervision works. Following nine common working systems are applicable:

（1） Work recording system;

（2） Document review system;

（3） Reporting system;

（4） Correspondence exchanging system;

（5） Meeting system;

（6） Emergency reporting and treatment system;

（7） Personnel training and education system.

15.6.10 Compilation of Key Documents and Data on Environmental Supervision

Environmental supervision report mainly consists of environmental supervision plan, detailed rules of environmental supervision, regular environmental supervision report and environmental supervision summary report.

15.7Environmental impact monitoring of remediation works

15.7.1 Monitoring of water & soil loss

According to characteristics of the project and each construction stage, water & soil loss monitoring is detailed in **Table 15.7-1**.

15.7.2 Monitoring of atmosphere, surface water, and noise in contaminated field

See **Table 15.7-2** for monitoring plan of atmosphere, surface water, and noise in construction stage, operation stage, remediation acceptance, later period and closure period.

15.7.3 Soil and ecological monitoring in remediation acceptance and later period

Environmental monitoring plan in later period at contaminated field shall be determined upon remediation contents of the project. Fixed monitoring station and mobile monitoring spots are both adopted. On-line monitoring devices will be provided by environmental demonstration center according to monitoring needs.

Long-term environmental monitoring shall be carried out to the soil, water, and ecological plants in remediation area after the completion of the project. 10 dynamic monitoring spots shall be arranged within 3 years after acceptance of the project; 3 years later, the number of monitoring spots can be reduced to 1 to 2 for dynamic monitoring over vegetation recovery progress, landscape ecologically recovered vegetation, and vegetation in wetland and ecological sewage intercepting wall. The community diversity of plants in remediation area shall be analyzed. Soil recovery quality and how much vegetation enriches heavy metals shall be comprehensively evaluated.

In addition, long-term inspection shall be conducted on soil around remediation area to make sure that there is no secondary pollution on surrounding area.

Table 15.7-1 Soil erosion Monitoring Schedule

Location of monitoring point	Monitoring content	Monitoring method	Monitoring time	Monitoring frequency
Whole area	Observation of rainfall , rain intensity and etc	Use local meteorological data	Construction period, initial operation period	Quarterly
	Check the area of land occupation and disturbed topsoil	Site investigation, check data	Construction period	Quarterly
	Status of heavy-metal pollution in project area	Field sampling survey	Construction period, initial operation period	Quarterly
	Check the quantity of cut earth and area of land occupation	Site investigation, check data	Construction period	Quarterly
	Area of vegetation coverage, survival rate of trees	Field measurement & survey	Initial operation period	Quarterly
	Hazard of soil erosion and surrounding impact	Site investigation	Construction period, initial operation period	Quarterly
Various construction areas	Terrain and relief	Site investigation, topographic survey	Construction period	Quarterly
	Quantity and quality of damaged water conservation facilities	Site investigation	Construction period	Quarterly
	Runoff erosion of temporary slope (Backfilled slope)	Simple slope measurement method, peg nail method	Construction period	Quarterly, monthly in rainy season; timely additional monitoring in case of rainstorm and strong wind
	Status of construction of water and soil conservation measures	Site investigation	Construction period, initial operation period	Once monitoring and recording for every 10 days
	Quantity and quality of completed water conservation	Site investigation	Construction period, initial operation period	Annually
	Status of construction of heavy metal control measures	Field sampling survey	Construction period, initial operation period	Quarterly
	Earthwork, quantity and quality of completed heavy metal control	Field sampling survey	Construction period, initial operation period	Quarterly
	Survival rate of plants with water and soil conservation measures	Site investigation	Construction period, initial operation period	Annually
	Stability, integrity and operation condition of construction protective measures	Field patrol & observation method	Construction period, initial operation period	Once before and after flood season, respectively

	Quantity of sediment	Grit chamber method	Construction period, initial operation period	Once before and after flood season, respectively, strengthen monitoring in flood season
	Vegetation coverage of forest and grassland	Site investigation	Initial operation period	Quarterly
	Status of vegetation restoration (Greening rate)	Site investigation	Initial operation period	Quarterly
	Runoff volume and sediment volume	Peg nail method	Construction period, initial operation period	Once before and after flood season, respectively, strengthen monitoring in flood season
	Vegetation coverage of forest and grassland	Method of purposive sample plot	Restoration period	Each May
	Vegetation restoration rate of forest and grassland	Method of purposive sample plot		Each Sep
	Tree resistance to heavy metal (Tree overwintering hazard)	Method of purposive sample plot		In spring and in summer

Table 15.7-2 Implementation of Environment Monitoring Schedule during Construction Period, Operation Period, Remediation Acceptance Period, Subsequent Period & Closing Period

Category	Item	Stage monitoring plan		
		Construction period	**Operation period**	**Remediation acceptance period, subsequent period and closing period of landfill**
Acoustic environment	Monitoring point	Many operation sites of operation equipments and unpaved roads or spaces close to sensitive areas or sensitive environment	Jianshe Village in the east of landfill, Heyeba residential area in the west of Xinqiao dewatering site, New Xiawan Village residential area in the west of Xinqiao solidification/stabilization ground, Xiawan dewatering site	
	Monitoring factor	Equivalent continuous sound level (L_{Aeq})	Equivalent continuous sound level (L_{Aeq})	
	Monitoring frequency	Once/month	Once/month	
surface wastewater environment	Monitoring point	Discharge outlet of mobile water treatment equipment, discharge outlet of construction camp, construction site and mine seeper treatment equipment	Leaching takeover intake	Leaching takeover intake
	Monitoring factor	COD_{Cr}, BOD_5, SS, oils, ammonia-nitrogen, As, Sb, Pb, Zn, Cd	pH, COD_{Cr}, $BOD_{5,}$ NH_3-N, TP, As, Sb, Pb, Zn, Cd	pH, COD_{Cr}, $BOD_{5,}$ NH_3-N, TP, As, Sb, Pb, Zn, Cd
	Monitoring frequency	Monitoring of discharge outlet of mobile water treatment equipment, mine seeper treatment equipment in terms of construction term (At least once/month) ; once/month monitoring at other points	Real-time monitoring of sewage outfall	Once/month in the first 3 years after closing; subsequent monitoring frequency depending upon testing results
Groundwater environment	Monitoring point	One monitoring well in the upstream and downstream close to construction site, respectively	One monitoring well in the upstream and downstream close to Xinqiao dewatering site, Xiawan dewatering site, Xinqiao solidification/stabilization ground, landfill, Qingshui Lake constructed wetland, respectively	One monitoring well in the upstream and downstream close to landfill, respectively; Use existing monitoring well, for the enterprises in production, set up long-term monitoring well in the downstream of groundwater flow along the boundary of the enterprises

	Monitoring factor	COD_{Cr}, BOD_5, SS, oils, ammonia-nitrogen, As, Sb, Pb, Zn, Cd, Cr, Hg	pH, COD_{Cr}, BOD_5, NH_3-N, TP, As, Sb, Pb, Zn, Cd, Cr, Hg	pH, COD_{Cr}, BOD_5, NH_3-N, TP, As, Sb, Pb, Zn, Cd, Cr, Hg
	Monitoring frequency	Monitoring in terms of construction term (At least once/month)	Once/month	Once/month
Air quality	Monitoring point	Many operation sites of operation equipment, operation sites of Zhuzhou Tiancheng Chemical Co., Ltd, organic contaminated soil, and unpaved roads or spaces close to sensitive areas or sensitive environment	Boundary and leeward organic contaminated soil operation sites of Xinqiao dewatering site, Xiawan dewatering site, Xinqiao solidification/stabilization ground, landfill, Zhuzhou Tiancheng Chemical Co., Ltd	
	Monitoring factor	Total suspended particles (TSP) , PM_{10}, additional measurement of H_2S, NH_3, odor intensity at construction sites of channels and ponds	TSP, H_2S, NH_3, odor intensity, organic contaminated soil operation site of Zhuzhou Tiancheng Chemical Co., Ltd, monitoring of benzopyrene and anilin	
	Monitoring frequency	Random sampling in construction peak	One day per month	
Soil	Monitoring point			《Guide for Site Environmental Survey, Assessment and Remediation of Industrial Enterprises (Provisional)》
	Monitoring factor			Cd, As, Pb, Ni, benzopyrene
	Monitoring frequency			once

15.7.4 Ground water monitoring

In light of the risk evaluation regarding the area, it is learnt that the pollution in the area have not extended to groundwater yet, even in the perspective of human health. Therefore, the project will not take groundwater remediation into account for now. However, in order to comprehensively understand the quality of groundwater, a plan has been prepared to conduct systematic and long-term tracking monitoring and research on the groundwater in the area.

15.7.5 Objectives and mission of monitoring

The groundwater quality monitoring plan is to fully understand the status quo of groundwater as well as change and pollution in the groundwater under key contaminated sources during and after project construction. Therefore, it can provide scientific basis for whether to conduct detailed groundwater environmental investigation, whether to build a groundwater pollution model to predict the pollution trend, and whether to carry out groundwater remediation (prevention & control).

The main tasks are as follows:

(1) Based on the geological and hydrogeological research on the investigation area, gather and use the relevant information and data that have been obtained and screen and analyze the data for reference (or comparison) in the research of the groundwater environment of the area.

(2) On the basis of sufficient research into the existing geological, hydrogeological and environmental geological information that have been collected, carry out groundwater quality analysis and water level dynamic observation.

(3) Analyze and summarize the results of groundwater investigation and monitoring and provide periodic analysis report annually. Determine the classifications, concentration and special distribution of the contaminants initially; analyze the information obtained from survey targets of the initial sampling, including the groundwater type, hydrogeological conditions, on-site and lab test data; if the contaminants are not covered in the standards, refer to the standard value for assessment based on the protection of water environment in *Investigation Report on Environmental Quality of Shallow Groundwater in Qingshuitang Industrial Area*

(2012) prepared by Institute of Soil Science, Chinese Academy of Sciences. Moreover, the quality assurance and quality control of initial sample analysis need to be evaluated.

15.7.5.1 Monitoring requirements

Time period: Based on the implementation of the project, groundwater monitoring will be carried out in three time periods: monitoring in construction phase, monitoring in operation phase and permanent monitoring.

Monitoring site selection: Based on the possible impact of the project contents and various project activities on groundwater, with overall consideration of the hydrogeological conditions of the area, current situation of the exploitation and use of groundwater, current situation of land use and the distribution of contamination sources, the monitoring wells should be set mainly at the upstream and downstream of the construction site, nearby environmental sensitive points and groundwater contamination sources. The upstream monitoring wells are comparative wells and the downstream monitoring wells are contamination monitoring wells. Contaminated area and potential contaminated area should be the focus of monitoring. The degree of contamination of the contamination sources on groundwater and its dynamic change should be monitored to reflect the dynamic changes of the water level and water quality of groundwater as well as the temporal-spatial distribution characteristics and contamination features in the area during and after the implementation of the project.

Monitoring Factors: Take samples from each drilled wells in the phreatic aquifer and confined groundwater layer and assay the samples respectively. The water quality monitoring factors are: color, smell and taste, turbidity, visible substances, pH, total hardness, total dissolved solids, sulfate, chloride, iron, manganese, copper, zinc, molybdenum, cobalt, volatile phenols, anion synthetic detergent, potassium permanganate index, nitrate, nitrite, ammonia nitrogen, iodide, fluoride, cyanide, mercury, arsenic, selenium, cadmium, chrome (hexavalent), lead, beryllium, barium, nickel, DDT, HCH, total coli-group, total number of bacteria, total α radioactivity, total β radioactivity, total nitrogen, total phosphorus, petroleum and derivatives, sulfide, halohydrocarbon, PAHs, BETX, phenol, alkylbenzene, total lead, total chromium, total vanadium, benzene, phenols, benzoapyrene, aluminum, copper, stibium, molybdenum, silver, thallium, gold, phosphates, organophosphorus pesticides, organochlorine pesticides, alkanes, olefins, nitrobenzoates, and oils. The 68 monitoring factors are used for investigating groundwater contamination.

15.7.5.2 Compilation of report

1. Name and format of report

The report shall include analysis, summarization and assessment of the process and results of stage survey. Specifically the content covers work plans, onsite sampling, lab analysis, quality control, data assessment, result analysis, conclusion and suggestions, and appendixes. For the format of the report, refer to the Appendix I of *Guide to Investigation and Assessment of Underground Water (Tentative)*

2. Conclusion and suggestions

The conclusion and suggestions shall state whether the subject and surrounding underground water are polluted and focus on the pollutants. The impact of difference between actual investigation and the work plan as well as the limitations on the conclusion shall also be stated

15.7.5.3 Follow-up work based on this survey

Based on the investigation of the above underwater environmental quality, this can provide basic materials for follow-up work and lay a solid foundation for proceeding next work.

（1）If the pollutant concentration surpasses the national and local standards as well as that of the concentration of cleaning control point, and this is confirmed by uncertainty analysis, a detailed sampling plan shall be compiled. Secondary detailed investigation needs to be conducted including sampling and analysis, so as to confirm the type, concentration and spatial distribution of the pollutants. On the other hand, one needs to analyze the necessity of risk assessment or pollution repairing, and when it does not satisfy the above operational demand, third underground water environment survey needs to be conducted, and the survey plan of the third underground water environment shall be compiled.

（2） If the third site environment survey is conducted, it mainly involves supplementary sampling and testing. The property of pollution source, pollution discharge characters, way of pollution, relation between pollution source and potential receptor, migration and transformation of pollutants, the parameters of risk assessment and groundwater remediation shall be satisfied, etc. The major content of the work includes investigation on the parameters of site characteristics and parameters of receptor exposure.

（3）When the toxicity indicator of underground water surpasses the Type III standard of *Quality Standard of Underground Water* (GB/T 14848) and *Sanitary Standard of Domestic Drinking Water* (GB 5749), any toxic or harmful materials are detected, the underground water health risk assessment can be initiated.

（4）If the concentration of pollutants in underground water surpasses related standards, or if the concentration remains within standard limits but shows a sign of deterioration, then an underground water pollution conceptual model should be constructed to conduct prediction of pollution trend.

（5） For concentration of pollutants surpasses related standards or acceptable risk level, underground water remediation (control) needs to be considered.

15.7.6 Supervision and monitoring of enterprise under production

For enterprises under production, a long-term monitoring well is set in the underwater downstream, and the ZREIDC can conduct long-term monitoring on the quality of the underground water

Moreover, the Zhouzhou Municipal Environmental Protection Agency carries out regular monitoring on the waste water and exhaust of the operating enterprises, and conducts monitoring of key pollution source once a month and monitoring on common enterprisese once a season, in order to supervise the pollution exhaust of the enterprises. Zhouzhou Environmental Inspection Detachment is responsible for the execution of the monitoring by directly supervised units and the implementation of pollution treatment measures, etc. Shifeng District Environmental Protection Agency is responsible for the site inspection and environmental protection of the distrct area except for the directly supervised units.

There are altogether more than 100 people of the Zhuzhou Environmental Protection Agency, Zhuzhou Shifeng District Environmental Protection Agency, Environmental Monitoring Center as well as the Environmental Inspection Detachment. The Environmental Monitoring Center and Environmental Inspection Detachment both reach the Class II of national construction standard. Currently there are enough and capable personnel of Environmental Protection Agency to meet the environmental inspection requirements. In the future, it is recommended to set up environmental monitoring stations in the district environmental protection agencies to further improve the monitoring capacity and meet the higher monitoring demands proposed by a more developed Zhuzhou City in the future.

