

Environment Management Plan

For

Liuzhou Environment Management Project (II)

Guangxi Environmental Protection Research Academy

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1. Profile of LZEMP II

1.1 General

The economic development of Liuzhou brings a deprivation of environment. At present, plenty of untreated urban wastewater from urban area and counties are discharged directly, thus rivers and ditches are polluted, and water body of Liujiang River (section of Liuzhou) runs from category II to III. The pollution of surface water environment now impacts the agricultural and industrial development substantially, especially the safety of drinking water source. According to the Decision on overall pushing construction of urban wastewater and living rubbish treatment facility of the party committee and the people's government of Guangxi Zhuang Autonomous Region (GF [2008] No.18), Liuzhou Municipal Government took decision to initiate LZEMP II which the World Bank agrees to finance.

EMP is prepared based on CEA. As an independent document, the objective of EMP is to put forward the mitigation measures against the potential environmental impacts analyzed by this environmental assessment, and prepare the environmental management system for ensuring the implementation of these measures to fulfill environmental protection responsibility and assignment of concerned parties. At the same time, to put forward the training plan, strengthen capacity building of implementation of EMP of LZEMP II, and put forward the environmental monitoring plan for verifying the implementation effect.

1.2 Sub-projects and Major Technical Indexes

LZEMP II consists of 8 sub-projects that are located in 2 districts in Liuzhou and 4 counties, including four wastewater treatment plants (WWTP) and associated sewer network in 4 counties and two WWTPs in Liuzhou urban area. Liuzhou suburban drainage project also includes river dredging in addition to sewer network construction. The sludge treatment subproject in Liuzhou is mixed combustion of sludge with cement production.. Details Refer to Table 1.1 and 1.2.

Table 1.1 Profile of Wastewater Sub-projects

Component	Service year (Year)	Population served (Ten thousand)	Designed capacity (10,000 m ³ /d)	Counterpart network length L (m) , pipe diameter d (mm)	Drainage system		Discharge to		Disinfection way of effluent
					Current Status	After construction completion	Current status	After construction completion	
Sanjiang WWTP	Short term: 2013 Long term: 2025	Short term: 6 Long term: 10	Short term: 1.0 Long term: 3.0	L: 9710 d: DN 400~DN 1200	Combined system	The old urban area adopts the combined system, and the new urban area adopts the separate system	Discharge directly to Xunjiang River	Xunjiang River	UV
Rong'an WWTP	Short term: 2013 Long term: 2025	Short term: 14 Long term: 20	Short term: 3.0 Long term: 7.5	L: 10740 d: DN 500~DN 1200	Combined system	The new urban area adopts separate system in short term, and old one adopts the combined system; fully adopts the separate system for long term	Discharge directly to Rongjiang River	Rongjiang River	UV
Rongshui WWTP	Short term: 2013 Long term: 2025	Short term: 9.6 Long term: 15	Short term: 2.0 Long term: 6.0	L: 27200 d: DN 300~DN 1200	Combined system	The old urban area adopts the combined system, and the new urban area adopts the separate system. The old urban area means Chengbei district (current district); the new urban area means Shuidong district and Chengnan district.	Discharge directly to Rongjiang River	Rongjiang River	UV
Liucheng WWTP	Short term: 2013 Long term: 2025	Short term: 8 Long term: 12.16	Short term: 2.0 Long term: 5.0	L: 11740 d: DN 300~DN 1200	Combined system	The old urban area at the east river banks the combined system and the new urban area at the west river bank adopts the separate system.	Discharge directly to Rongjiang River	Rongjiang River	UV
Shatang WWTP	Short term: 2013 Long term:	Short term: 6.29 Long term:	Short term: 2.0 Long term: 6.0	L: 48293 d: DN 300~DN 1200	Combined system	Adopting the separate system within the scope of planning area	Discharge directly to Xianglan	Liujiang River	UV

	2025	12.5					River		
Guantang WWTP	Short term: 2013 Long term: 2025	Short term: 10 Long term: 50	Short term: 5.0 Long term: 21.0	L: 296000 d: DN 300~ DN 1200	Combined system	Adopting the separate system within the scope of planning area	Discharge directly to Liujiang River	Liujiang River	UV

Table 1.2 Profile of Drainage and Sludge Management Sub-projects

Component	Nature	Construction Scope	Construction contents
Liuzhou urban-suburb drainage	Rebuild /expansion	The scope is in the urban and suburban area, including: Baisha WWTP network system: Huilongchong combined wastewater channel (section of Queershan park ~ River side); Longquanshan WWTP network system; Yanghe WWTP network system; Labao WWTP network system: Jiuquhe River sewage interception engineering.	The total length of pipeline to be built is 148215m and 4 sewage lifting pumping stations are proposed. Baisha WWTP network system: Huilongchong combined wastewater channel (section of Queershan park ~ River side), locate at old zone of city, adopts the combined system; Longquanshan WWTP network system: area at the south of Taohua section and east section of south part of Liushi road is new area or new planning area, adopts separate system, other places are located at old zone, adopt the combined system ; Yanghe WWTP network system: Yanghe development zone (except Gutingshan living area), north section of Hedong road, east area of east section of south part of Liushi road are new area or new planning area, and east natural drainage area (Dudengshan section) of east section of east ring road is basically new zone, they all adopt separate system; area between east ring road and Xueyuan road and other places locate at old zone of city which adopted combined system.
Sludge management	New project	Located within Yufeng Group Co., Ltd at Taiyangchun Village at the west suburb of Liuzhou city. Treat dewatered sludge produced by Longquanshan, Baisha, Yanghe, Labao and Guantang WWTPs.	Capacity of wet sludge treatment in short term is 300t/d, and 500t/d in long term, moisture rate of sludge is 78.3%

2. Environment Protection Targets

2.1 Water Environment Protection Targets

(1) Water Environment Protection Targets of Liujiang River

The Water Environment Protection Targets of Liujiang River (Liuzhou section) at lower reach is to ensure the water quality meet Class III standards in *Surface water environment quality standards (GB3838-2002)*

(2) Water Environment Protection Targets of Xinxiang River

The Water Environment Protection Targets of the assessed area is to ensure the water quality meet Class III standards in *Surface water environment quality standards (GB3838-2002)*

(3) Water Environment Protection Targets of Rongjiang River

The Water Environment Protection Targets of the assessed area is to ensure the water quality meet Class III standards in *Surface water environment quality standards (GB3838-2002)*

2.2 Ecological Environment Protection Targets

(1) hydrophilic Ecological Environment

The hydrophilic Ecological Environments around the effluent outfalls of WWTPs

(2) Terrestrial Ecological Environment

The Terrestrial Ecological Environment includes the farming land, woodland and meadow in project area.

2.3 Atmosphere and Noise Environment Protection Targets

The atmosphere and noise Environment Protection Target is to keep the habitants, enterprises an public institutions inside the project sites and around project sites away from the impact of atmosphere and noise impact or minish the atmosphere and noise impact to acceptance degree.

2.4 Major Environment Sensitive Receptors

The main environment Sensitive Receptors within the evaluated areas of the Sub-projects located in urban and suburb areas of Liuzhou refer to Table 2.1~2.10 below:

Table 2.1 Sensitive Receptors around Guantang WWTP

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Planned Residential Quarter	Northwest	/	Unknown
2	Nanzhaicun Village	North	200	200
3	Gaohuangcun Village	South	800	360
4	Xinmentun village	South	1000	90
5	Gaoyangcun Village	Southeast	600	450
6	Huangnicun Village	Southeast	800	110
7	Xincun Village	Southeast	1000	200

Table 2. 2 Sensitive Receptors around Sludge Management Site

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Features of Environment	Population (Person)
1	Shangdengcun Village	South	930	Plain. Fruit trees, rice and dry land crops are located around the Village.	1300
2	Heweicun Village	South	1200	Plain. Fruit trees, rice and dry land crops are located around the Village.	1100
3	Shangchencun Village	South	1700	Plain. Fruit trees, rice and dry land crops are located around the Village.	1300
4	Jieshancun Village	South	1790	Plain. Fruit trees, rice and dry land crops are located around the Village.	600
5	Shanwancun Village	South	1800	Plain. Fruit trees, rice and dry land crops are located around the Village.	2900
6	Residency Quarter of Plant	East	700	The terrain is flat, on which the houses are usually 5~7-storey buildings.	2000
7	Taiyangcun Township	Southeast	700~2500	The terrain is flat. This is a rural township and the location of township government where the houses are usually 3~4-storey buildings. Farmland, fruit trees, rice and dry land crops are located around the town.	5000
8	Cunwei Village	Southeast	2500	The terrain is flat. The farmland, on which dry land crops and rice are grown, is located around the Village.	800

Table 2.3 Sensitive Receptors around Shatang WWTP

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Yangliu Village	North to WWTP	240	Around 2000
2	Xinlongxiang, Shatang township	Northeast to 1# Sewage Pumping Station	80	Around 25
3	Liuzhou Farming Technology Research Institute	North to 1# Sewage Pumping Station	200	Around 60
4	Jiangwancun Village	Northwest to 1# Sewage Pumping Station	100	Around 360
5	Xinlongtun, Sanhecun Village	South to 1# Sewage Pumping Station	100	Around 520
6	Shatang township (including school)	Along sewage pipeline	/	Around 8000

Table 2.4 Sensitive Receptors around Liuzhou Urban-suburb drainage sub-project

NO.	WWTP	Network	Sensitive Receptors
1	Baisha WWTP Network	Huilonggou Combined Sewer	Nil
		Upstream Section of North Branch of Hexi Trunk Canal	Liuzhou No.1 Vocational School
2	Longquanshan WWTP Network	Upstream Section of Zhu'erxi rehabilitation	Nil
		Upstream section of Combined Sewer Trunk at Base 2 of Liuzhou Automobile Co.	Liuzhou Prefecture Vestibule School, Liuzhou Motor Vehicle School, Liuzhou Liuyong High School
		Combined Sewer Truck Outlet Section of Refrigerator Plant	Nil
		Sewage Interception Project along River at Shuinan Rd.	Nil
		Upstream Section of Liushi Combined Sewer Trunk Canal	Liuzhou Worker's Hospital, Liuzhou No.1 Middle School
		Sewage Interception Project along River from Lianhua Trunk Canal to Longquanshan WWTP	Nil
		Motan Combined Sewer	Nil
		Drainage Project of Taohua Southwest Region	Nil
		Upstream Section of Lianhua Trunk Canal	Guangxi Business School
3	Yanghe WWTP Network	Jianpan Combined Trunk Canal	Liuzhou Ethnic Senior High School
		Futoushan Combined Canal	Nil
		Guting Sewage Pumping Station & Sewage Trunk pipeline	Nil
		Yanghe Sewage Network	Nil
		Northeast Region of Hedong Rd.	Nil
		Region East to Donghuan Rd.	Guangxi Engineering College, Liuzhou No.16 Middle School, Liuzhou People's Hospital
		East Region, South Section of Liushi Rd.	Liuzhou Medical College
4	Labao WWTP Network	Sewage Interception Project for Jiuquhe River	Nil

Table 2.5 Sensitive Receptors around Liucheng Project Sites

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Office of Dapu Hydropower Station	Opposite riverbank of WWTP	400	50

2	Residential Quarter	West to 1# Sewage Pumping Station	60	45
3	Liucheng Secondary Vocational School	East to 1# Sewage Pumping Station	100	1000
4	Dapu No.1 Primary School	Northeast to 3# Sewage Pumping Station	60	1200
5	Pupil's Dormitory of Dapu No.1 Primary School	Northwest to 3# Sewage Pumping Station	60	200

Table 2.6 Sensitive Receptors around Rongshui WWTP

NO.	Sensitive Receptors	Location to WWTP	Distance to site (m)	Features
1	Sujiacun Village	West by north	400	Population: 132 with tap water
2	Aitoutun village	northeast	400	Population: 560 with tap water
3	Lingping	southwest	1000	Population: 300 with tap water
4	Dalicun Village	West	500	Population: 460 with tap water
5	Xiaocun Village	West	1000	Population: 780 with tap water
6	Zhongmacun Village	East	1500	Population: 870 with tap water

