REPUBLIC OF INDIA
GOVERNMENT OF JHARKHAND,
DEPARTMENT OF DRINKING WATER AND SANITATION
RANCHI MUNICIPAL CORPORATION

PREPARATORY SURVEY ON RANCHI SEWERAGE PROJECT

FINAL REPORT (MAIN REPORT)

September 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

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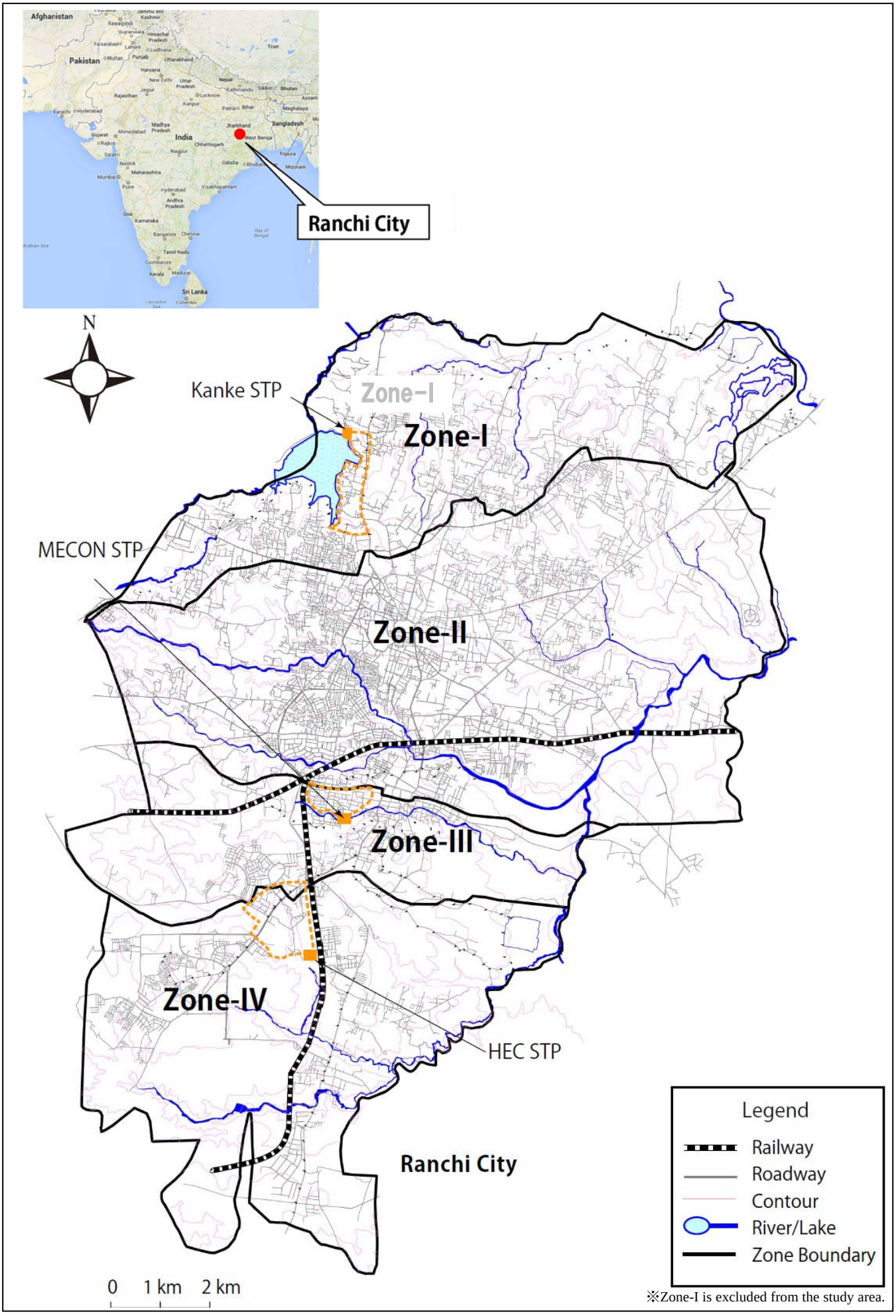