According to the *Environmental Protection Law*, the enterprises that violate the law shall be punished, either by day, or be ordered to close up or suspend business, or be taken under administrative detention, etc. Only enterprises that satisfy the related standards and indicators on pollution and environmental protection can continue operation.

15.7.7 Monitoring report

a). Environmental monitoring report during construction period

The construction term is the project is about 102 months; according to different construction stages of the project, Chinese environmental management laws and regulations, requirements of World Bank for pollution control operation policy, the project employer should develop Environmental Monitoring Report and submit it to World Bank and Zhuzhou Environmental Protection Bureau; purpose of the report is to convince environmental protection department that all environmental protection measures are executed according to applicable requirements of approved environmental monitoring plan, so as to control adverse environmental impact envisaged in project plan.

Environmental monitoring report should include:

a) Brief description of construction progress;

b) setup and responsibility of environmental management organization;

c) Content and method of main construction, resultant environmental impact and mitigation measures, as well as implementation of mitigation measures;

d) Environmental monitoring report;

e) Public complaints and treatment.

According to construction management regulations, construction contractor and environmental supervision engineer should submit environmental monitoring report to the project employer on a regular basis during construction period.

b). Environmental monitoring report during operation period

After the project is put into commercial operation, according to environmental monitoring plan, PMO should entrust qualified environment monitoring station for carrying out environment monitoring. Moreover, PMO should prepare annual environmental monitoring report, including setup of environmental management organization, operation status of the project, execution of environmental protection measures according to the requirements of Zhuzhou Environmental Protection Bureau, environment monitoring (Date, frequency, points, method, applicable standard and etc) , statistic and analytical results of monitoring data, as well as necessary follow-up works; environmental monitoring report should be submitted to Zhuzhou Environmental Protection Bureau and World Bank.

15.8Remediation Acceptance

15.8.1 Purpose and Working Content

Contaminated site remediation acceptance is the process of soil survey and assessment after remediation of contaminated site, assessment of site remediation effect mainly by means of document review, site investigation, field sampling, testing, analysis and etc, so as to determine whether acceptance standard is complied with, together with assessment of rationality and implementation of Post-management plan. After successful site remediation acceptance, commencement of recycling development procedures is permitted, and long-term monitoring and subsequent risk management should be carried out according to Post-management plan.

Working content of remediation acceptance includes soil clearing acceptance, soil remediation acceptance, and assessment of rationality and implementation of Post-management plan.

15.8.2 Working Procedure

Working procedure of contaminated site remediation acceptance includes document review and site investigation, determination of acceptance object and standard, planning of distribution of sampling points, field sampling and lab testing, assessment of remediation effect and compilation of acceptance report; process flow of working procedure is s shown in **Figure15.8-1**.

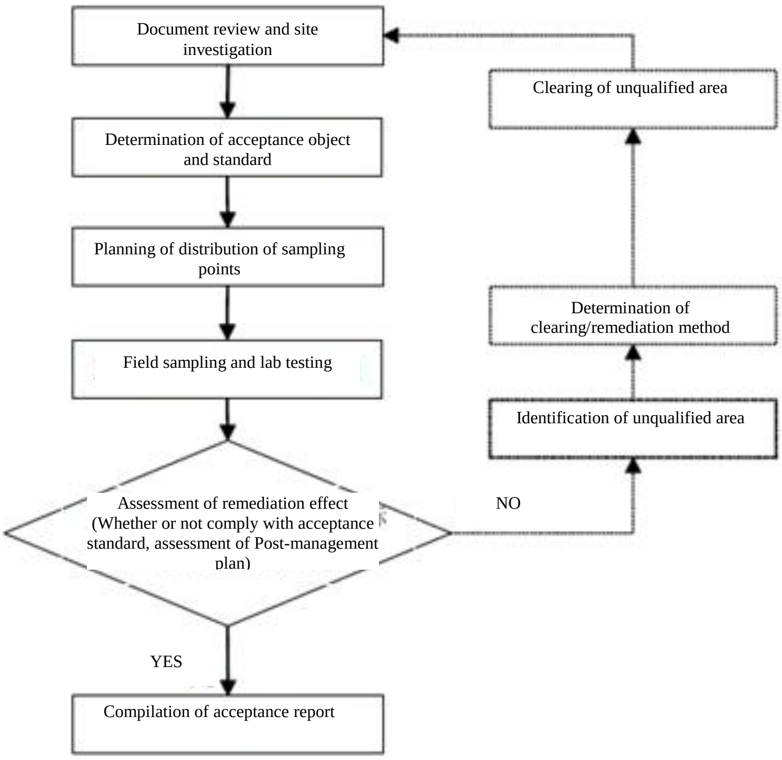


Figure15.8-1 Working Procedure of Remediation Acceptance

15.8.3 Document Review and Site investigation

15.8.3.1 Document Review

(1) Scope of data for review

Before commencement of remediation acceptance, data relating to site environmental pollution and remediation should be collected, a mainly including:

a). Documents regarding site environment survey, assessment and remediation plan: site environment survey and assessment report and comments on the records, site remediation plan comments on the records, and other related documents;

b). Site remediation construction documents: original records of remediation process, recorded documents of remediation construction process (e.g. dredging and handing records of contaminated soil) , handling records of backfill earth, operation records of remediation facility, discharging records of secondary contamination, remediation construction completion report and etc;

c). Construction and environmental supervision documents: construction and environmental supervision records and supervision report;

d). Other documents: structure of environmental management organization, related contract agreement (e.g. document and contract relating to entrusted treatment of contaminated soil) and .

Related drawings/pictures: schematic geographical location map, general arrangement, diagram of remediation scope, flow chart of pollution remediation, photos, video records of remediation process and etc.

(2) Content of review

Compilation and analysis of collected data, and determination of following contents by interviewing site manager, remediation operator and supervisor:

a). Determination of object contaminations, scope of remediation and objective of remediation based on site environment survey and assessment report, remediation construction plan and related executive documents as the basis for acceptance;

b). By reviewing site remediation process supervision records and monitoring data, verify the implementation of remediation construction plan and environmental protection measures;

c). By reviewing related shipping list and received correspondence, and according to remediation process supervision records, verify the quantity and destination of contaminated soil;

d). By reviewing related documents and testing data, verify the quantity and quality of backfill earth after completion of ex-situ remediation; backfill soil quality should comply with target values of remediation.

15.8.3.2 Site investigation

Site investigation includes verification of scope of remediation and identification of residual pollution trace.

(1) Verification of scope of remediation

Base on pegging information or geographical coordinates of site environment survey and assessment report, according to related reports presented by remediation process construction supervisor and environmental supervisor, determine scope and depth of site remediation, and verify whether scope of remediation conforms to the requirements of site remediation plan.

(2) Identification of residual pollution

Observe and determine the condition of topsoil and uncovered soil in side section as well as residual remains; make field testing with portable testing instrument, complement with visual inspection and smelling to identify residual pollution trace.

15.8.4 Determination of Acceptance Object & Standard

Main objects of contaminated soil remediation acceptance include following aspects; measurable acceptance standard should be supervised for different acceptance objects.

(1) Foundation pit left by inner dredging of contaminated soil

During acceptance, sampling and testing of residual soil in foundation pit are compulsory, remediation area must be analyzed for pollution; acceptance index is target contamination of site remediation; acceptance standard is target value of site soil remediation.

(2) Soil quality after in-situ remediation

Acceptance index is target contamination of site remediation; acceptance standard is target value of site soil remediation.

(3) Soil quality after ex-situ remediation treatment

For remediation technology with lower migration or toxicity after soil solidification/stabilization, acceptance index is leaching limit of target contamination.

Acceptance standard of ex-situ remediation is target value of site soil remediation.

(4) The area subject to potential secondary pollution in remediation process

The area of potential secondary pollution includes temporary storage and treatment area of contaminated soil, residual and spill area during demolition of facilities, and potential pollution diffusion area by application of remediation technology; acceptance index is typical contamination of site investigation and secondary pollution; acceptances standard is target value of site contamination remediation.

15.8.5 Plan on the Distribution of Sampling Points

The plan on the distribution of sampling points should include sampling medium, sampling area, sampling points, sampling depth, sampling number, testing items and etc. sampling by sections should be carried out in the scope of remediation according to various target contaminations and remediation target values; location and depth of sampling points should cover the scope of remediation and the edge; for the area of the most serious pollution determined by site environment survey and assessment, sample must be taken.

(1) Foundation pit within the site

For ex-situ remediation site, sampling at original locations in the scope of remediation and along the edge; sampling points should be set on pit bottom and side wall, mainly of topsoil sampling, but not excluding sampling in deeper stratum; collecting depth of volatile organic soil sample is generally of 0.2m beneath the topsoil.

Bottom layer of the pit is sampled by systematic distribution of sampling points, generally of random distribution of the first sampling point, and construct a grid across this point, and take sample at each points on the grid; the size of grid depends on sampling area and sampling number; sampling number may refer to stated number in **Table 15.8-1**; in principle, size of grid should not exceed 20m×20m.

Table 15.8-1 Distribution of Soil Sampling Points-Bottom Sampling Number

Sampling area (㎡)	Number of soil sampling points (Point)
＜100	3
100～500	4
500～1000	5
1000～1500	6
1500～2500	7
2500～3500	8
3500～5000	9
＞5000	≥10

Equidistance distribution of sampling points should be adopted on side wall in the scope of remediation, with which number of sampling points depends on side length; when depth of remediation≤1m, vertical stratified sampling is impossible on side wall; number of horizontal sampling points may refer to stated number in **Table 15.8-2**.

Table 15.8-2 Distribution of Soil Sampling Points-Side Wall Sampling Number

Circumference of sampling area (m)	Number of soil sampling points (Point)
50	4
50～100	5
100～200	6
200～300	7
＞300	≥8

15.8.6 Field Sampling and Lab Testing

Sampling method of soil samples, field quality control, field quality assurance, storage and handling method of samples, analysis method of samples, lab quality control, protection of sampling operators and field pollution emergency treatment and etc should comply with Guide for Site Environmental Survey, Assessment and Remediation of Industrial Enterprises (Provisional) , second phase of field sampling.

Detection limit of test method of acceptance items should be lower than remediation target value; the contents of test report presented by the lab should include test condition, testing instruments, test method, test results, detection limit, quality control results and etc.

15.8.7 Assessment of Remediation Effect

During remediation acceptance, in addition to precise sampling and lab testing, scientific and logic analysis of test data is necessary to determine whether site contaminations comply with acceptance standard, so as to judge whether the requirements for remediation effect are met; if the requirements for remediation effect are failed, suggestions should be made for further clearing or remediation; for Post-management of the project, assessment of rationality and implementation of Post-management plan is required.

15.8.7.1 Method of Assessment

T test assessment method is applicable to determine remediation effect of whole site.

With T test assessment method, the difference of test results and remediation target values of sampling points is determined at first, and then the site is assessed remediation effect:

a). When test results of sampling points are substantially lower than remediation target values or without substantial difference with remediation target values, it’s deemed to comply with acceptance standard;

b). When test result of a given sampling point is substantially higher than remediation target value, it’s deemed to fail acceptance standard; if T test assessment method is adopted, the site may be deemed with satisfactory remediation effect only when test values of contaminations in all samples comply with acceptance standard.

15.8.7.2 Suggestions for Further Clearing/Remediation

For foundation pit, if acceptance sampling and testing of a given sampling point fail, further clearing of local contaminated soil according to sampling grid is required fore additional acceptance; if necessary, detailed sampling in local area is advisable; grid sampling method is adopted for distribution of detailed sampling points.

For soil body after remediation, if acceptance sampling and testing of a given soil body fail, contaminated soil should be handled to the facility site, re-operate remediation facility for remediation before additional sampling acceptance.

15.8.8 Compilation of Acceptance Report

The content of acceptance report should be true and full, at least include following contents: summary of site environment survey and assessment conclusion, implementation of remediation construction plan, working procedure and method of acceptance, document review and site investigation, planning of distribution of sampling points, field sampling and lab testing, assessment of remediation effect, acceptance conclusions and suggestions, remediation environmental supervision report and test report.

15.9Post-management

15.9.1 Content of Post-management

Post-management is the process of working contents including long-term operation and maintenance of equipments and the project, long-term monitoring, long-term archiving, report and like systems, regular and irregular review inspection and etc according to scientific and logic Post-management plan and in terms of actual situation at site, the purpose of which is assessment of long-term effectiveness of site remediation activity, so as to ensure the site no longer causes hazard against surrounding environment and human health.

Post-management must be taken effect in combination with system construction, i.e. a set of long-term monitoring, tracing, review inspection, assessment and subsequent risk management systems should be established in terms of system design, system constitution, as well as definition of technical requirements and responsibilities of all parties involved.

Review inspection and assessment are core content of Post-management, including review of site data and site investigation, identification and diagnosis of potential risk, Post-management optimization measures and suggestions, as well as compilation of review report, working procedure of which is as shown in **Figure15.9-1**.

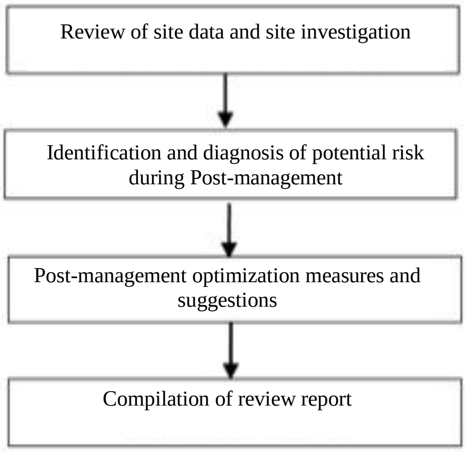


Figure15.9-1 Working Procedure of Review Inspection & Assessment

Major working contents for each step of review inspection and assessment are as follows:

(1) Review of site data and site investigation: the staffs for review inspection should at first review site data and conduct site investigation, including collection and reference of basic information, review and analysis of site data, site investigation, interview of related personnel and etc.

(2) Identification and diagnosis of potential risk: from review of site data and site investigation, identify and determine potential problems with potential existing remediation method or measures, for example, incomplete system control measures, difficuty to achieve remediation objective, unclear remediation objective, failure of operation of site remediation activity according to design, change of exposure approach, change of method of site sue and etc, so as to determine whether site remediation activity functions for achieving the objectives of human and environmental protection.

(3) Post-management optimization measures and suggestions: from identification and diagnosis of potential risk, if the site remediation activity is determined impossible or difficult to achieve the objective of human and

environmental protection, further measures and suggestions should be proposed for optimization of remediation action plan, including long-term response action, operation and maintenance, implementation of control system, optimization of remediation plan, additional survey and etc.

(4) Compilation of review report: from above survey and diagnosis, make review conclusion, determine whether further measures need to be taken, whether continuous review inspection and time span are necessary, and compile review report.

For some sites of complex conditions, with which site supervision is difficult due to large time span for review inspection, system control and like methods may be adopted at the same time for Post-management.

Review inspection and assessment of site should be conducted by qualified organization having corresponding capacity entrusted by responsible party of site remediation based on actual condition . site review report should be registered with local environmental protection department, and accept supervision and guidance by environmental protection department during review inspection and assessment.

15.9.2 Time of Post-management

Post-management of the project may be intervened at the time of starting remediation; site review inspection and assessment should be conduct once for every 5 years after site remediation acceptance, which is included in the whole process of the site, until the site is no longer hazardous to surrounding environment and human health; the time of subsequent site review inspection and assessment should be determined by the conclusion of previous review inspection, earlier review or additional review frequency is permissible, depending upon actual situation.