Table 2.7 Sensitive Receptors around Rong'an WWTP

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Shangbengcong Village	South	230	600
2	Hongweicun Village	Southeast	170	28

Table 2.8 Sensitive Receptors around Rong'an Pumping Stations

NO.	Sensitive Receptors	Location to site	Distance (m)	Population
1	Dormitory of grain Bureau	South to 1# Sewage Pumping Station	30	30
2	Residents' Houses	East to 1# Sewage Pumping Station	20~50	35
3	Hydrology Station	South to 2# Sewage Pumping Station	25	5
4	Timber Processing Plant	Southeast to 2# Sewage Pumping Station	20	10
5	Residents' Houses	Norwest to 2# Sewage Pumping Station	30	36
6	Beifucun Village	Northeast to 3# Sewage Pumping Station	70	700

Table 2.9 Sensitive Receptors around Sanjiang WWTP

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Tantoutun Village	East	50	366
2	Sanjiang Ferroalloy Co., Ltd	Northeast	50	60
3	Poweizhaitun Village	North	200	1050
4	Dazhoutun Village	Southeast	350	1300
5	Dazhou Primary School	Southeast	400	200
6	Sanjiang Middle School	Southeast	550	2000

Table 2.10 Sensitive Receptors around Sanjiang Pumping Stations

NO.	Sensitive Receptors	Location to Site	Distance to Site (m)	Population (Person)
1	Private Residency	North to Guyiqiao Sewage Pumping Station	10	35
2	Dormitory of Grain Bureau	East to Guyiqiao Sewage Pumping Station	10	175
3	Forestry Administration	East to Ershengqiao Pumping Station	10	112
4	Private Residency	Northwest to Ershengqiao Pumping Station	20	280
5	Dormitory of forestry Administration	Southwest to Ershengqiao Pumping Station	20	53
6	Ershengmiao Temple and ambient ancient trees	South to the Ershengqiao Pumping Station	50	

3. RELEVANT ENVIRONMENTAL STANDARDS

3.1 Environmental Quality Standard

3.1.1 Atmospheric environment

Environmental Air Quality Standard (GB3095-1996) and *Industrial Enterprise Design Health Standard* (TJ36-79) (Max. allowable concentration of harmful substances in atmosphere at residential area) is applied for atmospheric environment. refer to Table 3.1 and 3.2.

Table 3.1 standard value in *Environmental Air Quality Standard* (Excerpt)

Unit: (mg/Nm³)

Assessment factor	Time of Value	Limit value of class II standard	subproject applied
TSP	Yearly average	0.20	WWTP in Sanjiang, Rong'an, Rongshui, Liucheng County, Shatang WWTP, Guantang WWTP, Liuzhou urban-suburb drainage work, and sludge treatment work of Liuzhou wastewater treatment plant
	Daily average	0.30	
	Average/ Hour*	0.90	
PM ₁₀	Yearly average	0.10	
	Daily average	0.15	
	Average/ Hour*	0.45	
SO ₂	Yearly average	0.06	
	Daily average	0.15	
	Average/ Hour*	0.50	
NO ₂	Yearly average	0.08	
	Daily average	0.12	
	Average/ Hour*	0.24	

Table 3.2 standard value in *Industrial Enterprise Design Health Standard* (Excerpt)

Unit: (mg/Nm³)

NH ₃	Max. allowable concentration by once	0.20
	Daily average *	0.067
H ₂ S	Max. allowable concentration by once	0.01
	Daily average *	0.003
Subproject applied	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project	

*daily average concentration is 1/3 of average concentration/hour as per GB/T13201-1991

3.1.2 Surface Water Environment

Category III standard in Quality standard of surface water environment (GB3838-2002) is

applied for surface water environment. Refer to Table 3.3

Table 3.3 standard value in *Quality standard of surface water environment (Excerpt)*

Unit: (mg/L)

Category III	Assessment factor	pH value	Dissolution oxygen	CODMn	COD
	Standard value	6~9	5	6	20
	Assessment factor	BOD5	NH3-N	Fecal coliform	TP
	Standard value	4	1	10000	0.2
	Subproject applied	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management subprojects			

3.1.3 Noise Environment

Category II standard in *Quality standard of noise environment (GB3096-2008)* is applied for Noise Environment of different Sub-projects the applicable standard values refer to Table 3.4.

Table 3.4 standard value in *Quality standard of noise environment (Excerpt)*

Unit: dB(A)

Category	Daytime	Nighttime	Subproject applied
Category II	60	50	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project

3.2 Pollutant Discharge Standard

3.2.1 Atmospheric pollutant discharge standard

Atmospheric contamination discharge implements GB16297-1996 《Atmospheric contamination integral discharge standard》, GB14554-93 《Fetor contamination discharge standard》, GB4915-2004 《Cement industrial atmosphere contamination discharge standard》, GB14554-93 《Fetor contamination discharge standard》 and GB18485-2001 《Domestic rubbish burning pollution control standard》, refer to Table 3.5 to Table 3.8.

Table 3.5 standard value in integrated Atmospheric pollutant discharge standard (Excerpt)

Unit: (mg/Nm³)

Assessment factor	TSP
Grade (Category)	Non-point discharge
concentration limit value	5

Subproject applied	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project
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Table 3.6 standard value in Fetor Pollutant Discharge Standard (Excerpt)

Unit: (mg/Nm³)

Assessment factor	NH3	Fetor	H2S
Grade (Category)	II		
Standard concentration limit value	1.5	20	0.06
Subproject applied	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project		

Table 3.7 Cement industrial atmosphere pollutant discharge standard (Excerpt)

Unit: (mg/Nm³)

Assessment factor	During Production	SO2	Nitrogen oxide (counted by NO ₂)
Grade (Category)	Cement manufacturing	400	800
Assessment factor	Operation site	Monitoring point of particle inorganic discharge	TSP concentration limit value (1 hour concentration)
Grade (Category)	Cement factory	About 20m outside factory's boundary	1.0
Subproject applied	dewatered sludge management Sub-project		

Table 3.8 standard value in Living rubbish incineration control standard (excerpt)

Name of pollutant	CO	HCL	Hg	Cd	Pb	Dioxin
Unit	mg/m ³					ngTEQ/m ³
Standard value	150	75	0.2	0.1	1.6	1.0
Subproject applied	dewatered sludge management Sub-project					

3.2.2 Water pollutant discharge standard

Wastewater discharge standard of WWTP Sub-project implements GB18918-2002 《Contamination discharge assessment standard of urban WWTP》，and wastewater discharge standard of other Sub-projects implements GB8978-1996 《Wastewater integral discharge standard》, refer to Table 3.9 and 3.10.

Table 3.9 Integrated Wastewater discharge Assessment standard

Unit: mg/L, except pH value

Assessment factor		pH	SS	COD	BOD ₅	NH ₃ -N	Phosphate	Pb	Mn	Cu	2n	AS	Cd	Petroleum	Volatile Hydroxybenzene
Standard No. & Name															
<i>Integrated Wastewater discharge standard</i> GB8978-1996	Grade I	6~9	70	60	20	15	0.5		2.0	0.5	2.0			5	0.5
Subproject applied		Urban - suburban drainage and dewatered sludge management Sub-project													

Table 3.10 Pollutant discharge assessment standard of Municipal WWTP

(Extracted from Pollutant Discharge Standards of Municipal WWTP GB18918-2002)

Assessment factor		pH	SS	COD	BOD ₅	NH ₃ -N	TP	Total Nitrogen	Animal & plant oil	Petroleum	Total Pb	Mn	Cu	Zn	As	Cd	Fecal coliform (PCS/L)
Pollutant																	
Water pollutant ⁽²⁾ (aver./day mg/L)	Grade I A ⁽¹⁾	6~9	10	50	10	5 (8)	0.5	15	1	1	0.1	2.0	0.5	1.0	0.1	0.01	10 ³
	Grade I B ⁽¹⁾		20	60	20	8 (15)	1	20	3	3							10 ⁴
Max. allowable waste gas discharge	Grade	Ammonia			Sulfureted hydrogen			Odor concentration (without dimension)				Methane (Max. volume concentration of factory area/%)					
	Grade I	1.0			0.03			10				0.5					

concentration outside factory's boundary (mg/m ³)	Grade II	1.5	0.06	20	1				
	Grade III	4.0	0.32	60	1				
	Stabilization method	Anaerobic-digestion	aerobic-digestion	aerobic-composting					
Sludge stabilization control index	Control item	Degradation rate of organics (%)	Degradation rate of organics (%)	Moisture rate (%)	Degradation rate of organics (%)	Death rate of worm eggs (%)	Value of fecal coliform (PC/L)		
	Control index	>40	>40	<65	>50	>95	>0.01		
Pollutant control standard limit value when sludge used by farming	Control item	Total Cd	Total Hg	Total Pb	Total Cr	Total As	Total Zn	Total Cu	Petroleum
	In neutral or alkali soil (Max. allowable content mg/kg)	20	15	1000	1000	75	3000	1500	3000
Subproject applied		Grade I A: Guantang WWTP ;Grade I B: Sanjiang, Rong'an, Rongshui, Liucheng, Shatang WWTP							

3.2.3 Noise

Noise Standards of Boundary Environment of Industrial Enterprise GB1348-2008 and *Noise Limit Value of Boundary of Construction Site* GB1348-2008 are applied for noise of Construction Site.

Table 3.11 standard value in *Noise discharge standard of boundary environment of industrial enterprise* (excerpt)

Unit: dB(A)

Category	Day time	Nighttime	Subproject applied
Category II	60	50	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project

3.2.4 Watercourse dredging and Dewatered Sludge Management Sub-project

Sludge control standard of *Pollutant Discharge Standards of Municipal WWTP* GB18918-2002, *Pollutants Control Standards of c-used Sludge* GB4284-84 and *Pollutants Control Standards of General Industrial Solid waste Storage and Disposal Site Agricultural-used Sludge* GB18599-2001 are applied for watercourse silt and sludge of WWTP.

Table 3.12 Pollutants Control Standards of Agricultural-used Sludge

Item	Allowable maximum content (mg/kg)	
	In acid soil (pH<6.5)	In alkali soil (pH≥6.5)
Cd and its compound (by Cd)	5	20
Hg and its compound (by Hg)	5	15
Pb and its compound (by Pb)	300	1000
Cr and its compound (by Cr)	600	1000
As and its compound (by As)	75	75
Cu and its compound (by Cu)	250	500
Zn and its compound (by Zn)	500	1000
Ni and its compound (by Ni)	100	200
Subproject applied	Sanjiang, Rong'an, Rongshui, Liucheng, Shatang, Guantang WWTP, Liuzhou urban-suburban drainage Sub-project, dewatered sludge management Sub-project	

4. ENVIRONMENT MANAGEMENT PLAN

4.1 Objective

The objective of preparing an environmental management plan (EMP) is to put forward the mitigation measures against the potential environmental impacts, especially the negative impact analyzed by this environmental assessment, and set up the environmental management system for ensuring the implementation of these measures to fulfill environmental protection responsibility and assignment of concerned parties. At the same time, the EMP puts forward the training plan to strengthen capacity building of implementation of EMP of LZEMP II,. The EMP also put forward the environmental monitoring plan for supervising the implementation effect.

4.2 Environmental Management Mechanism and Duty

The major environment duty and staffing requirements of Project owner (PO), operators, design institute, EA consultant, engineering supervisor, contractors, county landfill owners, and environment monitoring and supervision agency at various stages vary, details see Table 4.1. Liuzhou Municipal Wastewater Treatment Company (LMWTC) is the owner and operator of all six WWTPs.