Location Map

PREPARATORY SURVEY ON RANCHI SEWERAGE PROJECT
FINAL REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAO	Assistant Accounts Officers
ADB	Asian Development Bank
AHS	Annual Health Survey
AO	Accounts Officers
ALRI	Acute Lower Respiratory Infection
ATP	Affordability to Pay
B/C	Benefit / Cost ratio
BOD	Biochemical Oxygen Demand
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
BOT	Build-Own-Transfer
CAPEX	Capital Expenditure
CAS	Conventional Activated Sludge
CAS	Condition Assessment Survey
C&I's	Criteria and Indicators
CDO	Community Development Officer
CDP	City Development Plan
CEO	Chief Executive Officer
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPI	Consumer Price Index
DCI	Ductile Cast Iron
DEAS	Double Entry Accounting System
DF	Director Finance
DFR	Draft Final Report
DPR	Detailed Project Report
DSR	Delhi Schedule of Rates
DVC	Damodar Valley Corportion
DWC	Double Walled Corrugated
DWSD	Drinking Water and Sanitation Department
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
FDI	Foreign Direct Investment
FE	Field Engineers

FR	Final Report
FIDIC	Federation Internationale des Ingenieurs-Conseils
	(International Federation of Consulting Engineers)
GDP	Gross Domestic Product
GIS	Geographical Information System
GL	Ground Level
GoI	Government of India
GPS	Global Positioning Systems
HEC	Heavy Engineering Corporation
HIG	High Income Group
HRD	Human Resource Development
HRM	Human Resource Management
HUDCO	Housing and Urban Development Corporation Limited
IBRD	International Bank for Reconstruction and Development
IBT	Increasing Block Tariff
ICR	Inception Report
IEC	Information Education Communication
IHDS	Indian Human Development Survey
IMR	Infant Mortality Rate
IP	Intersection Point
IRC	Indian Road Congress
IRC	Indian Road Congress
IT	Information Technology
ITR	Interim Report
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JSEB	Jharkhand State Electricity Board
JSPCB	The Jharkhand State Pollution Control Board
JSR	Jharkhand Schedule of Rates
JUIDCO	Jharkhand Urban Infrastructure Development Company Limited
LIG	Low Income Group
LO	Legal Officer
L/A	Loan Agreement
M/M	Man Month
MIG	Middle Income Group
MIS	Management Information System
MISO	Management Information System Officer

MOEF	Ministry of Environment and Forests
MORD	Ministry of Rural Development
MOUD	Ministry of Urban Development
MS	Micro Soft
NAC	Notified Areas Committees
NPV	Net Present Value
NERUDP	North Eastern Region Urban Development Programme
NGO	Non-governmental Organization
NRCB	National Capital Region Planning Board
NRW	Non Revenue Water
OA	Office Assistants
O&M	Operation and Maintenance
O&G	Oil and Grease
ODA	Official Development Assistance
PAHO	Pan American Health Organization
PD	Project Director
PIU	Project Implementation Unit
PM	Project Manager
PM	Particulate Matter
PMC	Project Management Consultancy
PO	Procurement Officer
PPP	Public-Private Partnership
PPR	Preliminary Project Report
PRIs	Panchayati Raj Institutions
PS	Pumping Station
R&R	Resettlement and Rehabilitation
RIADA	Ranchi Industrial Area Development Authority
RMC	Ranchi Municipal Corporation
R&R	Rest & Recuperation
RRDA	Ranchi Regional Development Authority
SAPROF	Special Assistance for Project Formulation
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control And Data Acquisition
SC	Steering Committee
SCF	Standard Conversion Factor
SCs	Schedule Castes
SIA	Social Impact Assessment

SISS	Sulabh International Social Service
SPS	Sewage Pumping Station
SPVs	Special Purpose Vehicles
SS	Suspended Solid
STP	Standard Penetration Test
STPs	Sewage Treatment Plants
STs	Schedule Tribes
TA	Technical Assistance
TBM	Temporary Bench Mark
TCPO	Town and Country Planning Orgnization
TNA	Training Needs Assessment
UASB+FPU	Up-flow Anaerobic Sludge Blanket + Final Polishing Unit
UDD	Urban Development Department
UFW	Unaccounted For Water
ULBs	Urban local Bodies
UPA	Urban Poverty Alleviation
U5MR	Under Five Mortality Rate
VAT	Value Added Tax
WSP	Waste Stabilization Method
WSS	Water Supply and Sanitation
WSSW	Water Supply and Sewerage Wing
WTP	Water Treatment Plant

CHAPTER I INTRODUCTION

1.1 Background

In recent years, sewage generation and disposal are significantly increasing due to the rapid growth in population and increase in water demand requirements, which are associated with industrialization in urban areas in India. Meanwhile, the present capacity of the sewage treatment facilities in the whole country is still inadequate, serving only approximately 30% of the total sewage disposal as of 2009. In a similar manner, accessibility to sanitary facilities is still at a low rate of approximately 35%, as of 2011.