15.10 Environmental Management of Solid Waste Landfill

15.10.1 Operation Period

a). Solidification waste residue landfill should strictly comply with Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid

Wastes (GB18599-2001) , regulations on the issue of Standard for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes (GB18599-2001) and statement on amendment directory of three national contaminations control standards (2013, NO. 36 Statement) and applicable laws and regulations.

b). In order to ensure effective operation of dredging, solidification and landfilling, complete waste residue dump dredging operation plan, solidification process operation plan of solidification treatment workshop, landfilling operation plan and operation specifications of new landfill, schedule plan and etc should be developed, and attention should be paid to following aspects in the process of practical solidification:

A. The blocks formed after solidification treatment of waste residue must be spot tested.

B. Only the blocks with concentration of noxious ingredients in lixivium conforming to control limit for entering in landfill area are allowed to deliver to safe landfill, otherwise such blocks should be crushed into waste residue for treatment again.

In the process of practical landfill, attention should be paid to following aspects:

A. Waste pile should be compacted as possible to ensure maximum landfill capacity.

B. Solidified waste residue block delivered to spoil ground should be piled strictly according to design requirement, and casual dumping is prohibited.

C. Working face of block landfill should be reduced as possible, time of exposure of solidified waste residue block should be shortened as possible, and timely temporary closing is required.

c). To ensure effective operation of new safe landfill, landfill plan of waste pile should be implemented to ensure final coverage of single landfill area in the shortest time.

d). During dredging of heavy-metal contaminated soil, leaching toxicity test of contaminated soil should be conducted timely in terms of dredging depth to reduce the quantity of solidification as possible.

e). In landfill area, existing waste pile dredging area and haulage road, regular watering is required to reduce fugitive dust pollution.

⑥During landfilling operation, care should be exercised to prevent damage of anti-seepage layer and blocking of pipe, so as to ensure smooth leaching collecting system and avoid occurrence of risky accident.

⑦ Strengthen environment monitoring management, keep detailed operation records, and find environmental condition and sewage discharge condition within the stations and waste pile.

15.10.2 Closing Period

a). Construction contractor should collected basic information on new safe landfill as well as meteorological, hydrological, soil, surrounding vegetation, residential area and etc surrounding areas, determine closing of new safe landfill based on land use planning, as well as greening pattern for remediation construction of existing waste pile, such as leisure greenbelt, woodland, nursery land and etc, plant species should be selected and configured in terms of ecological, safe and economic principle. Lastly, construction of surrounding landscape, road landscape, road median, greening furniture should be designed for different functional zones by stations.

b). Water and soil conservation is principal function of closing. Therefore, greening coverage materials of good effect of water and soil conservation should be used, design and construction of ground drainage should be implemented properly to prevent sheet flow erosion after greening construction.

c). To ensure integral closing coverage system, landform adjustment in large area should be avoided after closing. Therefore, waste pile must be trimmed according to landscape planning in closing design, construction of coverage system may only be carried out after design requirements are met.

d). Drought-enduring plants for closing help to save expenditure of water rates; planting of greening vegetation of low maintenance cost helps to reduce subsequent management and maintenance cost, planting of heavy-metal absorbing vegetation species helps to improve local soil and groundwater environment.

e). Regular monitoring of closed landfill, and real-time monitoring of ecological restoration, and adjustment of remediation plan accordingly.

15.11 Environmental Protection & Safety Protection Training

15.11.1 Training and Investigation

15.11.1.1 Seminar Training

Project management organization plays an important role of coordination and guidance during design and management of the project. In order to realize the project objectives during execution of the project, PMO will organize series of special seminar training activities regarding procurement, financial accounting, reimbursement, monitoring and assessment according to management requirement for World Bank financed project, so as to help project management staffs to build their professional ability; particular format of seminar training is as follows:

(1) Lecture of external experts: it’s planned that, during execution of the project, training class for promotion of project management knowledge and environmental protection technology will be organized as appropriate; external experts familiar with World Bank’s requirements of project management procedures and authoritative in the field of environmental protection sector will be engaged to give special training class to various levels of PMO for training of procurement, financial management and monitoring, as well as environmental protection and etc.

(2) Attend project management training class held by World Bank in the universities: It’s planned that, during execution of the project, project management staffs will attend various types of project management seminar held in domestic key universities such as Tsinghua University, Xi’an Jiaotong University and Shanghai Tongji University, when various levels of project management staffs from project execution organizations will be trained for project specific procurement, financial management and monitoring, so as to systematically learn and acquaint themselves with World Bank’s procurement, financial and safety guarantee policies, and discuss about the solutions in line with the project for various problems in connection with execution and management of the project. The training class will provide various levels of management staffs with a platform for exchange of experience and seminars, which aims to solve various problems, promote execution of the project, and improve capacity construction of various levels of project management unit.

(3) The project specific in-phase progress report seminar and summary plan seminar will be held: To cooperate with World Bank's arrangement of biyearly project inspection, and allow planned and orderly construction and timely summary of construction management experience of the project, it's planned that, during execution of the project, project specific in-phase progress report seminar and summary plan seminar will be held respectively in the first half and second half of each year, when experts from World Bank and construction contractor of the project will attend to discuss and study the problems and difficulties arising from construction and management of the project, scientific and logic solutions and action plan for the next year will be established, and experience and inspiration from actual operation management of the project will be summarized and shared.

15.11.1.2 Organization of Visits

Related government sectors and project execution units will be organized for domestic and overseas visits, the purpose is to learn advanced project management experience from other countries and regions, widen the view and open the mind through field visits, to allow more effective coordination services and management by project execution units, so as to improve overall project management level. There're three forms of visit:

(1) Outbound learning visit: by organizing outbound learning visit of provincial and municipal project execution units, learn advanced project management experience from developed countries, their research interest of heavy-metal contaminated soil control technology and their policy on the control of soil heavy-metal contamination, to allow more effective execution and management of the project.

(2) Domestic visit: by organizing PMO management staffs to visit other province having successful experiences in the construction and management of similar projects, for instance, control of soil contamination in Jiangsu and Zhejiang, objectively compare and understand the characteristic of construction of heavy-metal pollution control in Hunan and the gap with other provinces 的, learn from the development experience of developed provinces, actively explore valid control model of heavy-metal contaminated environmental improvement suitable for Hunan, and promote this practice in the provincial level.

15.11.1.3 Training of Applied Employment Skills for Laid-off Workers, House-demolished Families and Land-lost Farmers

(1) Training objects: laid-off workers, house-demolished families and land-lost farmer having basic literate and labor ability will have the opportunity for receiving skill training. The training will be arranged for not less than 50% affected population and not less than 1 trainee from each affected family.

(2) Training content: building construction training, vehicle driving training, workshop worker training, horticulture training, high-yield crop planting training, and training of breeding techniques, the purpose is to help them improve reemployment skill, agricultural production ability, and increase the income for the good of laid-off workers and land-lost farmers.

(3) Training mode: land-lost farmers will be trained in a vivid, apparent and understandable manner with the help of training CD, lecture, video tools, in combination with field visit, road show, appraisal through comparison, exchange of experience and periodic technical instructions, so as to improve the participants' ability for digestion, absorption and introduction of technology and technical analysis ability.

15.11.1.4 Environmental Protection & Safety Protection Training

(1) On-the-job Training of environmental management staffs

The purpose of on-the-job training of environmental management staffs is to strengthen environmental management during construction period and operation period, ensure environment monitoring quality and effective environmental management, so as to improve overall quality of the project. By on-the-job training, environmental management staffs are enabled to distinguish major environmental problems in construction stage, understand more about the problems and imperfections in environmental management, timely report to environmental protection office/division/department to allow necessary control measures be taken quickly. During construction, project management organization should invite environmental protection experts or environmental management staffs having similar management experience for field explanation of potential environmental problems and solutions.

(2) Training of subunit construction leaders and construction personnel

Before commencement of construction, awarded construction leaders and construction personnel should receive systematic training of special knowledge about environmental protection, so as to avoid environmental damage as a result of operation error during construction. The purpose of training of contract undertaker is to define the responsibility of construction contractor for environmental protection; the purpose of training of construction personnel is to strengthen correct operation method of construction operation during construction period, so as to reduce construction activity that could cause unnecessary environmental damage. By the training, construction leaders may understand their obligation to environmental protection, potential consequence of environmental damage, and construction personnel may have apparent understanding of the extent and method of protection of environment sensitive points. According to the actual situation of the project, training period of construction personnel is 1 week.

(3) During operation of the project, project management organization will organize periodic training of environmental protection knowledge for its staffs, so that they're able to identify potential environmental problems with respective jobs, and take necessary measures; each staff should behold the conception of environmental protection.

(4) Safety protection training

During field clearing and removal of contaminated site, extra care should be exercised to maintain working safety and sanitation. Before entering in the site of construction operation, all incoming personnel should receive education of safe construction, and particularity of field work should be emphasized. Incoming personnel includes field management staffs, cleaners, excavator operator car drivers et al. All personnel should receive safety education and skill training for proper performance of respective jobs.

15.11.2 Training Program and Action Plan of the Project

Technical assistance and training activities of the project will be arranged by united planning and hierarchical management. At first, training content should be determined and plan of various training activities be developed according to general objective and requirements of the project; furthermore, in order to support the project by technical assistance and training program, timing of action plan of the project will be given priority. Advance training will be organized; scheduled major technical assistance and training activities will be carried out 2 years before execution of the project.

The hierarchical management of technical assistance and training mainly includes provincial project management organization taking charge of coordination of external technical resources in and out of the province, the project owner assisting in the organization of special seminar, exchange and promotion of successful experience, as well as outbound learning visit and etc according to the requirements of the project; moreover, in order to give instructions to project unit to improve execution and management capacity, PMO will organize and arrange training of project management staffs.

In order to ensure training effect and training quality, PMO will take general responsibility to give instructions to project unit in training management and training effect assessment. Special questionnaire will be designed for training effect assessment; assessment of training effect, unsolved problems and proposals on improvement will be performed at the end of each training activity, so as to improve training effect continuously.

Table 15.11-1 Cost Estimates for Technical Assistance & Training Activity (Soft Environmental Construction)

No.	Cost category	Time	Place	Organization	Purpose	Unit	QTY	Unit price: RMB10,000	Total price: RMB10,000	Remark
1	Outbound visit								98.00	
1.1	Outbound visit	2016	USA	PMO	Visit and learn contaminated soil control technology	Person(s). time(s)	7	7.00	49.00	World Bank fund
1.2	Outbound training	2017	Europe	PMO	Visit and learn experience in environmental improvement construction	Person(s). time(s)	7	7.00	49.00	World Bank fund
2	Domestic visit								48.00	
2.1	Domestic visit 1	2016	Jianfsu, Zhejiang and etc	PMO	Environmental improvement technology	Person(s). time(s)	8 persons×2 group=16 persons	1.50	24.00	
2.2	Domestic visit 2	2017	Guangdong and etc	PMO	Visit and exchange experience in environmental improvement	Person(s). time(s)	8 persons×2 groups=16 persons	1.50	24.00	
3	Lecture of external experts					Person(s). time(s)	150	1.00	150.00	Including experts' cost
3.1	Special seminar on the development of environmental protection industry	2016	Domestic	PMO	Improve the ability of enterprise management staffs	Person(s). time(s)	50	1.00	50.00	
3.2	Special seminar on environmental improvement construction	2017	Domestic	PMO	Improve the ability of environmental improvement construction	Person(s). time(s)	100	1.00	100.00	

	and project operation				management staffs					
4	Training of procurement, financial, management staffs								28.00	
4.1	Procurement training	2015-2017	Domestic	PMO	Acquaint World Bank's procurement policy (Civil work, freight consulting services and etc)	Person(s). time(s)	2 persons×3 groups=6 persons	2.00	12.00	World Bank fund
4.2	Financial training	2015-2017	Domestic	PMO	Acquaint World Bank's financial management and payment of reimbursement policies	Person(s). time(s)	2 persons×2 groups =4 persons	2.00	8.00	World Bank fund
4.3	Training of management staffs	2015-2017	Domestic	PMO	Learn the knowledge about project contract management	Person(s). time(s)	2 persons×2 groups =4 persons	2.00	8.00	World Bank fund
5	Training of environmental protection management promotion								50.00	
5.1	Lecture of environmental protection promotion	2017	Zhuzhou	Environmental protection Station	Improve urban citizens' awareness of environmental protection	Person(s). time(s)	100 persons×2 groups =200 persons	0.1	20.00	World Bank fund
5.2	Public environmental protection promotion	2017	Zhuzhou	Environmental protection Station	Improve urban citizens' awareness of environmental	Person(s). time(s)	100 persons×2 groups =200 persons	0.1	20.00	World Bank fund

					protection					
5.3	environmental protection management	2018	Zhuzhou	Environmental protection Station	Improve environmental protection operation management level; Learn the knowledge about environmental protection management; Learn the knowledge about all aspects of environmental protection and environmental management, and understand the content of environmental impact report of the project	Person(s). time(s)	50	0.2	10.00	World Bank fund
6	Skill training of project management staffs								25.00	
6.1	Training of integrated procurement and financial management	2016	Domestic	PMO	Acquaint World Bank's financial management and payment of reimbursement policies	Person(s). time(s)	16	0.5	8.00	World Bank fund
6.2	Training of integrated procurement	2017	Domestic	PMO	Acquaint World Bank's financial management and	Person(s). time(s)	20	0.5	10.00	World Bank fund

	and financial management				payment of reimbursement policies					
6.3	Skill training of MIS operation	2018	Domestic	PMO	Acquaint operation of project information management system	Person(s). time(s)	10	0.5	5.00	
6.4	Supervision contractor's field manager and construction environmental supervisors	2015	Domestic	PMO	Learn the knowledge about environmental supervision, understand the content of environmental impact report of the project, and the content of corresponding environmental protection design documents of the project	Person(s). time(s)	2	0.5	1	
6.5	Construction contractor's technical engineer and construction manager	2015	Domestic	PMO	Learn the knowledge about environmental protection and environmental management	Person(s). time(s)	5	0.2	1	
7	Training of applied skill								175	
7.1	Laid-off worker & land-lost farmers	2016, 2017	Domestic	Shifeng District Human Resources Bureau	Reemployment training	Person(s). time(s)	40 persons×5 groups=200 persons	0.5	100	
7.2	Training of	2016,	Domestic	Shifeng District	Employment	Person(s).	50 persons×3	0.5	75	

	land-lost farmers	2017		Human Resources Bureau	training	time(s)	groups =150 persons			
7.3	Construction personnel	2015-2022	Domestic	PMO	Learn the knowledge about environmental protection of the project	Person(s). time(s)	100	0.06	6	
7.4	Field management staffs Field operators	2015-2022	Domestic	PMO	Safe production management system; civilized production management system, characteristic of toxicity of contamination; emergency treatment measures	Person(s). time(s)	20	0.1	2	
7.5	Operators of equipments & apparatuses (Inc. excavator operator and car driver)	2015-2022	Domestic	PMO	Excavator operator and car driver should receive corresponding training and hold qualification certificate before assignment	Person(s). time(s)	20	0.1	2	
	Total								584	

15.12 Pollution Control Measures and Personal Safety Protection Measures during Remediation

15.12.1 Pollution Control Measures during Remediation

15.12.1.1 Equipment Washing

All equipments, machinery and apparatuses entering from polluted area in unpolluted area should be washed, including excavator, transport vehicle and personal protection equipment.

Wash water should be collected and delivered to water treatment facility for treatment; treated wash water should be reused to reduce water consumption for cleaning; for washing of heavy-duty machinery, ground washing pool and sedimentation tank should be constructed; stop the equipment on washing platform, let wash water flowing in washing sedimentation tank, after settlement, it can be reused as wash water; settled sediment should be collected and disposed separately.