Table 4.1 Environmental Management Units at various Phases

Phase	Parties involved	Environmental Responsibility	Staffing
During Design and preparation	PO	1. Responsible for series of environmental management work at the stage of project design and preparation; 2. Make Environmental protection (EP) fund available; 3. Responsible for liaison with EPB on environmental management ;	2
	Design Institute	1. Bring EP measures into design program and budget; 2. Put the environmental mitigation measures of EMP in technical specification of bidding documents	1
During Construction period	PO	1. Responsible for series of environmental protection management work during construction; Make EP fund available; 2. Carry out management and supervision on EP During construction; and 3. Responsible for liaison with EPB on environmental management; 4. Follow up implementation of EMP, and report to the authorities in charge of the same level, and the World Bank.	2
	Contractor	1. Carry out EMP measures and work During construction as per bidding documents, contract, and EMP and EP design; 2. Subject to direction and supervision of environmental management personnel and environmental supervision engineers of PO and related governmental authorities; Get the technical support of EP consultants;	2
	Engineering /environment Supervisor	Supervise if environmental mitigation measures in contract fulfilled by contractor, and make site supervision upon implementation status of contractor, cooperate with contractor to do environmental management work well;	1

	Environment Monitoring agency	1. Carry out the environmental monitoring during construction based on the PO's entrustment and environmental monitoring plan. 2. If any abnormal situation during construction found, then carry out monitoring against the abnormal situation on behalf of PO;	
	Local EPB	1. Make selective examinations against EP measures of PO and contractors; Take over EMP implementation status report submitted by PO and PMO, and carry out administrative management based on the report; 2. If abnormal environmental circumstance during construction found, carry out the emergency measure;	1
	TA /consultant	1. Provide technical support to EP during construction as per PO's entrustment, CEA and EP design fruit; 2. Provide contractor with technical direction of EP work; Conduct EP training work during construction;	Without limit
During Operation period	PO/operator	1. Responsible for series of EP management during operation; carry out the mitigation measures during operation specified in EMP and perform monitoring; 2. Responsible for liaison with EPB to carry out environmental management; Environmental emergency treatment;	2
	County Landfill Owner	1. Responsible for series of EP management during operation; carry out the mitigation measures during operation specified in EMP and perform monitoring; 2. Responsible for liaison with EPB to carry out environmental management; Environmental emergency treatment;	1
	Environment Monitoring agency	1. Carry out the environmental monitoring during Operation based on PO's and county landfill owner's entrustment and environmental monitoring plan put forward by this EA; 2. carry out routine monitoring related with projects;	
	Local EPB	1. Carry out EP acceptance; 2. Supervise and manage the environment protection compliance during operation; 3. Supervise the operation of the environment facility; 4. include as common pollution source for supervision and management	2
	Civil society and NGOs	supervision by the society	Without limit

4.3 Mitigation Measures

LZEMP II has 6 domestic wastewater treatment subprojects whose treatment capacities are similar, only 1 domestic wastewater treatment subproject adopts different treatment process and the other 5 domestic wastewater treatment subproject adopt same treatment process; the construction contents, construction options and pipe material of proposed sewers are basically same, so there are many common environment impact among these WWTPs construction and operation. For the common environment impact, the same mitigation measures can be taken (refer to Table 4.2) and it is not necessary to repeat these same mitigation measures for each

WWTP. Meanwhile, for the specific environment impact due to different sites of WWTP, specific mitigation measures are proposed (refer to Table 4.3).

The mitigation measures during initial preparation, construction and operation for dredging and sludge management refer to Table 4.4 and 4.5.

Table 4.2 Common Mitigation Measures for Wastewater Treatment Plants and Sewers

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
Design and preparation stage	Feasible study on proposed site and layout		<ol style="list-style-type: none"> 1. Compare the alternative site to avoid the potential negative impact during construction and operation, design EP facilities and engineering facility simultaneously, and bring EP measure expenses into investment budget; 2. select reasonable site, enlarge scope of wastewater collection as far as possible; 3. Wastewater treatment process selected satisfies the discharge standards. 	Feasibility study consultant	EA consultant, Authority in charge of FSR approval, LMWTC
	Bidding/tendering and Contract management		<ol style="list-style-type: none"> 1. incorporate EMP to detailed design, include the environment measures in technical specification of bidding documents to ensure EMP is implemented effectively; 2. ask contractors and supervisors to receive training on environment protection and EMP before construction; 3. the mitigation measures during construction should be included in bids of contractors, and finally included in the construction contract as contract requirements against contractors; 4. Ask contractors to monitor the environment activity as per monitoring plan. PMO and construction supervision team should monitor and review these records; 5. Contractors should allocate at least 1 full time environment staff. These staffs should receive the training specified in monitoring plan to be competent for their task; 6. During construction, contractors should consult and communicate with local communities where project is located. The bulletin board should be set up to inform the public with specific construction activity and time. Meanwhile the spokesman and telephone number are disclosed for public to complain and give advice. 	LMWTC and bidding agent	LMWTC

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
Construction stage	Construction water, foundation pit waste water, living sewage	Water pollution	<ol style="list-style-type: none"> 1. Strengthen management During construction to save water, reduce quantity of construction wastewater production; 2. to prevent construction wastewater from surrounding surface water environment, project should set construction wastewater sedimentation tank at sites of WWTP and excavation of sewer network to recycle the wastewater after treated by sedimentation tank to ensure no external discharge; 3. Try not to build the builders' living facilities during construction, small quantity of domestic wastewater produced by builders will be collected in toilet, and clean them away uniformly after completion of construction, and use them as fertilizer. 4. Can not dump construction rubbish into receiving river of WWTP and nearby river. 	Incorporate into technical specification and executed by contractor	LMWTC Environment engineers of construction supervisor, local EPB
	Earthwork engineering, transport and disposal of abandoned earth, production of living solid waste	Solid waste pollution	<ol style="list-style-type: none"> 1. Advocate civilized construction, work out the waste treatment and transportation plan, prevent vehicles from overload to avoid solid waste dropping down along street and causing second-time pollution; 2. Abandoned building materials should be stacked by sort, and recycle ones that can be recycled by selling, ones that can not be recycled is transported to designated construction rubbish stacking point, mixed treatment with living rubbish is not allowed, and littering is not allowed; 3. Suggest to backfill the abandoned earthwork produced by construction on the spot, transport the surplus earth and stone to other local construction sites where needs it for backfilling; if no demand, must transport them to designated place for stacking as required of local EP department, dumping to wastewater receiving river and other rivers within the territory is strictly prohibited. Clear them away timely and orderly for innocuous treatment and reuse, this will not produce negative impact. 	Incorporate into technical specification and executed by contractor	LMWTC Environment engineers of construction supervisor, local EPB

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
	Excavation, backfilling, construction machinery's tail gas discharge	Air pollution	<ol style="list-style-type: none"> 1. To prevent surrounding environment and Villagers from impact by construction dust of WWTP, purdah should be set up during construction; 2. Stop earthwork construction if wind power is more than Grade 4; 3. Sprinkle water on bare earth surface within construction site timely to keep soil moisture for controlling dust; 4. Throw up in the air when loading/unloading dregs, cements, etc. is not allowed; use vehicles with closed carriages to transport bulk materials to avoid dust caused by material dropping; 5. Main operation points as cement stacking yard, etc which may produce dust should be covered or set temporary enclosure or wind-proof board around it; 6. Abandoned earth (stone) produced by base excavation should be cleared away from day to day. 7. To decrease impact to various environmental Sensitive Receptors and ambient air quality by dust of sewer network construction, set temporary retaining wall around sewer network, and Stop earthwork construction if wind power is more than Grade 4; 8. Throw up in the air when loading/unloading dregs, cements, etc. is not allowed; 9. Arrange construction schedule rationally, try to shorten construction period, and set isolation maintenance facility by related requirements of construction; 10. Abandoned earth should be treated on the spot, if impossible, then clear them away by transportation timely to shorten stacking time and reduce stacking quantity, transportation should also satisfy related requirements, carriages of vehicles should be covered, and limit vehicle's speed. At the same time, sprinkle water at place of earth excavation during construction in dry season to reduce dust; Main operation points as cement stacking yard, etc. which may produce dust should be set up at downwind of industrial field, cover powder material stack or set temporary enclosure or wind-proof board around it. 	Incorporate into technical specification and executed by contractor	LMWTC Environment engineers of construction supervisor, local EPB

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
	Construction machinery, transport vehicles	Noise pollution	<ol style="list-style-type: none"> 1. Choose low noise equipments; No trumpet during transportation at night; strengthen builders' EP education, advocate civilized construction, and reduce noise pollution; 2. Piping construction must arrange reasonable working time of various construction machinery to reduce impact to protective objective by construction noise. If construction is near school and kindergarten during 8:00 to 22:00, pile drivers and other high noise equipments are not allowed, and stop construction during school examination; 3. during 22:00~8:00 (nighttime), construction not allowed near hospital and residential area; 4. During construction, effective noise reducing measures are taken, e.g. use spring cushion, packing, sound isolation cover and etc. No trumpet is allowed for motor vehicles when passing in and out at construction site; 	Incorporate into technical specification and executed by contractor	LMWTC Environment engineers of construction supervisor, local EPB
	Land occupation by construction, surface soil vegetation cleanup	Water and soil loss	<ol style="list-style-type: none"> 1. Arrange the construction schedule reasonable to avoid large earthwork excavation and backfilling in rainstorm season, avoid surface soil to be washed out and destroyed by rainwater. 2. Recover land timely occupied temporarily. 3. Clear abandoned dregs away timely. Choose reasonable construction procedure, when stacking temporary dregs, stack surface soil in the middle which is easy drain and stone blocks around for temporary blockade, littering is not allowed; 	Incorporate into technical specification and executed by contractor	LMWTC Environment engineers of construction supervisor, local EPB
	Drainage of wastewater treatment facility, domestic wastewater of WWTP staff	Water pollution	<ol style="list-style-type: none"> 1. Work out complete operation rule and execute it strictly, conduct monitoring of quality of influent and effluent as required by production system to ensure stable production operation to avoid abnormal situations. Once abnormal situation found, deal with it in time to guarantee the effluent quality reach the discharge standards. Prevent quality of effluent after treatment fail to meet the designed standard and spoil pollutant reduction due to improper operation and improper control; 2. Both domestic wastewater produced by WWTP itself and wastewater produced by buildings and equipments are drained to wastewater treatment system for treatment, discharge to outside directly is not allowed; strengthen management, maintain sewer network, clear sewer periodically to ensure wastewater network in good condition; 	LMWTC	Local EPB, ambient community

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
Operation stage	Operation in WWTP	Air/odor pollution	<ol style="list-style-type: none"> 1. Transport sludge away after dewatering to reduce quantity of stacking; 2. Strengthen operation management, control ferment of sludge in condensation pool; 3. Sprinkle deodorant on water surface of pollution source to shield fetor; strengthen greening, plant protection forest at plant boundary, greening in plant area should include the arbor, shrub and grasses with tall and much leaves of arbor as priority to enhance ability of odor absorption; wastewater screen are built in house for closed operation, at the same time, sprinkle deodorant to shield fetor; 4. Suggest PO to submit written report to local government that no environmental sensitive objective such as residential area within buffer distance is not allowed to build; 	LMWTC	Local EPB, ambient community
	Greening, grit and sludge treatment in plant	Solid waste pollution impact on landfill	<ol style="list-style-type: none"> 1. Solid waste of WWTP, especially sludge, can not be abandoned discretionarily, must be collected and stacked well, and send to landfill which agrees to accept them for landfilling. 2. Sludge of urban WWTP can not be discharged to all surface water bodies and river bank, valley, marsh land, karst cave, farmland which is not the designated solid waste disposal site; 3. Temporary stacking field of sludge in WWTP must prevent second-time pollution through anti-leakage foundation, rainproof measure, and prevent odor get enriched in sludge shed and emit off from sludge shed; 4. Set up additional rainproof shed above sludge stacking, stacking ground must be hardened thoroughly, and set cofferdam, drain and collection well near the shed, and convey the water discharged by sludge stacking to wastewater treatment system for treatment; 5. Use trucks with closed tank to transport sludge outside. 6. Choose advanced sludge concentration/dewatering equipment to further decrease moisture rate of sludge to 75~80%, thus it can reduce quantity of bio-chemical sludge production, and make sludge can be used as resource more easy; 7. according to <i>Domestic rubbish burning pollution control standard</i> GB18485-2001, the water content of sludge must reach the landfill entrance threshold (60%). Most water of sludge from WWTP in 4 counties can be removed through natural vaporization or guiding to river. After the 	LMWTC, WWTP in 4 counties	Local EPB, ambient community, Liuzhou Environment Sanitation Division

Stage	Main activities	Negative impact	Mitigation/prevention and control measures	Executor	Supervisor
			water content of sludge reaches 60%, the sludge can be transported to landfills by closed vehicle. Sludge from Guantang and Shatang WWTP are sent to Yufeng Cement Plant for co-combustion. 8. When sludge can't get dry naturally during rain season, the sludge is landfilled after mixed with dry earth.		
	Operation of wastewater treatment facility in plant	Noise pollution	1. Use advanced low noise equipments, both wastewater pump and sludge pump adopt underwater pump; blower and other high noise equipments should be placed indoor to use building as sound isolation; at the same time, take steps to lower and reduce noise; strengthen greening around plant area to form green belt, and gradually form sound isolation belt; 2. Strengthen management measure: WWTP must set special EP unit to be responsible for EP work and greening work during project operation period and employees' EP education and propaganda work, and cooperate with EP authority to carry out EP supervision; 3.outfall construction of WWTP must be standardized, one WWTP can set only 1 outfall with obvious mark; outfall of WWTP should set on-line monitoring system to meet requirement of supervision management of "Wastewater discharge enterprise "; strengthen management to ensure that there are not industrial wastewater discharge within range of wastewater receiving area; 4. Strengthen management and maintenance of sewer network;	LMWTC	Local EPB, ambient community
	Sludge transport to landfills	Odor, leaking of sludge	1. sludge is transported by closed vehicle to confine the odor in the sludge tank; 2. mechanical loading/unloading to shorten unloading time; 3. the sludge cabinet is under negative pressure to stop the odor to leak	LMWTC	Local EPB, ambient community
	Sludge disposal at counties' sanitary landfills	Water pollution, air emission etc	The operation of landfill in four project counties must meet applicable Chinese regulations as well as applicable World Bank safeguards policy requirements (refer to in the EA Report of the project).Monitoring to this effect will be undertaken and remedial measures taken if needed.	Owner/operator of county landfills	Local gov, local EPB

Table 4.3 Site-Specific Mitigation Measures of Various WWTP

sub-project	Pollution prevention measure during construction and operation	Executor	supervisor
Sanjiang WWTP	<p><u>During construction:</u></p> <ol style="list-style-type: none"> 1. There are residential areas at east, west and north of planning area east, and west residential areas are near, noise During construction affects nearby inhabitant’s life obviously. So it should control construction time strictly, construction at rest time is not allowed. 2. Due to being close to Sensitive Receptor, therefore contractor should use hydraulic machinery to further reduce noise. 3. Protection marks should be set up around ershengmiao Temple and ancient trees , the protection scope should be marked and maintenance should be strengthened. <p><u>During operation:</u></p> <ol style="list-style-type: none"> 1. locate Guyiqiao wastewater pumping house toward south-west side along Xunjiang River, and as far as possible away from ambient environmental Sensitive Receptors; locate Ershengqiao wastewater pumping house at the central section of pumping station, and as far as possible away from ambient environmental Sensitive Receptors; 2. According to progress of WWTP and pumping stations construction, relocated the houses of inhabitant by stages within 100m of range of sanitation protection distance. Land use for new residential area, school and hospital can not be planned any more within range of sanitary protection distance of WWTP fetor source structure and wastewater pumping house; 	<p>During construction: contractor</p> <p>During operation: Sanjiang WWTP</p>	<p>LMWTC and Sanjiang urban appearance bureau</p> <p>During operation: liuzhou and Sanjiang EPB</p>
Rong’an WWTP	<p><u>During construction:</u></p> <ol style="list-style-type: none"> 1. Due to being close to Sensitive Receptor (shangpengchong village, 230m), noise During construction affects nearby inhabitant’s life obviously. So it should control construction time strictly, construction at rest time is not allowed. 2. Due to being clsoe to Sensitive Receptor, therefore contractor should use hydraulic machinery to further reduce noise; <p><u>During operation:</u></p> <ol style="list-style-type: none"> 1. The calculation indicates that sanitation protection distance in short-term and long-term of WWTP is 100m and 300m respectively. Distance of Sensitive Receptors around WWTP in short-term can meet requirement of sanitation protection distance (100m), however lots of inhabitants are in sanitation protection distance in long-term (300m). But the capacity and construction time of long –term WWTP are not certain, the specific sanitation protection distance and relocation of inhabitants should be decided based on EA of long-term WWTP 2. Local EPB must strengthen monitoring against top polluters whose wastewater can discharge to the urban wastewater network after reaching to level III standard of CJ3082-1999 《Water Quality standard of wastewater discharged to sewer》 and 《Integral wastewater discharge standard》 (GB8978-1996) 	<p>During construction: contractor</p> <p>During operation: Rong’an WWTP</p>	<p>LMWTC and Rong’an urban appearance bureau</p> <p>During operation: liuzhou and Rong’an EPB</p>

<p>Rongshui WWTP</p>	<p><u>During construction:</u></p> <ol style="list-style-type: none"> 1. Due to being close to Sensitive Receptor (Sujia Village, 400m), noise During construction affects near inhabitant's life obviously. So it should control construction time strictly, construction at rest time is not allowed. 2. Due to being close to Sensitive Receptor, therefore contractor should use hydraulic machinery to further reduce noise. <p><u>During operation:</u></p> <ol style="list-style-type: none"> 1. The calculation indicates that sanitation protection distance in short-term and long-term of WWTP is 100m and 200m respectively. The sanitation protection distance is measured from plant's boundary toward outside, within range of sanitation protection distance, school, hospital, residential area, office not allowed to build. But the capacity and construction time of long-term WWTP are not certain, the specific sanitation protection distance and relocation of inhabitants should be decided based on EA of long-term WWTP 2. Local EPB must strengthen monitoring against top polluters whose wastewater can discharge to the urban wastewater network after reaching to level III standard of CJ3082-1999 《Water Quality standard of wastewater discharged to sewer》 and 《Integral wastewater discharge standard》 (GB8978-1996) 	<p>During construction: contractor</p> <p>During operation: Rongshui WWTP</p>	<p>LMWTC and Rongshui urban appearance bureau</p> <p>During operation: liuzhou and Rongshui EPB</p>
<p>Liucheng WWTP</p>	<p><u>During construction:</u></p> <ol style="list-style-type: none"> 1. no inhabitant Within 300m around WWTP, so construction noise doesn't affect environment obviously. 2. There are inhabitants at nearest distance 60m to pumping station, noise During construction affects near inhabitant's life obviously. So it should control construction time strictly, construction at rest time is not allowed. <p><u>During operation:</u></p> <ol style="list-style-type: none"> 1. The calculation indicates that sanitation protection distance in short-term and long-term of WWTP is 100m and 200m respectively. The sanitation protection distance is measured from plant's boundary toward outside, within range of sanitation protection distance, school, hospital, residential area, office not allowed to build. But the capacity and construction time of long-term WWTP are not certain, the specific sanitation protection distance and relocation of inhabitants should be decided based on EA of long-term WWTP 2. Local EPB must strengthen monitoring against top polluters whose wastewater can discharge to the urban wastewater network after reaching to level III standard of CJ3082-1999 《Water Quality standard of wastewater discharged to sewer》 and 《Integral wastewater discharge standard》 (GB8978-1996) 	<p>During construction: contractor</p> <p>During operation: liucheng WWTP</p>	<p>LMWTC and Liucheng urban appearance bureau</p> <p>During operation: liuzhou and Liucheng EPB</p>
<p>Shatang WWTP</p>	<p><u>During construction:</u></p> <ol style="list-style-type: none"> 1. Due to being close to Sensitive Receptor (Yangliu Village, 240m), noise During construction affects near inhabitant's life obviously. So it should control construction time strictly, construction at rest time is not allowed. 2. One lifting pumping station is very close to Sensitive Receptor (Xinlong Alley, Shatang township, about 80m), therefore contractor 	<p>During construction: contractor</p>	<p>LMWTC and Liuzhou urban appearance bureau</p>

	<p>should use hydraulic machinery to further reduce noise, and construction at rest time is not allowed.</p> <p><u>During operation:</u></p> <p>1. The calculation indicates that sanitation protection distance in short-term and long-term of WWTP is 100m and 200m respectively. The sanitation protection distance is measured from plant's boundary toward outside, within range of sanitation protection distance, school, hospital, residential area, office not allowed to build. But the capacity and construction time of long-term WWTP are not certain, the specific sanitation protection distance and relocation of inhabitants should be decided based on EA of long-term WWTP</p> <p>2. Local EPB must strengthen monitoring against top polluters whose wastewater can discharge to the urban wastewater network after reaching to level III standard of CJ3082-1999 《Water Quality standard of wastewater discharged to sewer》 and 《Integral wastewater discharge standard》 (GB8978-1996)</p>			During operation: Shatang WWTP	During operation: liuzhou EPB
Guantang WWTP	<p><u>During construction:</u></p> <p>1. About 200m at the north of proposed site is old Village of Nanzhai Village, noise During construction affects near inhabitant's life obviously. So it should control construction time strictly, construction at rest time is not allowed.</p> <p>2. Construction of pumping station and network run through Guantang area, therefore contractor should use hydraulic machinery to further reduce noise, construction at rest time is not allowed.</p> <p><u>During operation:</u></p> <p>1. The calculation indicates that sanitation protection distance in short-term and long-term of WWTP is 200m and 400m respectively. The sanitation protection distance is measured from plant's boundary toward outside, within range of sanitation protection distance, school, hospital, residential area, office not allowed to build. But the capacity and construction time of long-term WWTP are not certain, the specific sanitation protection distance and relocation of inhabitants should be decided based on EA of long-term WWTP</p> <p>2. Local EPB must strengthen monitoring against top polluters whose wastewater can discharge to the urban wastewater network after reaching to level III standard of CJ3082-1999 《Water Quality standard of wastewater discharged to sewer》 and 《Integral wastewater discharge standard》 (GB8978-1996)</p>			During construction: contractor	LMWTC and Liuzhou urban appearance bureau
				During operation: Guantang WWTP	During operation: liuzhou EPB

Table 4.4 Mitigation measures of sludge management

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
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Design stage	Feasible study on proposed site and layout		<ol style="list-style-type: none"> 1. Compare the alternative Option to avoid the potential negative impact during construction and operation, design EP facilities and engineering facility simultaneously, and bring EP measure expenses into investment estimate; 2. Analyze feasibility of using cement kiln to treat sludge and experience of using cement rotary kiln to treat urban sludge. 	Design Institute	EA consultant, Authority for FSR approval, LMWTC, Guangxi Yufeng Group Ltd
	Bidding/tendering and Contract management		<ol style="list-style-type: none"> 1. incorporate EMP to detailed design, include the environment measures in technical specification of bidding documents to ensure EMP is implemented effectively; 2. ask contractors and supervisors to receive training on environment protection and EMP before construction; 3. the mitigation measures during construction should be included in bids of contractors, and finally included in the construction contract as contract requirements against contractors; 4. Ask contractors to monitor the environment activity as per monitoring plan. PMO and construction supervision team should monitor and review these records; 5. Contractors should allocate at least 1 full time environment staff. These staffs should receive the training specified in monitoring plan to be competent for their task; 6. During construction, contractors should consult and communicate with local communities where project is located. The bulletin board should be set up to inform the public with specific construction activity and time. Meanwhile the spokesman and telephone number are disclosed for public to complain and give advice. 	LMWTC and bidding agent	LMWTC