15.12.1.2 Control of Fugitive Dust

Set up not less than 2m high enclosure facility conforming to applicable specification around construction site; set up special earth deposit site in the construction field; strengthen construction management for civilized construction; spray water and clean to suppress fugitive dust in construction field and construction road; restore vegetation immediately after use of temporary land

15.12.1.3 Noise Control

Use low-noise mechanical equipment; strictly comply with applicable provisions of Emission Standard of Environment Noise for Boundary of Construction Site(GB12523－2011), control the time of construction operation leading to noise pollution; ban construction of high-noise equipment at nighttime (22:00-6:00) ; avoid noise emitting construction activity at noon (12:00-14:00) and nighttime (19:00-22:00) ; the site for access of construction vehicles or soil solidification field with soil carrying vehicles and other construction site should be kept away from sensitive points as possible, vehicles passing in and out of the site should be driven at low speed and honking is prohibited; construction machinery and construction intensity should be arranged rationally.

15.12.1.4 Solid Waste

1) If solid waste is discovered during field clearing or excavation, it should be treated according to following principles:

2) For solid waste needs to reserve and so confirmed by the employer, manually dig prospect hole to determine exact position and course of the waste, clearly mark with paint the position of solid waste to be reserved, and then start excavation; excavate solid waste by manual work in combination with backhoe excavator; buried waste should be excavated and manually to remove surrounding objects, waste in other areas should be excavated with backhoe excavator;

3) For buried waste needs to move and so confirmed by the employer, above excavation procedures should be applied until all buried waste appears, and moving plan should be developed separately;

4) For buried waste discarded and discarded for unknown use but further verified uselessness, which belongs to general solid waste, such solid waste should be directly removed and disposed; if solid waste belongs to hazardous wastes, it should be declared to the supervision contractor and finally handed over to qualified unit for disposal of hazardous waste for treatment.

15.12.1.5 Rainproof Measures and Surface Runoff Control

1) As the site is loaded with large amount of contaminated soil, measures should be taken to prevent rainwater erosion of contaminated soil, and surface runoff should be controlled effectively, particular measures are as follows:

2) Logic design of the course and capacity of diversion channel and collecting tank to ensure no overflow of contaminated rainwater;

3) The contaminated soil for temporary storage in appointed area should be covered with surface layer of earth, and diversion channel and collecting tank should be constructed around all staging areas;

4) Temporary drainage ditch should be constructed timely in terms of excavation progress of contaminated soil, so as to collect rainwater in collecting tank;

5) All contaminated rainwater collected collecting tank should be delivered to water treatment equipment for treatment before standard discharge.

15.12.1.6 Secondary Pollution Control

1) Full consideration should be given to take secondary pollution control measures during excavation, removal and disposal of contaminated soil;

2) Keep in mind to frequently spray water in the areas surrounding excavation site, haulage road and vehicle turnaround area to suppress fugitive dust;

3) The range of activity of excavator and transport vehicle should be limited strictly to prevent contaminated soil from be carried to other areas or out of the site.

15.12.2 Personal Safety Protection Measures

1）Strengthen safety protection education of management staffs and construction personnel;

2）Before operation, the workers should conduct safety inspection of machinery, apparatus, equipment, safety protection articles and working environment, so as to find safety problem and timely eliminate potential risk of safety accident;

3）The operators in excavation and loading areas must wear on work clothes, rubber overshoes, gloves, safety helmet and respirator;

4）During excavation and removal of dry contaminated soil, drenching facility should be sued to reduce dust concentration, and the operator should wear on protective respirator;

5）During construction operation of excavation machinery, no man is permitted to stand within turning radius of excavator;

6）Any person other than construction personnel is banned access to turnaround area of transport vehicle;

7）The operators should not commit any operation or command not allowed;

Construction personnel and machinery are banned activity and running beyond stated area; domestic waste and construction waste should be collected and treated together rather than littering around; closed container should be set up in residential area; wastes should be stored by sort, periodically disinfected and timely removed.

15.13 Environmental Emergency Safety Plan

Emergency measures of the project mainly deals with three parts, namely, personal injury, secondary pollution and rainfall during construction period.

15.13.1 Personal Injury

First-aid kit should be available at construction site; first-aid kit should be configured according to the principle of simplexes and applicability to ensure basic requirements for first aid on the spot; the inclusion of first-aid kit may be increased or decreased, as the case may be, examined and supplemented on a regular basis, so as to ensure readiness at all times.

a). Treatment of Cadmium Poisoning

In case of acute poisoning by inhaling large volume of fume of cadmium oxide, treatment is the same as with common irritant gas poisoning. The key is to prevent pulmonary edema.

Evacuate from the spot of accident as early as possible, keep calm, lie in the bed, inhale oxygen, maintain free respiratory tract, inhale 10% atomized silicone to defoam, cortin may cause lower capillary permeability and should be taken in fixed dosage as early as possible; limit intake of liquid, inject antibiotic to prevent secondary infection; in case of acute oral inhalation cadmium poisoning, apply symptomatic treatment, make fluid infusion in large volume, inject atropine to settle the stomach and eliminate bellyache.

In case of renal injury as a result of chronic cadmium poisoning, add intake of calcium and phosphate from meal, supply sufficient Zn and protein; metal complexing agent calcium disodium edetate ($CaNa_2EDTA$) functions for additional eduction of cadmium, but may worsen renal damage; use of $CaNa_2EDTA$ is not recommended in case of acute and chronic poisoning; it’s reported that oral intake of nitilotriacetic acid (NTA) facilitates eduction of cadmium (Mainly with dejection), so as to reduce inner cumulation without damage of renal function.

To prevent cadmium poisoning, good ventilation and closure devices should be available in the workplace; eating and smoking in production area are not preferred. Maximum permissible concentration of cadmium oxide in production area in China is $0.1mg/m^3$.

b). Treatment of As Poisoning

In case of accidental oral poisoning, treat with gastrolavage with warm water, normal saline or 1% sodium bicarbonate, then take in 30g activated carbon, 20～40g magnesia or protein water; alternatively, immediately take in newly prepared ferric hydroxide solution to react with arsenic and produce insoluble ferrous arsenate, then take in sodium sulfate for catharsis.

Alexipharmic of special effect is available for acute arsenic poisoning; sodium dimercaptopropane sulfonate, sodium dimercaptosuccinate and etc are effective to remove arsenic toxicity; penicillamine is also effective to remove arsenic toxicity and should be take in as early as possible (Dosage, method of oral intake by prescription) ; pay attention to prevent and correct dehydration, shock and electrolyte disturbance; critical patient should be treated by hemodialysis as early as possible, which is effective to remove arsenic in the blood and prevent acute renal failure.

Chronic arsenic poisoning can be treated with intravenous injection of 10% sodium thiosulfate to help renal excretion; dermal or mucous membrane damage can be treated by dressing of 2.5% dimercaprol ointment or dexamethasone ointment; in case of delayed and multiple pathological changes of peripheral nerve, symptomatic treatment is advisable.

To prevent arsenic poisoning, the first thing to do is control of arsenide dust, closing of dust-inducing, reclamation, installation of ventilation device, and prevent gas diffusion; secondly, strengthen personal protection, wear on anti-gas respirator, exposure suit, overshoes and etc; eating in the workplace is banned; carefully clean by washing at the end of work; arsenic contained sewage and exhaust gas must be treated before discharging.

The operators involving in arsenic operation should receive physical examination on a regular basis; any worker suffering disease of respiratory tract, hepatic and renal disease, blood disease or skin disease should be removed from the job of arsenic operation.

c). Treatment of Pb Poisoning

Skin exposure: take off contaminated cloths, thoroughly wash with soap water and flowing clean water.

Exposure of eyes: immediately unfold eyelid , wash with flowing clean water or normal saline; see the doctor.

Inhalation: quickly evacuate from the spot and go to an area having fresh air; maintain free respiratory tract; oxygen therapy in case of decompensation; artificial respiration in case of no breath; see the doctor.

Oral intake: drink sufficient quantity of warm water to force vomiting; see the doctor.

Preventive measures: protection of respiratory system: operation worker should wear on dustproof respirator; protection of eyes: wear on safety mask, if necessary; exposure suit: wear on work cloths; protection of hands: wear on gloves, if necessary; other: smoking, eating and drinking in workplace are banned; take shower and change cloths at the end of work; conduct physical examination before employment; maintain healthful hygienic habit.

d). Treatment of Anilin Poisoning

Skin exposure: immediately take off contaminated cloths, thoroughly wash skin with soap water and clean water; see the doctor.

Exposure of eyes: quick lift up eyelid, thoroughly wash with large amount of flowing clean water or normal saline for at least 15min; see the doctor.

Inhalation: quickly evacuate from the spot and go to an area having fresh air; maintain free respiratory tract; oxygen therapy in case of decompensation; artificial respiration in case of no breath; see the doctor.

Oral intake: drink sufficient quantity of warm water to force vomiting; see the doctor.

e). Treatment of Benzopyrene Poisoning

Protection measures: protection of respiratory system: no special protection is required in general cases, however, it’s recommended to wear on self-contained breathing apparatus in special circumstance.

Protection of eyes: wear on goggle.

Exposure suit: wear on PE film protective clothing.

Protection of hands: wear on chemical protective gloves, if necessary.

Other: take shower and change cloths at the end of work; avoid long and repetitive exposure; exercise extra care to prevent carcinogenicity; thirdly, first aid measures: skin exposure: take off contaminated cloths, thoroughly wash skin with soap water and clean water.

Exposure of eyes: immediately unfold upper and lower eyelids, wash with flowing clean water for 15min; see the doctor.

Inhalation: evacuate from polluting environment wash nasopharynx dust with water; see the doctor.

Oral intake: fully gargle , drink a lot of water to force vomiting; see the doctor. Method for fire extinguishment: CO2, dry powder, 1211 fire extinguishing agent, sand; water may cause boiling and splashing.

⑥ First Aid of Trauma

In case of trauma during construction, quickly evacuate the injured from dangerous area, clean and dress the wound; in case of severe wound, first control the condition of injury with first aid facility; the send the injured to the hospital for treatment.

⑦First Aid of Electric Shock

Immediately disconnect power supply; push away electrical wire or disconnect power supply with insulated tool such as dry wooden stick and bamboo stick; observe the condition of the injured; in case of heartbeat or faint breath and even cease of breath after electric shock, the rescue operator should conduct external cardiac massage and artificial respiration, do not stop or give up rescue before arrival of medical professional.

⑧First Aid of Collapse Accident

In case of collapse of slope during excavation, first rescue the injured, take effective measures to protect other workers, monitor and condition of slope at all times, timely remove materials piling on the slope, so as to prevent secondary accident.

⑨ Hospitalization

After spot treatment of the injured, send the injured to hospital for further examination; special ambulance should be available at construction site for the purpose of first aid.

15.13.2 Secondary Pollution

Full consideration must be given to secondary pollution emergency measures during excavation and removal of contaminated soil. Removal construction team is main execution object of emergency measures, responsible for preparation and execution of emergency work.

All field personnel for emergency measures must maintain proper personal protection.

Contaminated soil should be handled out of construction site in closed; personnel for handling of contaminated soil should be protected by safety protection measures.

In case of large amount of leakage during handling of contaminated soil, it must be promptly notified to the leader of removal site for assistance, and efforts should be made to prevent spreading of secondary pollution with spare tools.

Earth excavation, backfill, transfer and other construction likely to cause fugitive dust pollution are not allowed in the day of strong wind.

15.13.3 Rainfall during Construction

(1) Construction contractor should carry out environmental supervision in the whole process of construction, implement pollution control measures in environmental impact assessment report and construction plan without failure;

(2) Construction by areas should be adopted; wastewater emergency treatment reagents like caustic soda flakes, sodium sulphide, PAM and etc should be prepared during dredging and excavation construction for the purpose of emergency use in the case of accident; 24h manned watch should be arranged during construction period.

(3) Strengthen the contact with all heavy metal control construction contractors during simultaneous construction; establish linkage mechanism; in case of failure of any wastewater treatment equipment of pollution control project, stop all construction works to avoid excess pollution load as a result of superposed pollution impact.

(4) In rainy season, one on-board mobile wastewater treatment equipment should be configured, which is sued to pump wastewater in case of accident; treated wastewater should

be discharged to Xiawangang or Qingshuitang industrial wastewater treatment plant.

(6) Equipments such as water pumps for rainwater interception should be configured for one-operation-one-backup use to prevent failure of such equipment and resultant ingress of rainwater in the pond.

（1） Strengthen maintenance of equipments to avoid failure.

15.13.4 Emergency Contact

The telephone numbers for contact with related persons and units in case of emergency incidents are listed in the table below.

Table 15.13-1 Emergency Contact Numbers

Unit/person	Address	Telephone number
Robbery alarm	—	110
Fire alarm	—	119
First aid center	—	120
Power supply bureau	—	95598
Department of Environmental Protection of Hunan Province	#118, Section 3, Central Wanjiali Road, Yuhua District, Changsha, Hunan, China	12369 (Report & complaint hotline)
Zhuzhou Environmental Protection Bureau	137 Lujiang Road, Tianyuan District, Zhuzhou City, Hunan, China	
Shifeng Environmental Protection Bureau	1F, #4 Building, First Tianmutang Village, Zhuzhou City, Hunan, China	0731-28682795
Zhuzhou People’s Hospital	Special 1, Xinwu Street, West Xinhua Road, Zhuzhou City, Hunan, China	0731-22681058