Construction stage	Earthwork	Water pollution	<p>1. Strengthen project management, routine maintenance of machinery should be done well, and put an end to leakage of water from pores, valves, drips, and taps; in addition, cover machinery to prevent them in rainy day.</p> <p>2. Contractor should strictly manage wastewater discharge during construction period; discharge and flow in disorder are not allowed to pollute water body and ambient environment; Recycle wastewater produced from sand and stone processing after sedimentation, \Machinery's oily wastewater should be guided to and treated in existing sewage treatment station in cement plant;</p> <p>3. Don't set up collective construction encampment. In terms of whole city area, no additional domestic wastewater produced, domestic wastewater produced by builders is discharged to existing sewage treatment station in cement plant</p>	Incorporate into technical specification and executed by contractor	LMWTC, Guangxi Yufeng Group Ltd, Engineering supervisors; Local EPB
	Excavation, backfilling, construction machinery's tail gas discharge	Air pollution	<p>1. Strengthen smoke control at construction site, discharge of toxic smoke and gas at construction site is not allowed; strengthen maintenance and repair of transportation vehicles, excavators used and etc, use acceptable fuel to reduce smoke emitted by machinery;</p> <p>2. Sprinkle water on operation surface with possible second time dust pollution, arrange personnel to sprinkle water at construction site from time to time to reduce dust;</p> <p>3. Arrange construction schedule rationally, try to shorten construction period to reduce impact of construction waste gas and impact time;</p> <p>4. abandoned earthwork, building rubbish and building materials should be covered and transferred in time; if temporary stacking field is set up, cover those materials stacked temporarily which may cause dust easily;</p> <p>5. to use commercial concrete in urban construction area as far as possible, avoid construction under big wind weather. Concrete mixer should be located in shed, neighboring construction sites can share same mixer, mixer shed should be far from residential area, offices and school with high density of population, mixer should have sprayer for reducing dust while in operation;</p>	Ibid	Ibid

	Construction machinery, transport vehicles, mechanical vibration	Noise pollution	<ol style="list-style-type: none"> 1. Try to choose low noise equipment and process, strengthen maintenance and repair of machinery;. 2. For some vocal devices, install muffler or noise isolator (the nearest Sensitive Receptor is the dormitory of cement plant with distance more than 700m, the impact is little) 	Ibid	Ibid
Operation stage	rotary kiln cineration	Air pollution	<ol style="list-style-type: none"> 1. After the waste gas is discharged from the cinerating system, the measures are taken to decrease the temperature quickly to effectively prevent temperature from decreasing slowly to avoid dioxin can take shape in 200-300 °C. The high temperature can destroy the organism more completely and the whole system operates under negative pressure, the nocuous and hazardous gas can not go out; 2. No. 2, 3 and 4 rotary kilns are equipped with static dust catcher to collect dust, SO₂ and NO_x , HCl, HF, CO, heavy metal and its compound, dioxin also can be collected to some extent. At present, The waste gas can meet the emission standards; 3. If the pollutants in waste gas fails to meet the emission standards, then Grade I bag dust collecting system should be installed behind each static dust collecting system to ensure emission compliance; 	Guangxi Yufeng Group Ltd; LMWTC,	Local EPB and community
	Sludge transport, loading/unloading. Sludge cabinet	Odor	<ol style="list-style-type: none"> 1. sludge is transported by closed vehicle to confine the odor in the sludge tank; 2. mechanical loading/unloading to shorten unloading time; 3. the sludge cabinet is under negative pressure to stop the odor to leak 	Ibid	Local EPB and community
	Washing the Sludge conveying pipe and washing for overhaul	Wastewater pollution	<ol style="list-style-type: none"> 1. When examining and repairing machinery, it will produce small quantity of cleaning wastewater. Generally examining and repairing machinery once per year, the cleaning wastewater produced is discharged to wastewater treatment station of Guangxi Yufeng Group Ltd and used for production instead of discharging outside after treatment; 2. The treatment process of wastewater treatment station is biological contact oxidation treatment + coagulating sedimentation deep treatment.. 	Ibid	Local EPB and community

	Cement production	Noise pollution	Double spiral feeder, high pressure sludge pump and injecting unit are used for feeding sludge to kiln, noise produced by the said equipments during operation is of 80~110 dB(A). Position of mechanical equipment should be at least 70m in distance to boundary of plant, via distance attenuation and measure of installation of sound isolation and vibration absorption, the noise of site boundary meet the requirement of standards.	Guangxi Yufeng Group Ltd ; LMWTC,	Local EPB and community
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Table 4.5 Mitigating Measures of River Dredging

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
Design and initial preparation stage	Dredging option, drying site identification and layout		<p>According to testing result and pollution degree of silt, there are several disposal option as follow:</p> <ol style="list-style-type: none"> 1.silt of lower reaches of Huilongchong are transported to Lichonggou landfill for burying after natural drying, the silt can not be used directly for landscaping or agriculture; 2.Silt of both upper and lower reaches of Zhuexi can be used for landscaping (there is no farming land around project sites because the project is located in urban area, not economic in view of transportation) ; 3. Contaminations received by Zhutoutang is basic same like Zhuexi, therefore silt of Zhutoutang can be used for landscaping or agriculture; 4. the layout and construction methods of drying sites are designed ecologically to reduce land occupation and bothering peoples, keep the original river state, ecological slope and embankment; 	Design Institute	EA consultant, LMWTC,
	Bidding/tendering and Contract management		<ol style="list-style-type: none"> 1. incorporate EMP to detailed design, include the environment measures in technical specification of bidding documents to ensure EMP is implemented effectively; 2. ask contractors and supervisors to receive training on environment protection and EMP before construction; 3. the mitigation measures during construction should be included in bids of contractors, and finally included in the construction contract as contract requirements against contractors; 4. Ask contractors to monitor the environment activity as per monitoring plan. PMO and construction supervision team should monitor and review these records; 5. Contractors should allocate at least 1 full time environment staff. These staffs should receive the training specified in monitoring plan to be competent for their task; 	LMWTC and bidding agent	LMWTC

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
			6. During construction, contractors should consult and communicate with local communities where project is located. The bulletin board should be set up to inform the public with specific construction activity and time. Meanwhile the spokesman and telephone number are disclosed for public to complain and give advice.		
	Zhutoutang wastewater interception and dredging	Cultural relic protection (carving stone)	<ol style="list-style-type: none"> 1. abide by the rule that the protection scope is outward extension distance of 20m from carving stone, and outward extension distance of 50m from construction control belt, all construction activity must be beyond 50m from the carving stone; 2. no explosion, drilling and excavation by large excavating machine are allowed; 3. set up marks and protection belt within the specified protection scope; 4. Strengthen management, ensure nobody is allowed to be in the protection scope and do anything not related with relic protection; 5. During construction, if other cultural relic is found, the contractor should stop construction and report to the authority in charge of cultural relic. Based on the assessment result of cultural relic, the subsequent construction scope and schedule; 	contractor	LMWTC and Liuzhou Cultural Relic Bureau
Construction stage	Earthwork	Water pollution	<ol style="list-style-type: none"> 1. Strengthen project management, routine maintenance of machinery should be done well, and put an end to leakage of water from pores, valves, drips and taps; in addition, cover machinery to prevent them in rainy day; 2. Contractor should strictly manage wastewater discharge during construction period; discharge and flow in disorder are not allowed. Recycle wastewater produced from sand and stone processing after sedimentation, other construction wastewater should be guided to temporary sedimentation tank and use for sprinkling after sedimentation; 3. Machinery's oily wastewater should be collected and treated timely, and can not be discharged to river system; 4. materials easy to flow or containing harmful substance, abandoned earth can not be stacked near river, pond, irrigation channel etc, stacking point should set up cover, and set earthwork cloth enclosure during rainstorm to prevent them to be washed out into water body; 5. Don't set up collective construction encampment. In terms of whole city area, no additional domestic wastewater produced, domestic wastewater produced by builders is discharged to existing sewage system. 	Contractor	LMWTC, environment engineer from construction supervisor, local EPB
	Dredging and	Air pollution	1. Watercourse dredging area implements closed construction, height of enclosure is no less than 1.8m; Silt and	Contractor	Ibid

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
	silt disposal, tail gas emission	and orodor pollution	<p>abandoned soil and stone should be transferred by closed vehicles and the residential quarter and rest time should be avoided for transportation;</p> <p>2.the operation section and time should be controlled during dredging;</p> <p>3.the builders should wear mask;</p>		
	Construction machinery, transport vehicles,	Noise pollution , mechanical vibration	<p>1. Noise control measures refer to dewatered sludge management Sub-project</p> <p>2. The longest compliance distance of noise at night is 200m, and noise will impact the Sensitive Receptors little, especially Liuzhou Prefecture Vestibule School is impacted most at night. So high enclosure should be set up, and large machines should be arranged rationally, no large machines and construction activity with high noise are allowed at night to minish noise impact degree and scope;</p>	Ibid	Ibid
	Temporary stacking and drying of silt	Fetor pollution and water pollution	<p>1.The silt at the temporary stacking sites should be transferred in timely manner after preliminary drying; if not, the silt should be packed in straw bags g to minish dust and odor;</p> <p>2. the temporary stacking sites should be away from the roads or small drains should be available to guide the wastewater;</p> <p>3. The water content of silt in the drainage component usually is over 80%。 If the silt is stacked at open site, according to the experience of LZEMP, the self- gravity dewatering will take 10 hours to remove 5% water in silt under natural condition if the sludge stacking depth is 0.4~0.6m;</p> <p>4. Through 48 hours sunshine, the water content will decrease from 80% to 60% rapidly. If the silt is reversed and simple guide channels are built in the drying site to have several small sections as to improve usage rate of drying site and reduce land area of drying site, meanwhile, if the leachate is guided to river, the silt drying speed is further increased, the silt can be dried in 3~4 days to meet the water content requirement for landfilling in landfill;</p> <p>5.The reasonable construction time should be chosen to avoid rain season;</p> <p>6. The silt at the temporary silt stacking site will be come dry naturally, there is a water proof layer at the bottom of temporary silt stacking site (300mm thick clay layer) which is tamped. There is a manual water filter layer (300mm thick coarse slag layer or gravel layer) at the top. There is a temporary underdrain at middle. The leachate flow to river after getting together in underdrain to prevent groundwater pollution;</p> <p>7. The dredged silt complying with Class III standard of GB15618-1995 Soil environmental quality standard can</p>	Ibid	Ibid

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
			be directly used for greening;		
	River Dredging and drying site operation	Water and soil loss	<ol style="list-style-type: none"> 1. Choose suitable place for stacking earthwork excavated, and earthwork is better to be reused directly. Different engineering should be carried out by section to reduce impact on landscape; 2. Construction excavation will make the surface soil and abandoned dregs naked and loose, soil erosion intensity will be increased. After construction, cleaning and recovery work should be done as soon as possible. To reduce erosion of surface runoff to construction field in rain season, reduce Water and soil loss, it should combine with flood-control plan in initial construction period to set up flood drainage ditch outside construction site to discharge surface runoff outside the construction site; 3. It should build stacking yard to prevent loss of soil, excavated surface soil which may be used for greening; 4. Arrange reasonable construction schedule, expedite construction progress, shorten construction time, construction which causes easy water and soil loss should avoid rain season, especially foundation excavation should avoid construction in rain season or rain day; 5. Arrange reasonable greening engineering during construction, adopt "One section built, one section greened" way to organize construction to get better ecological environment benefit; 6. PO should sign EP contract with constructor, and stipulate: earth and stone must be procured from designated borrow pits, random excavation is not allowed; excavated surface soil should be stacked at suitable place and used for greening in later period; flood interception measure should be taken around temporary dregs stacking field; 	Ibid	Ibid
	temporary roads for construction, temporary construction fields, temporary silt stacking yard	Vegetation destroy	<ol style="list-style-type: none"> 1. Arrange suitable greening engineering during construction period further, adopt "One section built, one section greened" way to organize construction to get better ecological environment benefit; 2. Temporary construction field: engineering measure of this prevention and treatment area is against the earth drain and design drain section is the trapezoidal section, when sand, stone, cement and etc. building materials are stacked by sort, it must use the tarpaulin as cushion to keep the original surface components, prevent water and soil loss caused by stacking building materials; 3. After construction, recover vegetation in time by planting sward or sowing Bermuda grass. Seeds adopt broadcast sowing method; sowing density is about 25kg/hm². The grass seeds should be mixed with fine earth equally and covered with earth after sowing and rolled properly. 	Ibid	Ibid

Stage	Main activities	Negative impact	Mitigation measures	Executor	Supervisor
Operation	Domestic wastewater discharge	Surface water pollution	<ol style="list-style-type: none"> Domestic wastewater should be collected by wastewater interception network, and discharged after treatment in WWTP instead of discharge directly to river; Ensure that wastewater of communities and undertakings and enterprises along river banks flow into wastewater interception trunk pipes along river banks; 		
	Watercourse management and maintenance	ecological protection	<ol style="list-style-type: none"> Build perfect monitoring system to carry out long-term monitoring against biology and hydrogeology, carry out the evaluation by phase based on complete historic information and monitoring data, the evaluation contents are status and development trend of structure and function of river ecosystem; and according to evaluation result, adjust original project objective and engineering in time; Greening construction and management should strengthen self-maintenance mechanism and anti-disturbance ability of greenbelt itself; improve the planting and maintenance management level, promote the growth of plants; specific staff is responsible to routine management of various facility to ensure the normal operation and functioning; Strengthen the management of hydraulic structures to prevent river course is impacted during operation substantially; supervise the implementation of protection measures during operation regularly; 	LMWTC	Local EPB, LMWTC, Liuzhou Gardening Bureau, Liuzhou Water Conservancy Bureau, social supervision

4.4 Measures for Preventing and Mitigating Environmental Risks

Against potential environmental risks during construction and operation periods identified by EA, the counterpart measures refer to Table 4.6.

Table 4.6 Measures for preventing environmental risks

Stage	Prevention measures	Executor	Supervisor
WWTP Sub-projects——accidental discharge risk			
During design	<p>1. Double power sources for power supply to prevent accidental discharge due to blackout</p> <p>Build necessary standby system or equipments:</p> <p>2. set up the overflow pipeline within WWTP to enable wastewater to overflow partial or all structure in case of accident and enter into next structure or overflow;</p> <p>3. At least 2 tanks for each unit process of wastewater treatment technology, during repair due to accident, to ensure that rest tank can be still in normal operation under the condition of additional load when one tank does not work, depending on this circumstance to determine dimensions of each pond.</p> <p>4. Main dynamical equipments of WWTP like water pump, sludge pump should have 1~2 sets for standby, in case of failure of equipment, replacement is available in time. WWTP should adopt double power source for power supply to reduce occurrence of power cut accident;</p> <p>5. In order to enable wastewater to flow smoothly among treatment structures, it must pay special attention to the elevations of treatment structures, especially two structures operate in parallel, in case one defunctions, the other must accommodate full flow. Therefore, the elevation of structures must have much room to prevent occurrence of upwelling due to short water head;</p> <p>6. When designing WWTP, WWTP should have stormwater sewer to discharge rain water to rain water treatment system in time to avoid occurrence of seeping accident and environmental pollution. Elevation of effluent outfall of WWTP should be higher than flood level of receiving water body to allow the effluent flow by itself;</p>	<p>Consultants who prepare the Feasible study, preliminary design institute, bidding agency;</p> <p>LMWTC</p>	<p>EA consultant Authority to approve the Feasible study and preliminary design,</p> <p>Public utility bureau</p>
During Operation	<p>1. Rigid standardized operation: probability that WWTP effluent discharge fails the discharge standard is small. The effluent discharge fails the discharge standard can be fully avoided as long as proper management. Therefore, the operation and management practice of WWTP , post duties, rewards and punishment regulations should be prepared for WWTP to manage WWTP in standardized and systemized way, the operators in posts must be qualified with relevant certificate, and execute management and operation regulations strictly to control occurrence probability of accidental wastewater discharge caused by disoperation as far as possible.</p> <p>2. Work out accident emergency plan, set up accident disposal agency, and make the obligations of departments, posts and operators duty clear. In case of accident, take steps in time and notify EPB, municipal engineering department and water conservancy department to eliminate troubles in shortest times.</p>	LMWTC	<p>Local EPB</p> <p>Public utility bureau</p>
River dredging subproject——environmental risk of silt transportation and temporary stacking			
During Design	Choose reasonable transportation route, avoid transportation route passing by water source protection area;	Design Institute,	LMWTC and approving

		LMWTC	Authority
During Construction	1. Allocate special personnel to strengthen maintenance and cleaning work of road surface of transportation route, clear silt dropped on road in time; 2. Silt should be covered during transportation to reduce dropping; 3. Strengthen management to limit transportation vehicle's speed, and deter rude driving;	contractor	LMWTC, Local EPB
	1. Wastewater is the leachate from silt on river bank which is stacked for transfer with less leachate, but the wastewater flow to the original river. As long as the silt is transferred in timely manner, the impact to water body is less, and Leachate to be discharged outside after sedimentation treatment and the impact to water body is less; 2. Temporary silt stacking will give off odor. To minish odor, the silt on river bank should be transferred to Lichonggou Landfill. If silt is not transferred in timely manner, it should be packed in straw bag to minish dust and odor;	contractor	LMWTC, Local EPB
Sludge management subproject——environmental risk mainly during operation			
During operation	<u>In case the static dust collector fails to operate normally and great deal of smoke and dust emit to environment:</u> 1. stop co-combustion immediately to minimize emission of smoke and dust; 2. increase the concentration of oxygen to help fully combust usually by second time infusing air; 3. increase the temperature of kiln to help fully combust; <u>In case many organic halide is contained in material and incidental combustion happens or the temperature in kiln fail to meet the standards, it will bring more Dioxin, following measures are taken:</u> to install activated carbon injection unit in smoke purifying system to inject activated carbon to absorb the Dioxin and remove Dioxin in dust collector.	LMWTC, Yufeng Group Ltd	Local EPB

4.5 Environmental Monitoring Plan

4.5.1 Monitoring Objective and Monitoring Agency

Environmental monitoring should be carried out during construction period and operation period, its objective is to fully understand the pollution trend of proposed projects in time, understand extent of environmental quality change and impact range and environmental quality trend During operation at the place of construction area, feed back information to authority in charge to provide scientific evidence for project environmental management.

Environmental monitoring during construction and operation period is executed by local environmental monitoring station entrusted by contractor or operator. The environmental monitoring stations have the national environmental quality monitoring certification and equipments are well equipped with strong capacity and they can conduct monitoring missions well.

Based on forecast result of environment impact, the sensitive receptor which is polluted obviously is used as monitoring location to monitor the pollution during construction and operation. The monitoring contents include noise environment, atmospheric environment and surface water environment. The monitoring factors are fixed based on the engineering pollution factors. The monitoring analysis method adopts the ones in Environment Monitoring Technology Specification issued by the Environment Protection Ministry. The analysis standard is the national standards identified by EA of the various subprojects.

4.5.2 Environmental Monitoring Plan during Construction and Operation and Budget

Environmental monitoring plan during construction and operation and budget refer to Table below.

Environmental monitoring includes the landfills in four counties where the sludge from the project WWTP in each county which is provided in the Table 4.15 to 4.18 below.

Table 4.7 Guantang WWTP

Monitoring period	Environmental factor	Monitoring Location (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	1: Nanzhai Village	TSP	4 periods/year, 2 days/period, 1 time/day	120	480	960	2960	Liuzhou Environment Monitoring Station
	Water quality	1 : wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	1040		
	Noise	1: Nanzhai Village	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally	120	480	960		
	Subtotal (Yuan)						1480		
Operation period (3 Years)	Environmental atmosphere	5 : Nanzhai Village, boundary of WWTP (4)	H2S.NH3.concentration of odor	4 periods/year, 1 day/period , 4 times/day	13200	52800	158400	212250	Liuzhou Environment Monitoring Station
	Water quality	3 : 500m at upper reaches where outfall of Jiaoyonggou gully to Liujiang River, about 1km at lower reaches where outfall of Jiaoyonggou gully to Liujiang River, and near to outfall of	pH.DO.COD.BOD5.NH ₃ -N, TP, TN, TSP	3 periods/year, monitoring 1 period in dry season, wet season and average season severally, 3 days/period, 1 time/day	5040	15120	45360		

		Jiaoyonggou gully to Liujiang River							
	Noise	5 : Nanzhai Village, boundary of WWTP (4)	LeqdB (A)	4 periods/year, 1 day/period , 2 times/day, and 1 time at day and at night severally	600	2400	7200		
	Sludge	1: sludge tank	Heavy metals (As.Hg.Pb.Cr.Cd. Cu)	2 periods/year, 1 day/period , 1 time/day	430	430	1290		
	Subtotal (Yuan)					70750	212250		
Total (Yuan)								215210	

Table 4.8 Shatang WWTP

Monitoring period	Environmental factor	Monitoring Location (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	7: boundary of WWTP (4).Yangliu Village, Jiangwan Village, Xinlong of Sanhe Village	TSP	4 periods/year, 2 days/period, 1 time/day	840	3360	6720	14480	Liuzhou Environmental Monitoring Station
	Water quality	1: wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	1040		
	Noise	7: boundary of WWTP (4).Yangliu Village, Jiangwan Village, Xinlong of Sanhe Village	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night	840	3360	6720		

				severally				
	Subtotal (Yuan)					7240	14480	
Operation period (3 Years)	Environmental atmosphere	5: boundary of WWTP (4).Yangliu Village	H2S.NH3.Concentration of odor	4 periods/year , 1 day/period , 4 times/day	13200	52800	158400	188250
	Water quality	1: outfall of WWTP	PH.DO.COD.BOD5.NH3-N.TP.TN.TSP. animal plant oil.petroleum.chroma.fecal coliform	Except COD is online monitoring, others are manual monitoring, 4 periods/year , 2 days/period , 1 time/day	1540	6160	18480	
	Noise	7: boundary of WWTP (4).Yangliu Village, Jiangwan Village, Xinlong of Sanhe Village	LeqdB (A)	4 periods/year , 1 day/period , 2 times/day, and 1 time at day and at night severally	840	3360	10080	
	Sludge	1: sludge tank	Heavy metals (As.Hg.Pb.Cr.Cd.Cu)	2 periods/year , 1 day/period , 1 time/day	430	430	1290	
	Subtotal (Yuan)					62750	188250	
Total (Yuan)							202730	

Table 4.9 Liucheng WWTP

Monitoring period	Environment factor	monitoring locations (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	2: Liucheng Middle Professional Technology School. Dapu No.1 Primary School	TSP	4 periods/year, 2 days/period, 1 time/day	240	960	1920	4880	Liuzhou Environmental Monitoring Station
	Water quality	1: wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	1040		
	Noise	2: Liucheng Middle Professional Technology School. Dapu No.1 Primary School	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally	240	960	1920		
	Subtotal (Yuan)						2440	4880	
Operation period (3 Years)	Environmental atmosphere	6: Boundary of WWTP (4).Liucheng Middle Professional Technology School. Dapu No.1 Primary School	H2S.NH3.Concentration of odor	4 periods/year, 1 day/period, 4 times/day	15840	63360	190080	218490	Liuzhou Environmental Monitoring Station
	Water quality	1: outfall of WWTP	PH.DO.COD.BOD5.NH3-N.TP.TN.TSP. animal and plant oil. petroleum. chroma. fecal coliform	Except COD is online monitoring, others are manual monitoring, 4 periods/year, 2 days/period, 1 time/day	1540	6160	18480		