Table 15.13-2 Action Plan of Environmental Protection Measures

Content Environ ment	Contamination designation	Control measures	Execution unit	Supervision unit	Capital source	Execution stage
Ecological	Control of soil erosion	Cover temporary dump of spoil with dustproof tarpaulin	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	Construction period
	Vegetation restoration	Reclamation or plant grasses and trees in temporary land use	Project employer and construction contractor	Governmental sector	Special construction investment	Operation period
	Vegetation restoration	Earthing, greening	Project employer and construction contractor	Governmental sector	Special construction investment	Closing period
Noise	construction machinery noise	Logic arrangement of construction time, strengthen management	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	Construction period
		Construction of temporary sound insulating barrier	construction contractor	Governmental sector	Included in construction contractor's bid price	
	Traffic noise	Reserved cost of sound insulation measures	Project employer and construction contractor	Governmental sector	Special construction investment	Operation period
Water contamination	Initial rainwater in plant area of demolished facilities	Construction of 100m^3 initial rainwater collecting tank in each plant, initial rainwater after sedimentation is used to wash building without discharge	Construction contractor	Governmental sector	Included in construction contractor's bid price	Construction period
	Machinery wash water	Recycling after oil separation sedimentation	Construction contractor	Governmental sector	Included in construction contractor's bid price	
	Wastewater from washing structures of closed facilities	Treatment with mobile water treatment equipment before connecting to municipal sewer pipe network	Construction contractor	Governmental sector	Included in construction contractor's bid	

					price	
	Sediment dredging wastewater	After treatment with mobile water treatment equipment according to Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class I, directly discharge to Xiawangang	Construction contractor	Governmental sector	Included in construction contractor's bid price	
	Quarry seeper	By breakpoint chlorination treatment, construction of 1×500m³ reinforced concrete pond as breakpoint chlorination reaction tank, after treatment according to Integrated Wastewater Discharge Standard (GB8978-1996) ,Table 4, Class I, discharge to the stream beside Qingxia Road	Construction contractor	Governmental sector	Included in construction contractor's bid price	
	Sediment dewatering wastewater	After treatment with mobile water treatment equipment according to Integrated Wastewater Discharge Standard (GB8978-1996) , Table 4, Class I, discharge to the nearest receptor	Operator	Environmental protection department	Special construction investment	Operation period
	Leaching of landfill	Connected to Qingshuitang industrial wastewater treatment and reclaiming plant for further treatment	Operator	Environmental protection department	Special construction investment	
	Initial rainwater	construction of 75 m^3, 75 m^3, 100 m^3 and 180 m^3 initial rainwater collecting tank in Xinqiao solidification/stabilization plant, Xinqiao dewatering site, Xiawan dewatering site, temporary piling area, respectively, together with anti-seepage treatment; all initial rainwater is recycled without discharge	Operator	Environmental protection department	Special construction investment	
	Production sewage of landfill	SBR treatment technology and membrane bioreactor reclaimed water recycling system, recycling; Lavatory washing wastewater connected to Xiawan wastewater treatment plant for further treatment	Operator	Environmental protection department	Special construction investment	
	Landfill	Connected to Qingshuitang industrial wastewater treatment and reclaiming plant for further treatment	Operator	Environmental protection department	Special construction investment	Closing period
Groundwater	Wastewater during construction period	Laying geomembrane or hardening anti-seepage measures for initial rainwater collecting tank, oil	Project employer and construction	Governmental sector	Included in construction	Construction period

		separation tank, sedimentation tank and chlorination reaction tank; buildings/structures washing ground of all closed facilities to be hardened; rainproof, ground hardening and anti-seepage measures for temporary piling area of all stations	contractor		contractor's bid price	
	Station initial rainwater	Construction of 75 m^3, 75 m^3, 100 m^3, 180 m^3initial rainwater collecting tank in Xinqiao solidification/stabilization plant, Xinqiao dewatering site, Xiawan dewatering site, temporary piling area, respectively, together with anti-seepage treatment	Operator	Environmental protection department	Special construction investment	Operation period
	Sediment dewatering wastewater	Laying geomembrane or hardening anti-seepage measures for collecting tank of sediment dewatering wastewater	Operator	Environmental protection department	Special construction investment	
	leaching of landfill	Construction of double anti-seepage structure for bottom anti-seepage treatment at landfill, anchoring shotcrete anti-seepage treatment is adopted for slope substrate	Operator	Environmental protection department	Special construction investment	
	leaching of landfill	Periodic monitoring	Operator	Environmental protection department	Special construction investment	Closing period
Air contamination	Fugitive dust	setup of not less than 2m high enclosure facility conforming to applicable specification around construction site; setup of special earth deposit site; cover vehicles with tarpaulin; spray water and clean to suppress fugitive dust in construction field and construction road; restore vegetation immediately after use of temporary land	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	Construction period
	Exhaust gas discharged by oil-fueled machinery and construction vehicles	Setup of enclosure in dredging area; strengthen management of heavy-duty construction machinery and vehicles, mechanical equipment equipped with corresponding smoke and dust removal device, regular examination and maintenance	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	

	Odor of dredged sediment	It's recommended that watercourse dredging work is carried out in dry season by means of section construction; before commencement of dredging construction in a given period, construction contractor must inform surrounding residents to close their windows; Mechanical dredging should be adopted; the sediment should be carried to dewatering ground immediately after dredging, instead of deposit at dredging site; The construction workers should be protected properly; The dredged sediment should be handled with enclosed tank car to prevent spill along the way; handling of dredged sediment should be kept away from downtown area and densely populated residential area.	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	
	Dust from solidification/stabilization treatment	To ensure water content of soil, sediment, waste residue and ingredients, automatic feeding is adopted for solidification mixing, finished mixture is stored in enclosed workshop; during solidification batching, water is added by ejecting around mixing tank.	Operator	Environmental protection department	Special construction investment	Operation period
	Fugitive dust of landfill	Spray water to suppress dust at landfill; cover transport vehicles with tarpaulin	Operator	Environmental protection department	Special construction investment	
	Odor of sediment dewatering and stabilization deposit reaction	According to the principle of deposit by layers, surface layer of sludge is deposited in the bottom of spoil ground; odorous facility structures are arranged in leeward area; set up cover plate or protective greenbelt in the area of concentrated odor source; setting of health protection distance of 100m beyond Xinqiao solidification/stabilization plant, 50m beyond dewatering site near Xinqiao solidification/stabilization ground, and 50m beyond Xiawangang dewatering site	Operator	Environmental protection department	Special construction investment	
Solid waste	Construction waste	Reclaiming and recycling	Project employer and construction	Governmental sector	Included in construction	Construction period

			contractor		contractor's bid price	
	Demolished building waste	Reclaim and recycle reclaimable waste, deliver irreclaimable building waste not containing residual heavy metal to landfill for landfilling treatment, wash heavy-metal contaminated building waste before landfilling treatment	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	
	Sludge from wastewater treatment	Deliver to solidification/stabilization ground for treatment before landfilling treatment at landfill	Project employer and construction contractor	Governmental sector	Included in construction contractor's bid price	
	Domestic waste	Regular removal of urban sanitation department	Operator	Urban sanitation department	/	Operation period
Environmental management & monitoring	/	Practice construction environmental supervision system, adopt contract constraint mechanism, incorporate related environmental protection measures in production quality management system and acceptance index system of various stages, strengthen dedicated supervision of measures for the control of construction fugitive dust, noise, soil erosion, publicize environmental protection laws and regulations	Contracted to qualified unit by project employer	Governmental sector	Special construction investment	Construction period
Environmental monitoring	/	Local environmental noise, air, surface water, groundwater, environmental quality	Contracted to qualified unit by project employer	Zhuzhou environmental protection department	Special construction investment	Construction period, operation period, closing period

15.14 Environmental and Social Management Framework

15.14.1 Purpose and Scope of the ESMF

The ESMF is needed due to the following considerations

- In the 8.48km^2 project area, there are still industrial facilities in operation. Per domestic regulations, any closure of industrial facilities is subject to site investigation and remediation as necessary;
- There are around 5.75km^2 land plots in the project area have been considered risk acceptable or risk controllable. Nevertheless, risk assessment is based on planned land use which may change. If, for example, a planned industrial land plot is changed to residential use, its risk to human health may become unacceptable and further remediation effort is needed.
- Other remediation or development activities proposed by the ZREIDC, such as the Qingshui Lake Constructed Wetland.Some repaired sites of the project need to be backfilled with clean soil. This soil shall be got from the spoil of Tianyuan District, Zhuzhou City. However, implementation of the project will take 6 years and at the present, we are unable to identify the specific location of the clean soil and its source, and are unable to confirm if we need new a borrow site. For this part of the clean soil, whether it comes from the spoil area or the newly establised soil-taken field, need to meet the domestic laws and regulations, as well as the legal sampling procedures.

Since the specific locations of such potential remediation activity is not known during the project preparation, this ESMF will guide the ZREIDC on the environment and social screening and subsequent assessment of sub projects during implementation, including the relevant sub project-specific plans that have to be developed in compliance with the World Bank policies.

Given substantial site investigation has been conducted during the project preparation, a good understanding of the project area is obtained. Potential environmental and social impacts and mitigation measures are known. This ESMF provides a streamlined procedure for the preparation of environmental and social assessment, including the screening, environmental documentation, review, public consultation and information disclosure, etc. A resettlement policy framework for potential remediation activities has been prepared during the project preparation as well.

15.14.2 Framework Procedures

A. Environment and Social Screening

The PMO/PIU will complete the below screening form to identify key environmental and social issues associated with a proposed remediation activity. The PMO/PIU will send the form to the World Bank and Zhuzhou EPB/Shifeng District EPB and place in the project file.

Screening Form for Potential Environmental & Social Safeguards Issues

This form is to be used by the ZREIDC for to screen potential environmental and social safeguards issues of a sub project, determine Bank policies triggered and the instrument to be prepared for the sub project

Subproject Name	
Subproject Location	
Subproject Proponent	
Subproject Type/Sector	
Estimated Investment	
Start/Completion Date	

Questions	Answer		If Yes WB Policy triggered	Documents requirement if Yes
	yes	no		

Are the subproject impacts likely to have significant adverse environmental impacts that are sensitive [2], diverse or unprecedented? [3] Please provide brief description:			*OP 4.01 Environmental Assessment* Category A	Environmental and Social Impact Assessment (EIA)
Do the impacts affect an area broader than the sites or facilities subject to physical works and are the significant adverse environmental impacts irreversible? Please provide brief description:			*OP 4.01 Environmental Assessment* Category A	EIA
Is the proposed project likely to have minimal or no adverse environmental impacts?[4] Please provide brief justification:			*OP 4.01 Environmental Assessment* Category C	No action needed beyond screening
Is the project neither a Category A nor Category C as defined above? [5] Please provide brief justification:			*OP 4.01 Environmental Assessment* Category B	Limited EIA or EMP

[2] Sensitive (i.e., a potential impact is considered sensitive if it may be irreversible - e.g., lead to loss of a major natural habitat, or raise issues covered by OP 4.04, Natural Habitats; OP 4.36, Forests; OP 4.10, Indigenous Peoples; OP 4.11, Physical Cultural Resources; or OP 4.12, Involuntary Resettlement; or in the case of OP 4.09, when a project includes the manufacture, use, or disposal of environmentally significant quantities of pest control products);

[3] Examples of projects where the impacts are likely to have significant adverse environmental impacts that are sensitive, diverse or unprecedented are large scale infrastructure such as construction of new roads, railways, power plants, major urban development, water treatment, waste water treatment plants and solid waste collection and disposal etc.

[4] Examples of projects likely to have minimal or no adverse environmental impacts are supply of goods and services, technical assistance, simple repair of damaged structures etc.,

[5] Projects that do not fall either within OP 4.01 as a Category A or Category C can be considered as Category B. Examples of category B sub-projects include small scale *in-situ* reconstruction of infrastructure projects such as road rehabilitation and rural water supply and sanitation, small schools, rural health clinics etc.

Are the project impacts likely to have significant adverse social impacts that are sensitive, diverse or unprecedented[6]? Please provide brief description:			*OP 4.01 Environmental Assessment* Category A	ESIA
Will the project adversely impact physical cultural resources?[7] Please provide brief justification:			*OP 4.11 Physical Cultural Resources*	Addressed in ESIA (ESIA with PCR Management Plan and/or Chance Find Procedures)
Will the project involve the conversion or degradation of non-critical natural habitats? Please provide brief justification:			*OP 4.04 Natural Habitats*	Addressed in EIA
Will the project involve the significant conversion or degradation of critical natural habitats[8]?			*OP 4.04 Natural Habitats*	Not eligible

[6] Generally, sub projects with significant resettlement-related impacts should be categorized as A. Application of judgment is necessary in assessing the potential significance of resettlement-related impacts, which vary in scope and scale from sub project to sub project. Subprojects that would require physical relocation of residents or businesses, as well as sub projects that would cause any individuals to lose more than 10 percent of their productive land area, often are categorized as A. Scale may also be a factor, even when the significance of impacts is relatively minor. Sub projects affecting whole communities or relatively large numbers of persons (for example, more than 1,000 in total) may warrant categorization as A, especially for projects in which implementation capacity is likely to be weak. Sub projects that would require relocation of Indigenous Peoples, that would restrict their access to traditional lands or resources, or that would seek to impose changes to Indigenous Peoples' traditional institutions, are always likely to be categorized as A.

[7] Examples of physical cultural resources are archaeological or historical sites, including historic urban areas, religious monuments, structures and/or cemeteries particularly sites recognized by the government.

[8] Subprojects that significantly convert or degrade critical natural habitats such as legally protected, officially proposed for protection, identified by authoritative sources for their high conservation value, or recognized as protected by traditional local communities, are ineligible for Bank financing.

Does the project procure pesticides (either directly through the project, or indirectly through on-lending, co-financing, or government counterpart funding), or may affect pest management in a way that harm could be done, even though the project is not envisaged to procure pesticides?			*OP4.09 Pest Management*	Addressed in EIA (Pest Management Plan)
Does the sub-project involve involuntary land acquisition, loss of assets or access to assets, or loss of income sources or means of livelihood? Please provide brief justification:			*OP 4.12 Involuntary Resettlement*	Resettlement Action Plan
Are there any ethnic minority communities present in the sub project area and are likely to be affected by the proposed sub-project negatively or positively? Please provide brief justification:			*OP 4.10 Indigenous People*	Ethnic Minority Development Plan/Indigenous Peoples Plan
Will the project have the potential to have impacts on the health and quality of forests or the rights and welfare of people and their level of dependence upon or interaction with forests; or aims to bring about changes in the management, protection or utilization of natural forests or plantations? Please provide brief justification:			*OP4.36 Forestry*	Addressed in EIA
Will the project have the potential to have significant impacts or significant conversion or degradation of critical natural forests or other natural habitats?			*OP4.36 Forestry*	No eligible

Conclusion and Safeguards Instruments Required:

The sub project is classified as a Category ________ project as per World Bank OP4.01, and the following safeguards instruments will be prepared:

1. ____
2. ____
3. ____

4. ____
5. ____

B. Due Diligence

The PMO/PIU will carry out due diligence of the site that is proposed for remediation, including necessary additional monitoring, risk assessment, land ownership, worker settlement (in the case of factory closure), etc. The due diligence report should be included in the project file.

C. Environmental Documentation

The PMO/PIU is required to prepare Environmental Impact Assessment (EIA) and/or Environmental Management Plan (EMP) to address environmental, social, health and safety issues for site remediation or development activities in the project area.

D. Review and Approval

The EA will need to be reviewed by local environmental protection bureau and the World Bank who will provide comments, recommendations and clearance to the EIA/EMP.

E. Public consultation and information disclosure

During preparation of the environmental documents, public consultation and information disclosure should be carried out following domestic requirements and World Bank policies. The disclosure and consultation should be carried through questionnaire survey, interviews and group meetings. Full draft EA reports should be disclosed. Public opinions and concerns should be incorporated into the technical design and environmental documents where appropriate.

16 Assessment Conclusion

16.1Project overview

The World Bank-China Proposed Zhuzhou Brownfield Remediation Project is implemented in the Zhuzhou Qingshuitang Circular Economy Industrial Zone (Qingshuitang Industrial Zone), located in the Shifeng District in Zhuzhou, Province of Hunan. The Zone covers a total area of 8.48 km^2, with the Xiangtian Road in the east, the Beijing-Guangzhou high-speed railway in the west, the Zhuzhou Smelting Plant in the north, and the Xiang River River in the south.

The feasibility study has further analyzed the risk assessment results to prevent excessive remediation on the basis of risk control. Therefore, the project area was divided into three parts: risk acceptable area, risk controllable area, and remediation area. The remediation area is the risk unacceptable areas identified in the risk assessment report and not included in the risk controllable areas. The Remediation area, covering 2.73 km^2, is the area in which this project is involved. Under the project, the area will be treated in the following four ways:

(1) Soil surface cleaning and polluted site treatment and remediation:

a). Land clearance: The area of soil surface to be cleared is 2.30km^2; the volume of buildings to be demolished is 45,843m^3.

6 closed industrial facilities: Zhuzhou Yongfa Metal Refining Co., Ltd., Zhuzhou Brothers Industry Co., Ltd., Zhuzhou Kangli Smelting Plant, Zhuzhou Tiancheng Chemical Co., Ltd., Zhuzhou Xinda Smelting Co., Ltd., and Zhuzhou Hehua Cement Plant. The area of buildings to be demolished is 9,546.8m^2, the volume of construction debris is 6,532.0m^3, and the area of buildings to be cleaned is 7,710.8m^2.