	Noise	6 : Boundary of WWTP (4).Liucheng Middle Professional Technology School. Dapu No.1 Primary School	LeqdB (A)	4 periods/year , 1 day/period , 2 times/day, and 1 time at day and at night severally	720	2880	8640		
	Sludge	1: sludge tank	Heavy metals (As.Hg.Pb.Cr. Cd.Cu)	2 periods/year , 1 day/period , 1 time/day	430	430	1290		
	Subtotal (Yuan)						72830		
Total (Yuan)								223370	

Table 4.10 Rongshui WWTP

Monitoring period	Environmental factor	monitoring locations (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	9 : Boundary of WWTP (4).Sujia Village,Yatou Village. Dali Village. Jiangbin garden (west of 1# pumping station) .residential point of Rongshui town (south of 2# pumping station)	TSP	4 periods/year , 2 days/period, 1 time/day	1080	4320	8640	18320	Liuzhou Environmental Monitoring Station
	Water quality	1 : wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year , 1 day/period, 1 time/day	130	520	1040		
	Noise	9 : Boundary of WWTP (4).Sujia Village,Yatou Village. Dali Village,	LeqdB (A)	4 periods/year	1080	4320	8640		

EMP

		Jiangbin garden (west of 1# pumping station) .residential point of Rongshui town (south of 2# pumping station)		, 1 day/period, 2 times/day, and 1 time at day and at night severally					
	Subtotal (Yuan)					9160	18320		
Operation period (3 Years)	Environmental atmosphere	4: boundary of WWTP (4)	H2S.NH3.Concentration of odor	4 periods/year, 1 day/period, 4 times/day	10560	42240	126720	155130	
	Water quality	1: outfall of WWTP	PH.DO.COD.BOD5.NH3-N.TP.TN.TSP. animal and plant oil.petroleum.chroma.fecal coliform	Except COD is online monitoring, others are manual monitoring, 4 periods/year, 2 days/period, 1 time/day	1540	6160	18480		
	Noise	9: boundary of WWTP (4).Sujia Village,Yatou Village.Dali Village, Jiangbin garden (west of 1# pumping station) .residential point of Rongshui	LeqdB (A)	4 periods/year, 1 day/period, 2	1080	4320	8640		

		town (south of 2# pumping station)		times/day, and 1 time at day and at night severally					
	Sludge	1: sludge tank	Heavy metals (As.Hg.Pb.Cr.Cd.Cu)	2 periods/year , 1 day/period, 1 time/day	430	430	1290		
	Subtotal (Yuan)					53150	155130		
Total (Yuan)								173450	

Table 4.11 Rong'an WWTP

Monitoring period	Environmental factor	monitoring locations (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	10: Boundary of WWTP (4).Shangpengchong village of Hongwei Village. Dormitory of food supplies bureau. Residence near 1# pumping station. residence near 2# pumping station.Beifu Village (near 3# pumping station)	TSP	4 periods/year, 2 days/period, 1 time/day	1200	4800	9600	20240	Liuzhou Environmental Monitoring Station
	Water quality	1: wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	1040		
	Noise	10: Boundary of WWTP (4).Shangpengchong	LeqdB (A)	4	1200	4800	9600		

		village of Hongwei Village. Dormitory of food supplies bureau. Residence near 1# pumping station. residence near 2# pumping station.Beifu Village (near 3# pumping station)		periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally				
	Subtotal (Yuan)				10120	20240		
Operation period (3 Years)	Environmental atmosphere	6: Boundary of WWTP (4).Shangpengchong village. Hongwei Village	H2S.NH3.Concentration of odor	4 periods/year, 1 day/period, 4 times/day	15840	63360	190080	224250
	Water quality	1: outfall of WWTP	pH.DO.COD.BOD5.NH ₃ -N.TP.TN.TSP. animal and plant oil.petroleum.chromatofecal coliform	Except COD is online monitoring, others are manual monitoring, 4 periods/year, 2 days/period, 1 time/day	1540	6160	18480	
	Noise	10: Boundary of WWTP (4).Shangpengchong village of Hongwei Village. Dormitory of food supplies bureau. Residence near 1# pumping station. residence near 2# pumping station .Beifu Village (near 3# pumping station)	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally	1200	4800	14400	
	Sludge	1: sludge tank	Heavy metals	2	430	430	1290	

		(As.Hg.Pb.Cr.Cd.Cu)	periods/year, 1 day/period, 1 time/day					
	Subtotal (Yuan)					74750	224250	
Total (Yuan)								244490

Table 4.12 Sanjiang WWTP

Monitoring period	Environmental factor	monitoring locations (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (2 Years)	Environmental atmosphere	12: Boundary of WWTP (4).Tantou Village .Sanjiang Ferroalloy Co., Ltd. Poweizai Village.Dazhou Village.Dazhou Primary School.Sanjiang Middle School. dormitory of food supplies bureau (east of Guyi bridge pumping station) .Forest bureau (south-west of Ershenqiao pumping station)	TSP	4 periods/year, 2 days/period, 1 time/day	1440	5760	11520	24080	Liuzhou Environmental Monitoring Station
	Water quality	1 : wastewater collection tank at construction site	pH.TSP.petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	1040		
	Noise	12: Boundary of WWTP (4).Tantou Village.Sanjiang Ferroalloy Co., Ltd..Poweizai Village.Dazhou Village.	LeqdB (A)	4 periods/year, 1	1440	5760	11520		

		Dazhou Primary School.Sanjiang Middle School. dormitory of food supplies bureau (east of Guyi bridge pumping station) .Forest bureau (south-west of Ershengqiao pumping station)		day/period, 2 times/day, and 1 time at day and at night severally				
	Subtotal (Yuan)					12040	24080	
Operation period (3 Years)	Environmental atmosphere	10: Boundary of WWTP (4).Tantou Village.Sanjiang Ferroalloy Co., Ltd..Poweizai Village.Dazhou Village. Dazhou Primary School.Sanjiang Middle School	H2S.NH3.Concentration of odor	4 periods/year, 1 day/period , 4 times/day	26400	105600	316800	353850
	Water quality	1: outfall of WWTP	pH.DO.COD.BOD 5.NH ₃ -N.TP.TN.TSP. animal and plant oil.petroleum.chroma.fecal coliform	Except COD is online monitoring, others are manual monitoring, 4 periods/year , 2 days/period , 1 time/day	1540	6160	18480	
	Noise	12: Boundary of WWTP (4).Tantou Village.Sanjiang Ferroalloy Co., Ltd..Poweizai Village.Dazhou Village.Dazhou Primary School.Sanjiang Middle School. dormitory of food supplies bureau (east of Guyiqiao pumping station) .Forest	LeqdB (A)	4 periods/year, 1 day/period , 2 times/day, and 1 time at day and at night severally	1440	5760	17280	

		bureau (south-west of Ershengqiao pumping station)							
	Sludge	1 : discharge sludge outside from sludge pool	Heavy metals (As.Hg.Pb.Cr.Cd. Cu)	2 periods/year, 1 day/period , 1 time/day	430	430	1290		
	Subtotal (Yuan)					117950	353850		
Total (Yuan)								377930	

Table 4.13 Liuzhou suburb drainage Sub-projects

Monitoring period	Environmental factor	monitoring locations (Qty)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage Expenses (Yuan)	Total (Yuan)	Monitoring agency
Construction period (years)	Environmental atmosphere	12: Liuzhou Technical School. Liuzhou Auto Transport School. Luyong High School. Liuzhou Worker's Hospital. Liuzhou No.1 Middle School .Liuzhou No.1 Professional School. Guangxi Business School. Liuzhou Minority High School. Guangxi Institute of Technology. Liuzhou No.16 Middle School. Liuzhou People's Hospital. Liuzhou Medical College		4 periods/year, 2 days/period, 1 time/day	1440	5760	28800	72240	Liuzhou Environmental Monitoring Station
	Water quality	Set 1 monitoring location respectively at outfalls of different construction sites and machinery maintenance areas, wastewater discharge points of work sheds, wastewater discharge point of concrete mixing station	pH.SS. petroleum	4 periods/year, 1 day/period, 1 time/day	130	520	2600		
	Noise	12: Liuzhou Technical School. Liuzhou Auto Transport School. Liuyong High School. Liuzhou Worker's Hospital. Liuzhou No.1 Middle School. Liuzhou No.1 Professional School. Guangxi Business School. Liuzhou	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day	1440	5760	28800		

		Ethnic High School. Guangxi Institute of Technology. Liuzhou No.16 Middle School. Liuzhou People's Hospital. Liuzhou Medical College		and at night severally				
	Subtotal (Yuan)					12040	60200	
During operation (3 years)	Environmenta l atmosphere	4: 4 pumping stations	pH.SS. petroleum	4 periods/year, 1 day/period, 1 time/day	8600	34400	103200	181360
	Water quality	2: 1 in proposed Zhuerxi Rehabilitation Section and 1 in Liujiang River	Temperature. pH.DO.COD. BOD ₅ .NH ₃ -N .TP.TN	3 periods/year, monitoring 1 period in dry season, wet season and average season severally, days/period , time/day	2100	6300	18900	
	Noise	4: 4 pumping stations	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally	860	3440	10320	
	Silt	I: for regular pipe dredging	As,Hg,Pb,Cr, Cd,Cu	2 periods/year, 1 day/period, 1 times/day	600	1200	3600	
	Subtotal (Yuan)					45340	136020	
Total (Yuan)								253600

Table 4.14 WWTP sludge treatment sub-projects

Monitoring period	Environmental factor	monitoring location (Quantity)	Monitoring item	Monitoring frequency	U/P (Yuan/Period)	Annual expenses (Yuan/Year)	Stage expenses (Yuan)	Total (Yuan)	Monitoring Agency
Construction period (1 Year)	Environmental atmosphere	5: 4 around construction site boundary, 1 in Shangdeng village	TSP	4 periods/year, 2 days/period, 1 time/day	480	1920	1920	3640	Liuzhou Environmental Monitoring Station
	Water quality	Set 1 monitoring location respectively at outfalls of construction site and machinery maintenance areas, wastewater discharge points of work sheds	pH,SS,petroleum	4 periods/year, 1 days/period, 1 time/day	150	640	640		
	Noise	5: 4 around construction site boundary, 1 in Shangdeng village	LeqdB (A)	4 periods/year, 1 day/period, 2 times/day, and 1 time at day and at night severally	280	1080	1080		
	Subtotal (Yuan)						3640	3640	
Operation period (5 Years)	Environmental atmosphere	7: Shangdeng village, Hewei village, Shangcheng village, Jieshan village, Shanwan village, Taiyang village, Chunwei village	TSP、SO ₂ 、NO ₂	4 periods/year, 1 days/period, 4 times/day	2200	8800	44000	200950	
	Water quality	1: general effluent outfall cement plant	Temperature,pH,D O,COD,BOD ₅ ,NH ₃ -N,TP,TN	3 periods/year, monitoring 1 period in dry season, wet season and average season severally,	1050	3150	15750		

EMP

				days/period, time/day					
Noise	4: around boundary of cement plant	LeqdB (A)	4 periods/year , 1 day/period , 2 times/day, and 1 time at day and at night severally	860	3440	17200			
Pollution source	1: Chimney of cement kiln	TSP,SO ₂ ,NO ₂ ,diox in , heavy metals and their compounds, HCl	4 periods/year, 2 days/period, 2 times/day(dioxin: 2 periods/year, 2 days/period, 1 times/day)	6200	24800	124000			
Subtotal (Yuan)					40190	200950			
Total (Yuan)								204590	