Residential area to be cleaned: 94 households are required to be relocated, with 372 residents affected mainly ine, Yingfeng Community, Qingxia Community and Jianshe Village. The area of buildings to be demolished is 21,993m^2, and the volume of construction debris is 39,310m^3.

b). Soils exchange: Replace the uncovered soil in the contiguous residential areas in the Xiangshiling area, Qingshi area and Tongtanwan area and around the relocated facilities. The size of soil-replacement area in non-remediation area is about

110,855m^2, and the depth of soil to be replaced is 0.5m. The volume of clean soil to be filled is 55,427.5m^3.

c). Soil treatment of polluted sites

Treatment of site contaminated by heavy metals: refer to relevant specifications in China and the framework of Superfund experiences of US Environmental Protection Agency (USEPA) to determine the treatment method in this project:

- ex-situ stabilization and solidification (S/S): 0.47km^2
- transporting to planned non-sensitive land (landfill as backup): 0.62km^2
- in-situ stabilization + capping: 0.74km^2
- in-situ stabilization + vegetation covers: 0.13km^2
- in-situ phytoremeidation: 0.23km^2
- Bio-interception: apply to 0.10 km^2

For the 6 closed plants to be handled under the project, the total remediation area is 0.13km^2. Heavy metal contaminated soils will be excavated and moved to the project S/S facility for treament. The total volume is 74313m^3.

Treatment of soil subject to organic pollution: The soil subject to organic pollution is in the plant of Zhuzhou Tiancheng Chemical Co., Ltd., with an area of 8,274m^2; the volume of polluted soil is 16,548m^3, which will be transported to Sinoma Zhuzhou Cement Co., Ltd. for incineration.

d). Treatment of waste piles: the waste residue in the project area is distributed in Tongxia area, Hongxin Plant, and sporadic residues along the low discharge channel, with total volume of 84,700m^3, which will be transported to the stabilization/solidification operation site for treatment and will then to the solid waste landfill for filling after treatment.

e). Treatment of sediments in ponds and eclogical restoration along Old Xiawanggang Channel: the total area of the 26 ponds to be treated is 0.17km^2, with total water volume of 259,500m^3 and total volume of polluted sediment of 173,000m^3; The polluted sediment will be transported to the stabilization/solidification operation site for treatment after dewatering. Elogical restoration of 54279m^2 along the Old Xiawanggang Channel.

(2) Construction of treament/disposal works

- To modify existing Xinqiao solid waste facility to a stabilization and solidification facility: land area: 4000m^3, daily treatment capacity: 400m^3/d;
- To rent existing Xiwangang dewatering plant: land area: 5,500m^2,

including dewatering field of 4000m^2 and temporary storing yard of 1,500m^2;

- Newly built Dewatering plant (i.e. Xinqiao dewatering site:) land area: about 4,200m^2, including dewatering field of 4,000m^2 and temporary storing yard for sediment of 200m^2;
- Newly built temporary storing field: build a temporary storing field beside the stabilization and solidification operation site with an area of 10,000m^2, the volume of temporarily stored demolition wastes and treated residues is 150,000m^3.
- Newly built temporary road: The main transportation roads of the project are existingTongxia Road, Qingxia Road, the old Tongxia Road, and the Huanbao Avenue which is under construction, and the other village roads are auxiliary transportation roads. By using the existing road, the project is planned to renovate the village roads and build some temporary roads for the purpose of earth transportation. The length of village roads to be renovated is 13,832m, and the length of temporary roads to be built is 1,802m.

(3) Building new solid waste landfill

The project is planned to build a landfill using the abandoned quarry of Zhuzhou Hehua Cement Plant, which has a land area of about 36,265m^2 and the usable volume of the mine is 200,000,000m^3.

(5) Building a new Environmental Information and Demonstration Center: The Environmental Information and Demonstration Center consists of the demonstration center building, environmental protection museum, engineering test area, with planned total construction area of 7970m^2.

The total investment of the project is initially planned to be 242 million US dollars, including 150 million US dollars of World Bank loan. The implementation period of the project is from October, 2015 to December, 2022.

16.2Site investigation findings

16.2.1 Findings of soil contamination investigations

(1) Topsoil in the Yingfeng sub-region has been heavily contaminated. As reaches a maximum of 48mg/kg, Cd reaches a maximum of 37.5mg/kg, Zn reaches a

maximum of 1430mg/kg, Hg reaches a maximum of 2.41mg/kg, Se reaches a maximum of 1.4 mg/kg, Ag reaches a maximum of 3.4mg/kg. According to the investigation, the sub-region soil is contaminated through man-made factors. The pollutants that the investigation focuses on are Cd, Pb, Zn, Sb, Hg, As, and Ag. The depth of contaminated soil is roughly estimated as 40cm; in some locations, this depth has exceeded 60cm.

(2) Topsoil in the Qingshui Lake sub-region has been heavily contaminated. Cd reaches a maximum of 19.4 mg/kg, Pb reaches a maximum of 576mg/kg, Zn reaches a maximum of 907mg/kg, Sb reaches a maximum of 10.9mg/kg, Ag reaches a maximum of 2mg/kg, and As reaches a maximum of 58.3 mg/kg. According to the investigation, the sub-region soil is contaminated through man-made factors. The pollutants that the investigation focuses on are Cd, Pb, Zn, Sb, Hg, As, and Ag. The depth of contaminated soil is roughly estimated as 60cm; in some locations, this depth has exceeded 60cm.

(3) The Qingshui sub-region soil is widely contaminated by heavy metals and the topsoil contamination is the worst in this area. Pb reaches a maximum of 3400mg/kg, As reaches a maximum of 400mg/kg, Cd reaches a maximum of73.7mg/kg, Zn reaches a maximum of 11200mg/kg, Ni reaches a maximum of 150mg/kg, Cu reaches a maximum of 350mg/kg, and Co reaches a maximum of 550mg/kg. The Qingshui sub-region is contaminated through man-made factors and the main pollutants are Pb, As, Cd, and Zn. The depth of contaminated soil in the Qingshui area is roughly estimated as 20cm-40cm; in some locations, this depth has exceeded 60cm.

(4) The Tongxia sub-region soil is widely contaminated by heavy metals and the topsoil contamination is the worst in this area. Pb reaches a maximum of 3726mg/kg, As reaches a maximum of 450mg/kg, Cd reaches a maximum of 250mg/kg, Zn reaches a maximum of 9701mg/kg, Ni reaches a maximum of 150mg/kg, Cu reaches a maximum of 2119mg/kg, and Co reaches a maximum of 500mg/kg. The Tongxia sub-region is contaminated through man-made factors and the main pollutants are Pb, Cd, As, Zn, and Co. The depth of contaminated soil in the Tongxia area is roughly estimated as 50cm; in some locations, this depth has exceeded 60cm.

(5) The Tongtangwan sub-region soil is widely contaminated by heavy metals and the topsoil contamination is the worst in this area. Pb reaches a maximum of

1240mg/kg, As reaches a maximum of 671mg/kg, Cd reaches a maximum of 353mg/kg, Zn reaches a maximum of 2620mg/kg, Cu reaches a maximum of 237mg/kg. The Tongtangwan sub-region is contaminated through man-made factors and the main pollutants are Pb, Cd, As, and Zn. The depth of contaminated soil in the Tongtangwan area is roughly estimated as 50cm; in some locations, this depth has exceeded 60cm.

(6) The Qingshi sub-region soil is widely contaminated by heavy metals and the topsoil contamination is the worst in this area. Pb reaches a maximum of 951mg/kg, As reaches a maximum of 65.1mg/kg, and Zn reaches a maximum of 1200mg/kg. The Qingshi sub-region is contaminated through man-made factors and the main pollutants are Pb, As, and Zn. The depth of contaminated soil in the Qingshi sub-region is roughly estimated as 50cm; in some locations, this depth has exceeded 60cm.

(7) The Xiangshiling sub-region soil is widely contaminated by heavy metals and the topsoil contamination is the worst in this area. Pb reaches a maximum of 661mg/kg, As reaches a maximum of 122mg/kg, and Zn reaches a maximum of 444mg/kg. The Xiangshiling sub-region is contaminated through man-made factors and the main pollutants are Pb, As, and Zn. The depth of contaminated soil in the Xiangshiling sub-region is roughly estimated as 50cm; in some locations, this depth has exceeded 60cm.

16.2.2 Findings of pond (channel) contamination investigation

According to the investigation conducted by Hunan New World Science & Technology Co., Ltd in old Xiawangang, Xinqiao Low Discharge Channel, ponds in Qingshui sub-region, ponds in Tongxia sub-region, and ponds in Tongtangwan sub-region within the project area, the following findings have been made：

(1) The water quality of the old Xiawangang can meet the Class V of "Surface Water Quality Standards (GB3838-2002)". The sediment in the Old Xiawangang has a high heavy metal content, among which Pb reaches a maximum of 2991.4mg/kg, Cd reaches a maximum of 283.17mg/kg, As reaches a maximum of 392.3mg/kg, Zn reaches a maximum of 4084.0mg/kg, and Cu reaches a maximum of 796.81mg/kg.

The sediment is identified as Class II of general soil wastes according to the leaching concentration of heavy metal in sediment.

(3) The water quality of the Xinqiao Low Discharge Channel can meet the Class V of "Surface Water Quality Standards (GB3838-2002)". The pollutants in the sediment are Cd, Pb, As, Zn, and Cu, and they have exceeded the standard in various degrees. The sediment is identified as Class II of general industrial soil wastes.

(4) The water quality of ponds in the project area can meet the Class V of "Surface Water Quality Standards (GB3838-2002)". The sediment has a high heavy metal content. The pollutants in the sediment are Pb, Cd, As, and Zn. The sediment is identified as Class II of general soil wastes according to the leaching concentration of heavy metal in sediment.

16.2.3 Findings of waste residue contamination

Waste piles in the Tongxia sub-region have a high heavy metal content, among which Cd reaches a maximum of 263.6mg/kg, Pb reaches a maximum of 5956.7mg/kg, Zn reaches a maximum of 77724mg/kg, As reaches a maximum of 220.3mg/kg, and Cu reaches a maximum of 1317.8mg/kg.

16.2.4 Findings of contamination investigations in closed facilities

(1) The main heavy metal pollutants in the Yongfa Refinery are Pb, Cd, As, Zn, Cu, among which the range of variation of the Pb concentration is 153.3～5956.7mg/kg, the range of variation of the Cd concentration is14.5-263.6mg/kg, and the range of variation of the As concentration is 11.0-220.3mg/kg. In the refinery the pollutant that exceeds standards by the highest percentage is Pb, with sampling on average being 46.7% above the standard.

(2) The main pollutants in the Brothers Industry are Pb, Cd, As, and Zn, among which Pb reaches a maximum concentration of 1505.5mg/kg, 2.5 times above the standard; Cd reaches a maximum concentration of 55.6mg/kg, 1.8 times above the standard; As reaches a maximum concentration of 160.6mgkg, 2.7 times above the standard; Zn reaches a maximum concentration of 108kg/kg, 7.2 times above the

standard. Pb sampling exceeds the standard by 41.7%.

(3) The main pollutants in the Kangli Smelter are Pb, Cd, As, Cu, and Zn, among which the range of variation of the Pb concentration is 100.1～12689.0mg/kg, with sampling on average being 46.2% above the standard；the range of variation of the Cd concentration is 14.5～1832.6mg/kg, with sampling on average being 38.5% above the standard； the range of variation of the As concentration is15.0～832.6mg/kg; the range of variation of the Zn concentration is 368.3～38989.0mg/kg； the range of variation of the Cu concentration is 69.0～4093.9mg/kg.

(4) There are heavy metal contamination and organic contamination in the Tiancheng Chemicals. The main pollutants are Pb, Cd, As, Ni, BaP, and aniline, among which Pb reaches a maximum concentration of 970.0mg/kg, 2.43 times above the standard；Ni reaches a maximum concentration of 2850.0mg/kg, 57 times above the standard; the range of variation of the BaP concentration is 0.1～0.6mg/kg, with sampling on average being 75% above the standard；the range of variation of the aniline concentration is 0.1～45.2mg/kg, with sampling on average being 62.5% above the standard.

(5) The main pollutants in the Xinda Smelter are Pb, Cd, As, Zn, and Cu, among which the range of variation of the Pb concentration is 153.3～17729.0mg/kg, with sampling on average being 33.3% above the standard；the range of variation of the Cd concentration is 5.7～8864.5mg/kg, with sampling on average being 26.7% above the standard; the range of variation of the As concentration is 11.0～883.9mg/kg, with sampling on average being 13.3% above the standard；the range of variation of the Zn concentration is 280.1～18950.0mg/kg, with sampling on average being 40% above the standard; and the range of variation of the Cu concentration is 8.1～15666mg/kg, with sampling on average being 13.3% above the standard.

(6) The main pollutants in the Hehua Cement are Pb and Zn, of which Pb reaches a maximum concentration of 638.5mg/kg, with sampling on average being 8.3% above the standard；Zn reaches a maximum concentration of 100500.0mg/kg, with sampling on average being 25% above the standard.

16.2.5 Findings of contamination investigations in uncovered soil in residential and its surrounding areas

According to the investigation, the pavement of the residential areas in the project area is mostly concrete, and no exceedance of heavy metals such as Pb, Cd, As, Zn, and Cu has been detected in the subsurface soil beneath the concrete pavement in the residential areas.

Investigations have been conducted in this project to test the uncovered soil in the attached residential areas of the Xiangshiling, Qingshi, and Tongtangwan sub-regions, as well as in the residential area surrounding the demolished facilities. The test results show that Cd and Pb have been detected in the uncovered soil in some areas, and soil in an area of 0.11km^2 needs to be replaced.

16.3Risk assessment conclusion

Using the data collected from site investigation results, Nanjing Institute of Environmental Sciences under the Ministry of Environmental Protection (MEP) and the Institute of Soil Science under the Chinese Academy of Sciences try to identify the characteristics of the sources of pollution. Combined with consideration for the future usage of land in the Zhuzhou Qingsuitang Industrial Zone, they then identify areas that are potentially sensitive to contamination and the ways through which sensitive areas will be exposed to pollutants, so as to develop a model for the removal of pollutants in the environment as well as to develop a model for identifying pollutants in sensitive areas. Both institutes use the risk assessment software, models and parameters from domestic and international authoritative organizations to undertake risk assessment.

Goals for decontaminating soil in this area: the advised goal for the decontamination of As, Cd, and Pb in the soil of residential areas is to reduce amounts by 30mg/kg, 10mg/kg, and 400mg/kg respectively； the advised goal for the decontamination of As, Cd, and Pb in the soil of non-residential areas is to reduce amounts by 60mg/kg, 30mg/kg, and 600mg/kg respectively.

Based on the risk assessment conclusion, according to the goals set in the risk assessment for pollutants decontamination, and considering implementation of the current project in this area and operation of manufacturers, the Institutes have further analyzed the risk assessment report, and have divided the project area into three parts: risk acceptable area, risk controllable area, and remediation area.

The remediation area is the risk unacceptable areas identified in the risk assessment report and not included in the risk controllable areas. The Remediation area, covering 2.73 km^2, is the area in which this project is involved.

16.4Feasibility of policies for implementing the project

The World Bank-China Proposed Zhuzhou Brownfield Remediation Project reflects the spirit of and meets the requirements of relevant national laws, regulations, policies, and documents, including *Environmental Protection Law of the People's Republic of China* , *Catalogue for Guiding Industry Restructuring (2013 Version, Amendment)*, *Opinions on Strengthening Soil Pollution Prevention and Control (No.48 [2008], issued by the MEP)*, *Notice on Ensuring the Environmental Safety of Redeveloped and Reutilized Industrial Sites (No.140 [2012], promulgated by the MEP), the Implementation Plan for the Heavy Metal Pollution Control in Xiang River Drainage Area*, the *12th Five-Year Plan for Environmental Treatment and Protection in Zhuzhou*.

The project has solid political, economic, social, technological, and civilian foundations. Implementation of the project will improve environmental quality in the area, promote social harmony, serve people's interests, and promote sustainable development in the area. Therefore, the policies for implementation of the project are feasible.

16.5Environmental quality in the project area

1. Atmospheric environment

According to results from the latest atmospheric tests and given the data from past atmospheric environment monitoring in the past, CO, NO2, and PM10 concentrations in the atmosphere over the area have exceeded secondary standard. Given this exceedance, atmospheric quality in 2011-2012 is better than that of 2013-2014; more contaminants have risen above standards in the Zhu Hospital area closest to the project area than in other locations, showing that the general quality of the atmosphere over the project area is worse than in other areas. However, the levels of fluoride, mercury, plumbum and its compounds, arsenide, chromium (hexavalent), manganese and its compounds, phenol, and ammonia in the project area have all met the requirements of the Hygienic Standards for the Design of Industrial Enterprises (TJ36-79).

2. Surface water environment

At sampling cross-sections of Xiang River within the area, Xinqiao Low-bank Channel, New Xiawangang, and Old Xiawangang, the detected values of pH, SS, cyanides, volatile phenols, Cd, Hg, Zn, Pb, As, Ni, Cr6+ and Cu had all met the relevant standards in “Environmental quality standards for surface water” (GB3838—2002). The total phosphor from the water inlet cross-section of the 3rd Water Plant on Xiang River failed to meet GB3838—2002’s Class II requirement, with a maximum excess factor of 0.20. The COD from the Xiang River inlet cross-section of Xinqiao Low-bank Channel cannot meet the same standard’s Class V requirement, with a maximum excess factor of 0.37. The ammonia nitrogen and total phosphor at the cross-sections of New Xiawangang’s inlet into the project area, New Xiawangang’s inlet into Xiang River, and Old Xiawangang’s inlet into Xiang River had all failed to meet the same standard’s Class V requirements, with maximum excess factors of 0.25, 1.04 and 0.56 respectively for ammonia nitrogen, and 0.55, 0.77 and 0.51 for total phosphor.

The results of this survey, coupled with the historical survey data, show that the area’s water environment mainly suffers from excesses of ammonia nitrogen and total phosphor. The heavy metal content has not exceeded the relevant water quality standards.

3. Groundwater environment

The groundwater runoff of the evaluated area is somewhat complicated. The groundwater mainly consists of pore water in loose strata, and fissure water in base rock, both in small amounts, generally resupplied by precipitation, with no obvious resupply, runoff or outflow processes. The groundwater flows have flat gradients, with poor runoff conditions.

This survey sampled shallow groundwater that had primarily been resupplied by precipitation. Judging from results from the survey and historical data, the main excess parameters have been nitrites, nitrite nitrogen, ammonia nitrogen, nitrate nitrogen, etc., meaning the shallow groundwater is highly likely to be polluted by agricultural or living waste water from the surface. This survey also shows excessive beryllium and manganese at certain spots, indicating some degree of industrial pollution in the area that must be remediated.

4. Sediment

Statistical data shows that in the year of 2011, the Xiawan cross-section’s sediment showed relatively large reduction of total arsenic, mercury, copper, lead, cadmium and zinc from 2010, however its total chromium had increased. In overall, the heavy metal contamination in this cross-section’s sediment has seen relatively large improvement.

5. Noise

The noise detection points received acceptable results. The sound environment of project construction area has met the requirements.

16.6Economic, environmental and social benefits

The project is a comprehensive environmental remediation project for an urban industrial zone. The project would neutralize soils from the heavy metal-contaminated area of Qingshuitang, Zhuzhou, and consequently mitigate the potential risks of contaminated soils to Xiang River, improving the quality of Xiang River’s waterbody, with great social, economic and environmental benefits.

Specifically, the project will neutralize the cadmium, lead, arsenic and other heavy metal pollutants from the contaminated soils and sediments, remove the endogenous heavy metal pollution of Qingshuitang Industrial Zone, eliminate its potential risks, and contribute to improving the water quality and environment of Xiang River. The ecological benefits are significant.

The project’s social benefits include:

1) Supporting the creation of a more eco-friendly and livable city; 2) improving the regional investment environment and supporting the city’s development plan; 3) boosting the local economic development and the upgrading of economic structure; 4) expanding the city’s useable space; 5) exploitation of Zhuzhou’s historical and cultural resources; 6) the creation of a technological demonstration project will help the development of environment-related industries; 7) attracting new investments and technologies.

16.7Main environmental impacts and mitigations

While the project offers overall social, economic and environmental benefits, some environmental impacts are inevitable during its construction and operation.

16.7.1 Construction period

16.7.1.1 Environmental impact

16.7.1.1.1 Air impacts

During the construction period, the following impacts will be created: dusts, gases from excavation of soils with organic contamination, emissions from oil-fueled machinery and construction vehicles, and foul odor of underwater sediments.

Generally, the affected range of dusts from construction yards and roads under natural winds should be within 100m.

Soils with organic contamination are relatively small in amount. By taking measures including spraying smell retardants, sealed packaging for excavations, thin film coverage for the excavation pit, and prompt cleaning and transportation, the resulting pollution should be reduced, satisfying the requirements of "*Ambient air quality standards*" (GB3095-2012) Class 2.

The pollutants emitted by oil-fueled machinery and construction vehicles are primarily carbon monoxide, nitrogen dioxide, and hydrocarbons. The small number and scattered locations of machinery should not cause heavy pollution, satisfying the requirements of "*Ambient air quality standards*" (GB3095-2012) Class 2.

Offensive odors can be detected near the working areas and their sludge pile sites, at strength levels 2 to 3 (Level 3 is obvious odor). The odor caused by sediment clearing should be very weak at 80m from the banks, and ineffective at 100m from the banks. The odor can reach levels 2 to 3 at the river beds.

16.7.1.1.2 Surface water impacts

(1) Living waste water from construction workers

During the construction period, workers can all be settled in nearby settlements, with no need for separate living quarters. This keeps the amount of new living waste water at a negligible minimum.

(2) Initial rainwater during the demolition of closed enterprises

The initial rainwater will be collected by rainwater pipelines for temporary storage in early rainwater cisterns. They will be used for washing building structures rather than discharged to the external environment, minimizing their impact.

(3) Waste water from washing of vehicles and machinery

The washing water will be processed by the facility for construction waste water processing, then used for ground dust suppression water spray. They will not be externally discharged, minimizing their impact.

(4) Heavy metal-contaminated water from washing buildings to be demolished

The main pollutants are SS, Cd, Hg, Zn, Pb, As and Cu. The water will be collected by ditches and transmitted to sedimentation cisterns. After sedimentation, the supernatants will be processed by mobile water processing vehicles, and finally discharged into urban pipelines, with minimum impact.

(5) Tail water from sediment-clearing at channels and ponds

The main pollutants in tail water from sediment-clearing are suspended substances. The tail water will be processed using mobile water treatment equipment. It will meet the Class 1 standard from Table 4 of "*Integrated wastewater discharge standard*" (GB8978-1996), and directly discharged into Xiawangang, with minimum impact.

(6) Ponding water at landfills and quarries

The ponding water will be processed by breakpoint chlorination. They will meet the Class 1 standard from Table 4 of "*Integrated wastewater discharge standard*" (GB8978-1996), and be discharged into a stream near Qingxia Road, with minimum impact.

16.7.1.1.3 Groundwater impact

With proper seepage prevention measures in place, the contaminants will be effectively disposed, with minimal impact on groundwater.

16.7.1.1.4 Solid waste impact

The construction wastes, debris of demolished buildings, and sludge from waste water treatment can all be properly disposed. The environmental impact is insignificant.

16.7.1.1.5 Noise impact

(1) When using a single construction machine, the daytime noise at 42m from the construction site boundary can meet "*Emission standard of environment noise for boundary of construction site*" (GB12523－2011), and the standard nighttime noise limit can be met at 200m. However, the actual construction will more likely involve more than one machine, affecting a larger area.

(2) In cases where noise-sensitive spots are within a range of 14 to 42m from site boundaries, the noise will have a stronger impact. During daytime, the first row of resident buildings in such areas will be affected to varying degrees; during nighttime, the noise can significantly affect the resident's sleep. Measures must be taken to minimize the construction noise impact on these protected targets.

(3) The noise will end with the completion of construction. Its impact is a temporary and short-term effect.

16.7.1.1.6 Ecological impacts

The plant species that will be destroyed by the construction are all common species to the area, without any protected species or wild vegetation systems. The project does not have a significant impact on plant species and vegetation, and will not cause any extinction of genus or species. After the construction period, the vegetation will be recovered through greening works, and the plant diversity will be restored.

No important activities of mammal, reptile and amphibian animals have been found. The main animal species are common small birds, frogs and lizards. They are small in numbers, and have good mobility. The construction will not affect their survival.

The project's water-related construction areas are small in size compared to the entire river waterbody. The cofferdams during construction will minimize the range of impact on planktons. The waterbody will generally be self-restored after construction.

The cofferdam works will not cause any significant impact on water quality. The affected waterbodies are also not spawning grounds, feeding grounds or wintering grounds for fish species. Any impact on fish species within the water area is unlikely.

The project area has concentrated rainy seasons during the year. Precipitation can significantly worsen the soil loss during the construction period. Hence the overlap between the construction period and the rainy season should be minimized.

16.7.1.2 Mitigation of environmental impacts during construction period

16.7.1.2.1 Air pollution

(1) Dusts from construction

The following measures will be taken: regulation-compliant barricade facility no less than 2m tall; dedicated piling sites for excavated soils etc. at construction sites; strict management of the works; water spray on construction sites and roads for dust suppression; post-use vegetation recovery on temporarily used land plots.

(2) Waste gases from excavation of organic-contaminated soil

Prior to soil excavation, samples will be taken from the boundaries, vertical sides and bottom levels of the soils to be excavated. The exact boundaries of the excavation will be determined by the sampling results. Steel plates will be laid on the ground of target zones to prevent contamination of the surface and vehicles. All vehicles will be cleaned before leaving the sites. Transportation vehicles will have dust and rain-proof covers to prevent any contaminant leakage. The excavation pits will be covered using thin films. The organic waste gases will be suppressed by spraying odor suppressants. The soils will be sealed into standard packages.

(3) Emissions from oil-fueled machinery and vehicles

The excavation zones will be surrounded by barricades. Strict control will be exerted on large machinery and vehicles, with proper emission and dust-cleaning devices on machinery and periodic inspection and maintenance.

(4) Odor from river sediment

The river sediment-clearing is advised to be done during the drought season. The works will be conducted one segment at a time. When one segment will be under the works, the contractor must notify nearby residents to close their windows. The clearing will be done using machinery, with excavated sediment immediately transported to dewatering site. Workers will be protected by personal gears; the sediments will be transported using sealed tankers; the convoy will avoid areas with high population concentration.

16.7.1.2.2 Surface water pollution

Early rainwater from structures to be demolished: a $100m^3$ early rainwater cistern will be built for each zone. The settled rainwater will be used for washing of buildings, and will not be externally discharged.

Washing water from machinery will be settled and separated from oil, then recycled.

Washing water from buildings to be demolished will be processed using mobile water treatment vehicles, then reused for building washing, and will not be externally discharged.

Wastewater from river sediment-clearing will be processed using mobile water treatment vehicles until the Class III waterbody quality standard from "*Environmental quality standards for surface water*" can be met, then directly discharged into Xiagang Channel.

Ponding water at quarries will be processed by breakpoint chlorination. A 500m³ cistern will be built with reinforced concrete for chlorination. The outgoing water will meet the Class 1 standard from Table 4 of "*Integrated wastewater discharge standard*" (GB8978-1996), and be discharged into a stream near Qingxia Road.

16.7.1.2.3 Prevention and control measures of underground water contamination

Anti-seepage measures will be taken for initial rainwater collecting basin, oil separator, settling pond and chlorination reaction pool, such as paving geomembrane or hardening the pool surface; the structures flushing and washing site of all closed enterprises shall all be harden; for the temporary storage sites of all fields, anti-seepage measures such as rain-proof, floor hardening should be taken; impermeable layer should be constructed.

16.7.1.2.4 Prevention and control measures of solid waste contamination

Construction waste: recycle;

Demolished building rubbles: recycle if suitable; in case that not suitable, the ones without heavy mental residue will be delivered to landfill site for landfill, while the ones with heavy mental contamination will be disposed by landfill after flushing and washing;

The sludge from waste water treatment: deliver to stabilization/solidification site for treatment and to landfill site for landfill.

16.7.1.2.5 Prevention and control measures of noise contamination

Choose low-noise machinery equipment for use; implement relevant stipulations of *Emission Standard of Environment Noise for Boundary of Construction Site*

(GB12523－2011) strictly, control the time of operation with noise contamination; the operation of high-noise equipments should be prohibited at night (22:00-6:00); the construction activities with noise should be avoided at noon (12:00-14:00) and in the evening (19：00-22：00) ; the entrance and exit point of construction vehicles should be as far as possible from sensitive points, and the soil transportation vehicles, too, should be as far as possible from sensitive points when entering and exiting soil solidification site or other construction sites; arrange the construction machine and construction intensity reasonably.

16.7.1.2.6 Mitigation measures of ecological influence

Attention should be paid to protecting the trees, green land and other vegetations in adjacent area; the piled soil and other materials should not invade into the farmland nearby; baffle (of wood, glass or iron sheet) can be set as barrier to reduce contamination to landscape; conduct reasonable allocation of earth works in excavation and filling, and avoid excavation and filling of earth works during rainy days to prevent rainwash to cause water and soil loss, water body contamination, and drainage pipe blocking; clean the construction field up timely after the project is finished, withdraw from temporary occupied site, recover the original road and green land; arrange the construction period reasonably avoiding construction during rainy season, reduce water and soil less as far as possible.

16.7.2 Operation period

16.7.2.1 Environmental impact during operation period

16.7.2.1.1 Impact on air environment

The pmax of all air contamination discharged from the project is 5.96%(<10%) ; the maximum concentration in the downwind direction of odor substance NH_3 and H_2S is 0.004659mg/m^3 and 0.000596mg/m^3 respectively, which are less than corresponding threshold concentration (the threshold concentration is 1.54ppm or 0.5mg/m^3 for NH_3, and 0.0047ppm or 0.0008mg/m^3 for H_2S) ; and the maximum concentrations in the downwind direction of all contaminations are less than the monitoring concentration at factory boundary. Thus, the construction of the project will have little impact on the surrounding environment, and it can be ensured that, all the sensitive points can meet the requirements of level-2 standard of *Ambient Air*

Quality Standard (GB3095-2012) or relevant standards.

According to calculation, it's not necessary to set atmospheric environment protection zone. The hygienic protecting zone is the scope of 100m around Xinqiao stabilization/solidification site, and 50m around the dewatering site near Xinqiao stabilization/solidification site, 50m around Xiawangang dewatering site, and 50m around landfill site.

There are residents in the protecting zone of Xinqiao stabilization/solidification site, Xinqiao dewatering site, and Xiawangang dewatering site. But these sites are temporary, and will be demolished after the soil remediation is finished. In the operation of stabilization/solidification site and dewatering site, the sediment should be piled by layer, and covering plate or protecting green belt should be set in the places where the sources of stench gathers, to reduce the impact of stench; watering dust prevention should be conducted on transportation road. Choose low-noise equipment, and arrange equipments with higher noise far from residential point, and arrange the transportation route reasonably to reduce the noise for disturbing residents.