Table 4-15 Sanjiang County Domestic Waste Landfill

Monitoring period	Environ. Factors	Monitoring Localities (quantity)	Monitoring items	Monitoring frequencies	Unit rate (Yuan/term)	Annual cost (Yuan/year)	Interim cost (Yuan)	Total (Yuan)	Monitoring institution
Operation (5 years)	Ambient Air	3 loctions: 1 loction at the boundary of the plant upwind of the annual prevailing wind direction, 2 locations at the boundary of the plant downwind of the annual prevailing wind direction.	particulate、OER、NH ₃ 、H ₂ S、CH ₄	4terms/year, 1day/term, 4times/day	12560	50240	150720	247380 (the amount is to be paid by the owner of the Landfill) The PMO will assume the responsibility of collecting monitoring results and reporting to WB.	Qualified ESMS
	Noise	Noise at boundearies (2 locations)	LeqdB (A)	2terms/year, 1day/term, 2times/day	240	960	2880		
	Underground Water	6 locations: a background monitoring well 40m upstream of the underground flow direction of the landfill site (1 location); a drainage well at discharge; (2 pollution diffusion wells) 40m away from the landfill site, both sides; 2 pollution monitoring wells 30m and 50m	Nitrate, Nitite, Fluoride, Chloride, Bromide, Sulphate, Phosphate, Ammoniu, Na, K, Mg, Ca, Total Fe, Mn, Cu, Cd, Zn, Pb, As, Total Hg, Petroleum	3 terms/year, one in low water period, high water period and mean water period respectively, 1 day/term, 1 time/day	5880	17640	52920		

		downstream of the landfill site respectively.							
	Surface Water	3 sections	Water quantity, COD、 BOD ₅ 、 SS、 Animal oil, vegetable oil, petroleum、 Anionic Surfactant、 TN、 NH ₃ -N、 TP、 Chroma、 pH、 Fecal Coliform	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1 time/day	3280	9840	29520		
	Leachate	Discharge outlet of the leachate treatment facilities (1 location)	Chroma、 COD、 BOD ₅ 、 SS、 NH ₃ -N、 Fecal Coliform、 TN、 CrVI	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1time/day	1260	3780	11340		
	Subtotal					82460	247380		
	Total (Yuan)							247380	

Table 4-16 Rongshui County Domestic Waste Landfill

Monitoring period	Environ. Factors	Monitoring Localities (quantity)	Monitoring items	Monitoring frequencies	Unit rate (Yuan/term)	Annual cost (Yuan/year)	Interim cost (Yuan)	Total (Yuan)	Monitoring institution
Operation (5 years)	Ambient Air	3 loctions: 1 loction at the boundary of the plant upwind of the annual prevailing wind direction, 2 locations at the boundary of the plant downwind of the annual prevailing wind direction.	particulate、OER、NH ₃ 、H ₂ S、CH ₄	4terms/year, 1day/term, 4times/day	12560	50240	150720	247380 (the amount is to be paid by the owner of the Landfill) The PMO will assume the responsibility of collecting monitoring results and reporting to WB.	Qualified ESMS
	Noise	Noise at boundearies (2 locations)	LeqdB (A)	2terms/year, 1day/term, 2times/day	240	960	2880		
	Underground Water	6 locations: a background monitoring well 40m upstream of the underground flow direction of the landfill site (1 location); a drainage well at discharge; (2 pollution diffusion wells) 40m away from the landfill site, both sides; 2 pollution monitoring wells 30m and 50m	Nitrate, Nitite, Fluoride, Chloride, Bromide, Sulphate, Phosphate, Ammoniu, Na, K, Mg, Ca, Total Fe, Mn, Cu, Cd, Zn, Pb, As, Total Hg, Petrolium	3 terms/year, one in low water period, high water period and mean water period respectively, 1 day/term, 1 time/day	5880	17640	52920		

		downstream of the landfill site respectively.							
	Surface Water	3 sections	Water quantity, COD、 BOD ₅ 、 SS、 Animal oil, vegetable oil, petroleum、 Anionic Surfactant、 TN、 NH ₃ -N、 TP、 Chroma、 pH、 Fecal Coliform	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1 time/day	3280	9840	29520		
	Leachate	Discharge outlet of the leachate treatment facilities (1 location)	Chroma、 COD、 BOD ₅ 、 SS、 NH ₃ -N、 Fecal Coliform、 TN、 CrVI	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1time/day	1260	3780	11340		
	Subtotal					82460	247380		
	Total (Yuan)							247380	

Table 4-17 Rongan County Domestic Waste Landfill

Monitoring period	Environ. Factors	Monitoring Localities (quantity)	Monitoring items	Monitoring frequencies	Unit rate (Yuan/term)	Annual cost (Yuan/year)	Interim cost (Yuan)	Total (Yuan)	Monitoring institution
Operation (5 years)	Ambient Air	3 loctions: 1 loction at the boundary of the plant upwind of the annual prevailing wind direction, 2 locations at the boundary of the plant downwind of the annual prevailing wind direction.	particulate、OER、NH ₃ 、H ₂ S、CH ₄	4terms/year, 1day/term, 4times/day	12560	50240	150720	247380 (the amount is to be paid by the owner of the Landfill) The PMO will assume the responsibility of collecting monitoring results and reporting to WB.	Qualified ESMS
	Noise	Noise at boundearies (2 locations)	LeqdB (A)	2terms/year, 1day/term, 2times/day	240	960	2880		
	Underground Water	6 locations: a background monitoring well 40m upstream of the underground flow direction of the landfill site (1 location); a drainage well at discharge; (2 pollution diffusion wells) 40m away from the landfill site, both sides; 2	Nitrate, Nitite, Fluoride, Chloride, Bromide, Sulphate, Phosphate, Ammoniu, Na, K, Mg, Ca, Total Fe, Mn, Cu, Cd, Zn, Pb, As, Total Hg, Petroleum	3 terms/year, one in low water period, high water period and mean water period respectively, 1 day/term, 1 time/day	5880	17640	52920		

		pollution monitoring wells 30m and 50m downstream of the landfill site respectively.							
	Surface Water	3 sections	Water quantity, COD、 BOD ₅ 、 SS、 Animal oil、 vegetable oil、 petroleum、 Anionic Surfactant、 TN、 NH ₃ -N、 TP、 Chroma、 pH、 Fecal Coliform	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1 time/day	3280	9840	29520		
	Leachate	Discharge outlet of the leachate treatment facilities (1 location)	Chroma、 COD、 BOD ₅ 、 SS、 NH ₃ -N、 Fecal Coliform、 TN、 CrVI	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1time/day	1260	3780	11340		
Subtotal						82460	247380		
Total (Yuan)								247380	

Table 4-18 Liucheng County Domestic Waste Landfill

Monitoring period	Environ. Factors	Monitoring Localities (quantity)	Monitoring items	Monitoring frequencies	Unit rate (Yuan/term)	Annual cost (Yuan/year)	Interim cost (Yuan)	Total (Yuan)	Monitoring institution
Operation (5 years)	Ambient Air	3 loctions: 1 loction at the boundary of the plant upwind of the annual prevailing wind direction, 2 locations at the boundary of the plant downwind of the annual prevailing wind direction.	particulate、OER、NH ₃ 、H ₂ S、CH ₄	4terms/year, 1day/term, 4times/day	12560	50240	150720	247380 (the amount is to be paid by the owner of the Landfill) The PMO will assume the responsibility of collecting monitoring results and reporting to WB.	Qualified ESMS
	Noise	Noise at boundearies (2 locations)	LeqdB (A)	2terms/year, 1day/term, 2times/day	240	960	2880		
	Underground Water	6 locations: a background monitoring well 40m upstream of the underground flow direction of the landfill site (1 location); a drainage well at discharge; (2 pollution diffusion wells) 40m away from the landfill site, both sides; 2	Nitrate, Nitite, Fluoride, Chloride, Bromide, Sulphate, Phosphate, Ammoniu, Na, K, Mg, Ca, Total Fe, Mn, Cu, Cd, Zn, Pb, As, Total Hg, Petroleum	3 terms/year, one in low water period, high water period and mean water period respectively, 1 day/term, 1 time/day	5880	17640	52920		

		pollution monitoring wells 30m and 50m downstream of the landfill site respectively.							
	Surface Water	3 sections	Water quantity, COD、 BOD ₅ 、 SS、 Animal oil、 vegetable oil、 petroleum、 Anionic Surfactant、 TN、 NH ₃ -N、 TP、 Chroma、 pH、 Fecal Coliform	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1 time/day	3280	9840	29520		
	Leachate	Discharge outlet of the leachate treatment facilities (1 location)	Chroma、 COD、 BOD ₅ 、 SS、 NH ₃ -N、 Fecal Coliform、 TN、 CrVI	3 terms/year, one in low water period, high water period and mean water period respectively, 3 days/term, 1time/day	1260	3780	11340		
Subtotal						82460	247380		
Total (Yuan)								247380	

4.6 Environmental Management Training

4.6.1 Training objective

Environment capacity building training is a part of technical support of project. In order to ensure a smooth and effective implementation of environment management work, it must carry out training of EMP and other related knowledge, skills for working personnel of PO/PIU, operation unit, competent authority, contractor, engineering supervisor, local project management office and EP bureau, also carry out different training for different posts.

4.6.2 Training contents

Training is organized for contractors and their site environmental staffs, team chief, environmental supervision engineers, PIU, operation agency and their environmental staff, refer to Table 4.19

Table 4.19 Training plan of environment protection

Trainee	Training Contents	Number of Participants	Time (day)	Cost (ten thousands RMB)
contractors and their site environmental staffs, team chief	Mitigating measures during construction as per EMP, post safety	2 for each construction section	4	30
	Simple monitoring methods(self monitoring) and control measures for noise during construction	2 for each construction section	1	
environmental supervision engineers	Relevant measures and requirements in EMP; EP laws and regulations. Construction planning and supervision implementation rules	1-2 for each construction section	1	8
	Environmental atmosphere monitoring and control technology, noise monitoring and control technology	1-2 for each construction section	1	
PIU/PO/operators* and their environmental staff	Above-mentioned contents, measures during operation in EMP, EP facility operation and maintenance	Some	3	72
Total		/	10	110

* PMO/PO/Operators for all subprojects are LMWTC plus Yufeng cement plant for sludge treatment.

4.7. Environment Reporting System

PO, Contractor, engineering supervision unit and PMO, during implementation of project, should record progress of project, implementation status of EMP, result of environmental quality monitoring and so on and report to concerned departments in time with objective to ensure the implementation of requirements and measures of EMP, discover issues in time, analyze and summarize issues so as to control disadvantaged influence in consequent work.

The reporting system includes the following 3 levels:

- 1) Engineering supervision unit and contractors: make particular records in monthly supervision report against implementation of EMP and measures, and report to PO and PMO in time;
- 2) Environmental monitoring unit: carries out monitoring work as per monitoring plan, make brief explanation to data, whether meet the applicable standards or not, explain the existing

problems and reason of non-compliance, and propose countermeasures;

3) PMO: prepare project progress monitoring and evaluation report (semiannually), including chapter on EMP implementation;

The semi-annual EMP implementation monitoring and evaluation report (or chapter) should include following contents:

- 1) Implementation of EMP: main construction contents at this stage, implementation status of mitigation measures, existing problems and causes, countermeasures at next step;
- 2) Result of environmental monitoring and explanation, compliant or not, existing problems and causes, and suggested countermeasures;
- 3) Implementation status of training plan, existing problems and causes, and suggested countermeasures;
- 4) Whether public complaint or not, if occurrence, record main contents of complaint, solutions and degree of public satisfaction;
- 5) EMP implementation action plan for next half year.

Project owner, during implementation of project, will require contractor, supervision party and environmental monitoring unit to report actual situations and environmental pollution events occurred against different stages of project to project owner and local EPB in time.

To secure the effective operation of environment management system, a recording system must be established, and following information should be maintained: environmental staffing of PO and contractors, mitigating measures taken during construction and operation, implementation and its effect of environment management training, environmental monitoring data during construction and operation, environment incident and how it is handled, social supervision.