At present, there are 4 households in the protecting zone of the landfill site. According to *Regulatory Detailed Planning of Core Area of Zhuzhou Qingshuitang Ecological Industrial City*, the land parcel of the 4 households is planned for industry and office, so the houses of the households will be demolished. Before demolition, the landfill site should control the road dust caused by vehicle transportation and landfill operation strictly, and take the measures of water spray system and watering dust prevention at fixed time and fixed quantity to control it. The transportation vehicles are not permitted to overload, and leakage should be avoided; covering tarpaulin and other measures can be taken; strengthen the management of road, repair and fill the broken section at any time, to reduce the impact on residents.

16.7.2.1.2 Impact on environment of surface water

The waste water from dewatering of sediment with heavy mental contamination will be discharged after being treated to meet standards; leachate of landfill site will flow to Qingshuitang Industrial Waste Water Treatment and Recycle Plant through pipes for treatment, and the tail water will be discharged into Xiang River; at initial stage, all site will collect rain for recycling with out discharging outside; the water from daily washing and bathing and a small number of domestic sewage of Environmental Information and Demonstration Center, will be treated by buried integrated recycled water reuse equipment, and be used for toilet flushing, green area irrigation and road cleaning; the waste water from toilet flushing will flow into urban sewage pipe network system which is being paved after treatment in biochemical pool, and enter into Xiawan Sewage Treatment Plant for treatment, with the tail water discharged into Xiang River.

As that Qingshuitang Industrial Waste Water Treatment and Recycle Plant and Xiawan Sewage Treatment Plant has conduct prediction of the impact of tail water discharged into Xiang River, this report won't predict again. The waste water from the process of the project can all discharge through pipes after treated to meet standard, which has little impact on Xiang River.

16.7.2.1.3 Impact on underground water

Appropriate rain-proof drainage measures has been taken and anti-seepage design has been conducted for dewatering site and initial rain pool, which can avoid effectively the sewage of dewatering site to have impact on the surrounding underground water.

For the landfill site, bottom anti-seepage engineering containing anti-seepage system and leachate treatment system which meets Class-II requirements of general industrial solid waste landfill site has been designed; in general cases, there won't be impact of leakage. It's only the leachate of adjustment emergency reaction pool that may have impact of leakage. After anti-seepage measures have been take for the adjustment emergency reaction pool, the leachate of the landfill site will have little impact on underground water.

The waste water and domestic waste of Environmental Information and Demonstration Center can be treated reasonably without impact on underground water by and large.

16.7.2.1.4 Environmental impact of waste solid

Domestic waste will be cleared and delivered by sanitation department everyday, which has little impact on environment.

16.7.2.1.5 Impact on acoustic environment

(1) The high-noise equipments at stabilization/solidification site, such as crusher, mixer, vibrating screen, etc.

According to prediction, the noise impact value at day and night of noise created by high-noise equipment of stabilization/solidification site superposed with ground noise can all meet class-3 standard of Emission Standard for Industrial Enterprises

Noise at Boundary (GB12348-2008)(at day, ≤65dB(A); at night, ≤55dB(A)).

(2) Equipments at landfill site such as excavator, earthmover.

Single equipment at landfill site such as excavator, earthmover can reach Emission Standard of Environment Noise for Boundary of Construction Site (GB12523－2011) beyond 42m from the construction site at day, and can meet standard value beyond 200m at night. But in actual process of construction, the case is always that multiple machines are used simultaneously, and the impact scope of noise will be larger.

In case that the sensitive point of engineering noise is 14-42m from the boundary of construction site, the construction noise have large impact on the surrounding environment. Thus, the construction noise will have impact on the first row of residential buildings in the scope to different degrees at day, which will become especially obvious at night. So, strict measures should be taken to lower the impact of construction noise on environmental protection targets as far as possible.

16.7.2.2 Mitigation measures of social impacts during project operation

16.7.2.2.1 Prevention measures of air pollution

(1) Stench

For treatment of stench generated from desilting and sediment dewatering as well as from stockpile stabilization, the waste will be piled by layer, and covers or protective green belts will be established at places where stench sources are concentrated; meanwhile, designers consider about putting stench-generating devices and equipments in the downwind direction and setting up greenbelts around them.

(2) Dust

For treatment of dust, guarantee a certain water content of the soil, sediment, waste and burdening, curing and mixing adopts automatic feeding, mixing and storing in closed plant; add water in the form of spraying in all direction in the process of solidifying ingredients through mixing tank. Through the measures stated above, the dust can be reduced effectively, and the measures are feasible.

(3) Dust of landfill site

Watering dust prevention can be conducted to landfill site and transportation road.

16.7.2.2.2 Prevention and control measures of contamination to surface water

The dewatering of sediment with heavy mental contamination is planned to be treated through mobile treatment equipment to meet level-1 standard of *Integrated*

Wastewater Discharge Standard (GB8978-1996). The leachate will flow to Qingshuitang Industrial Waste Water Treatment and Recycle Plant through pipes for treatment.

In Xinqiao stabilization/solidification treatment site, Xinqiao dewatering site, Xiawan dewatering site, temporary storage site, initial rain collecting basins of 75 m^3, 75 m^3, 100 m^3, 180 m^3 will be built respectively, and anti-seepage treatment will be conducted. The initial rainwater on road surface of all sites will be collected through rainwater pipes and stored in initial rain collecting basin temporarily. The initial rainwater of stabilization/solidification treatment site will all be recycled in stabilization process, and the initial rainwater of dewatering site and temporary storage site will be treated through mobile water treatment equipment and used in watering of road and sites without discharge. The late rainwater and rainwater of other area of the sites will be discharged out of the sites through rainwater guiding drainage pipes, and the treatment measures are feasible.

The water used for daily washing and bathing and other domestic waste water as well as a small number of domestic sewage of Environmental Information and Demonstration Center, will be collected, recycled and treated to meet Reuse of Recycling Water for Urban, Water Quality Standard for Urban Miscellaneous Water Consumption (GB/T 18920—2002), and used for floor cleaning, flower watering, toilet flushing which are without direct contact with human body. Other waste water from flushing toilets will flow to Xiawan Sewage Treatment Plant through pipes for treatment.

16.7.2.2.3 Prevention and control measures of contamination to underground water

(1) Waste water from sediment dewatering with contamination of heavy mental

For the facilities of collecting pool of waste water from dewatering sediment with contamination of heavy mental, anti-seepage measures such as paving geomembrane and hardening pool surface are taken to prevent the leakage of waste water. The anti-seepage performance should be equivalent to the performance of clay layer with a permeability coefficient of 1.0×-7cm/s and a thickness of 1.5m.

(2) Initial rainwater of sewage dewatering site and stabilization/solidification site

The anti-seepage performance of the existing hardened ground of stabilization/solidification site should be examined; in case of failure to meet standard, the ground need to be hardened again to reach the anti-seepage performance equivalent to the performance of clay layer with a permeability coefficient of 1.0×-7cm/s and a thickness of 1.5m. In Xinqiao stabilization/solidification treatment site, Xinqiao dewatering site, Xiawan dewatering site, temporary storage site, an primary rain collecting basin of 75 m^3, 75 m^3, 100 m^3, 180 m^3 will be built respectively, and anti-seepage treatment will be conducted. The initial rainwater on road surface of stabilization site will be collected through rainwater pipes and stored in initial rain collecting basin temporarily, which will all be recycled in stabilization process without discharge.

(3) Leachate of landfill site

1) Anti-seepage system of landfill site

This landfill site refers to Class-II requirements of general industrial solid waste landfill site. As the topographic condition of the project is complex with steep side slope and bare stones, to ensure the safety and long-term stabilization of the project, the bottom anti-seepage treatment will set as double-layer anti-seepage structure, and the basic level of side slope will be treated by suspended net shotcrete.

16.7.2.2.4 Prevention and control measures of contamination of solid waste

Garbage points (cans) are set in lots of points of Environmental Information and Demonstration Center, the domestic waste will be delivered to municipal garbage transfer station timely by sanitation department, which will clearing them every day.

Thus, the solid waste created in this project can be disposed effectively, and the prevention and control measures are feasible.

16.7.2.2.5 Prevention and control measures of contamination of noise

Choose low-noise equipment and machinery for use; in general layout, arrange the larger equipment as far from the factory boundary and office as possible; for high-noise equipments, add shock absorber base, put them in the plant, and strengthen the maintenance and management; strengthen the maintenance of machinery in landfill site, examine and repair them regularly, repair the machinery timely when abnormal operation occurs, to ensure normal operation of them; arrange the operation time of landfill site reasonably; strengthen traffic assignment and transportation vehicle management, reduce the solid waste transportation vehicle to whistle in the scope of road of landfill site.

With the above measures, the noise at boundary of the project can meet class-3 standard of Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008). Thus the prevention and control measures of noise taken in the project planned to construct are feasible.

16.7.3 Closing site period

When the service period of the landfill site is ended, cover soil and plant trees and grasses on the premise of ensuring the safety of the landfill site. Cover soil in the landfill site designedly, follow the sequence of covering soil and planting vegetations, spread out the soil on which vegetations depends to grow in the covering-soil area after leveling. To prevent the direct exposure of landfill site and rain infiltration, when closing the site, two layers of soil should be covered. The first layer is separate layer, covering soil of a thickness of 20~45cm, and pressing tight to prevent rain to seep into dry residue; the second layer is covering layer, covering with natural soil, to facilitate plants to grow, the thickness of which depends on the species of plants grown on it.

After closing the site, special person should be arranged to guard the landfill site, who can withdraw after the whole process is finished.

After closing the site, the leachate monitoring system will keep on normal operation, until the water quality is stable. The underground water monitoring system will keep on normal operation.

16.8Establish environmental management and monitoring system of the project

The implementation of the project including the activities of construction period and operation period, will bring certain impact on the ecological environment, so effective environmental management and monitoring system should be established. The project management department will cooperate closely with local environmental protection, agriculture, and water conservancy departments, to master the dynamic and degree of adverse impact on environment, implement all the measures raised in environmental management and monitoring plan, so as to facilitate the economic construction to develop at the same pace with environmental construction.

16.9Public attitude toward the project

Adhering to the principles of public participation and caring for people, this project get to know public opinion and suggestion through online announcement, posting announcement in the communities involved in the project,interviewing, issuing questionnaire, and holding symposiums, etc. and the information are published. No feedback has been received from residents since online announcement was made and announcement in the communities was posted. According to the information collected from symposiums and questionaire:

In the first personal questionnaire, 87.2 percent of respondents supported the project, 12.8 percent of respondents were indifferent to the project, and there was no respondent against the project. Generally, the public understands and supports the land acquisitions and housing demolitions that are involved in the project; many people want to be collectively relocated.

In the first group questionnaire, 100 percent of respondents supported the project, with people in different communities voicing their demands and offering their advice; people suggested that the project should serve all sub-regions and do more to benefit villagers; residents voiced a strong desire to be collectively relocated.

In the first symposium, attendees expressed their gratitude to the World Bank for giving attention to the topic of pollution in the Qingsuitang area; residents of Qingsuitang were in favor of environmental treatment at both large and small scales. But residents have also voiced concerns about air pollution, relocation, treatment of waste in the area, and other issues. At the symposium, the EPA (environmental protection agency) explained these issues and used the opportunity to communicate with local people. According to the EPA, based on the plan for new eco-cities, contaminated soil in this area would be restored and residential areas would be replanned; in the future, residents would be gradually relocated based on the progress of restoring contaminated soil in the area. At present, the EPA would strengthen its supervision over the area’s enterprises in accordance with the new environmental protection law, and it would ensure that exhaust gas emissions and the discharge of wastewater and solid wastes meet standards. Enterprises in the area would be relocated gradually according to relocation plans.

In the second personal questionnaire, 89.95 percent of respondents favored the implementation of this project, 7. 04 percent of respondents were indifferent to it, and 3 respondents (1.51 percent of respondents) were against it. These three respondents were against it because they believed that land treatment alone would not help much and that residents would still suffer from groundwater, air and other types of pollutions; they instread favored the idea that treatment should be implemented after residents are relocated altogether. According to this questionnaire, being collectively relocated before land is treated is the general voice of residents in the area. The EPA , the construction organization, and residents communicated with each other. Given financial resources at this time, collective relocation will be difficult to carry out. Currently, it is advised to restore contaminated soil in the area. Land designated as residential land can be restored to a target value; concentrated resettlement communities are being constructed in the area; and in the future, residents will be relocated gradually based on the usage of land.

In the second symposium, all attendees were in favor of the project as they believed that the project could improve soil environmental of the area. They also voiced their own opinions and advice: they demanded environmental treatment be implemented after they relocate; they pointed out that some of the excavated soil involved in the project had been backfilled without treatment; they pointed out that sediment at the Xiawangang channel and at the estuary that the Xinqiao low discharge channel discharges into has been severely contaminated; they pointed out that excessive lead levels had been found in children's blood. At the symposium, the EPA explained these issues and used the opportunity to communicate to relevant residents that given financial resources at this time, collective relocation will be difficult to carry out. Currently, it is advised to restore contaminated soil in the area. Land designated as residential land can be restored to a target value; concentrated resettlement communities are being constructed in the area; and in the future, residents will be relocated gradually based on the usage of land. Environmental monitoring and management will be applied to this project and soil restoration will undergo acceptance tests according to national regulatory requirements so as to ensure that contaminated soil is restored to its target value. In this remediation plan, sediment in the Xinqiao low discharge channel and at the old Xiawangang channel which has been contaminated by heavy metals will be dredged and stabilized/solidified after the port is dry. Excessive lead levels in blood are caused by long-term industrial pollution in the area. To lower lead levels in blood, the following efforts should be made: the project should restore soil that has been contaminated in the area; the EPA should intensify its supervision over active facilities to prevent excessive emissions/discharge; in the future, active facilities will be gradually relocated; and regular medical check-ups should be conducted on children whose blood has been identified as having excessive lead levels with deleading reagents being provided to the children to be taken orally.

16.10 Environmental issues requiring special attention

Pollutant emissions from the companies inside and outside the region poses threat to the environmental quality after the remediation of the project, so these companies should reach the discharge standard before relocation, and actively take measures to reduce the generation and emission of pollutants. Besides, the progress of relocation and industry transformation of these companies should be promoted.

16.11 Conclusion

In conclusion, based on the analysis of the project environmental impact, the project is in line with the national industry policies, the local urban planning, overall planning and other development planning. It is also in line with the environmental functional district planning; the negative environmental impact on the surrounding environment before and after project implementation is within acceptable range so it can bring positive social, environmental and economic benefits; the project implementation can promote sustainable regional development and improve the environment quality of the region.

So environment impact assessment holds that: as long as the "three-simultaneous" rule is strictly implemented and the World Bank's environment requirements are met, and the simultaneous design, construction and implementation between various pollution control measures and main works ensured for minimizing its adverse impact on the project, we can organically unite the benefits of economy, society and environment, thus realizing a sustainable development of economy, society and environment. Pollutant emissions of the companies inside and outside the region poses threat to the environmental quality after the governance of the project, so these companies should reach the discharge standard before relocation, and actively take measures to reduce the generation and emission of pollutants. Besides, the progress of relocation and industry transformation of these companies should be promoted. After adopting the above measures, from the perspective of environmental protection, “World Bank-China Proposed Zhuzhou Brownfield Remediation Project” is environmentally feasible.