As a result, contamination of surface water and groundwater has been worsening the sanitary conditions and living environment in urban areas. In addition, sewerage service providers have been experiencing difficulties in the promulgation of households to be connected to the system, inefficiency in tariff collection, lack of skilled personnel, and necessity for strengthening the technical and financial structures for a sustainable operation and maintenance (O&M) system.

Under such conditions, the Central Government of India established a target to promulgate sewerage and sanitary facilities to all households in the urban areas, as proposed in the 12th Five-Year Plan (May 2012 to March 2017). Particularly, the provision and extension of sewerage facilities to protect the water resources that are being used for public water supply have been carried out extensively. At the same time, the reuse of water from treated sewage has also been taken into consideration.

The proposed study area is Ranchi City, which is the capital city of Jharkhand State. It is located in the eastern part of India and has a population of 1,100,000, as of 2011. The poverty ratio in this state, as of 2010, was reported at 31.1%, which is much higher than that of the national average of 20.9%. Ranchi City has not yet been provided with a public sewerage system consisting of sewerage pipe reticulation and sewage treatment plant, except for U-drains provided along the streets that are being used for discharging both rainwater and wastewater into downstream rivers.

Relative to the increase in population of Ranchi City, water consumption has been increasing along with the provision of new water supply facilities, resulting in the increase in generation of sewage water being discharged into the streams and rivers. Thus, the pollution load in rivers has increased, bringing about environmental deterioration as well as health damages to the residents. Therefore, the establishment of a public sewerage system is urgently required.

Under such circumstances, the establishment of a sewerage system in Ranchi City was requested by the Central Government of India to the Japan International Corporation Agency (JICA) through the “rolling plan” in June 2013. JICA, having as one of its main development policies the provision of industrial and urban infrastructure, has decided to support the provision of a sewerage system in Ranchi City. This aims to improve public sanitary

conditions, enhance living standards, and mitigate water pollution of the rivers in and around the city.

Subsequently, JICA decided to carry out the Preparatory Survey on Ranchi Sewerage Project, as agreed between Ranchi Municipal Corporation (RMC) and JICA in October 2013. The objective of this preparatory survey is to appraise whether the proposed project will be justifiable and sustainable as a Japanese yen loan project under official development assistance (ODA). This objective will be achieved by studying the project in terms of technical aspects, estimated project cost, implementing organization and government, O&M structure, and social and environmental considerations.

This final report has been compiled based on the results of the study from the end of January 2014 until the beginning of August 2014. The basic policy of this preparatory study was to comply with the existing detailed project report (DPR) which was approved by the Central Government of India in 2013. However, a lot of modification on the technical aspects has been carried out in the course of the survey, which was particularly due to the serious environmental problems. The compiled final report will be submitted to RMC and Jharkand State government in October 2014.

1.2 Study Area

The location map of the study area of the Preparatory Survey on Ranchi Sewerage Project is shown in the opening page of this final report.

1.3 Scope of Works for the Preparatory Survey

The principle items of the scope of works are as follows:

(1) Collection of Basic Information
(2) Review of Existing Plan
(3) Site Condition Survey
(4) Determination of Project Scope
(5) Preliminary Facility Design
(6) Preliminary Cost Estimate
(7) Procurement Plan
(8) Environmental and Social Consideration
(9) Project Implementation Schedule
(10) Project Implementation and O&M System
(11) Organization Improvement Program
(12) Financial Analysis
(13) Project Evaluation

1.4 RMC Counterpart Team and the JICA Study Team Members

(1) RMC Counterpart Team:

1)	Organization Management	Mr. Sri Om Prakash Sah, Dy. CEO
2)	Sewerage and Drainage System	Mr. Sri Vijay Kumar Bhagat, Superintendent
3)	Operation and Maintenance Planning	Mr. Sri Anil Kumar, Executive Engineer
4)	Economic/Financial/Procurement Planning	Mr. Sri Prakash Singh, C.A. JNNURM

(2) JICA Study Team:

1)	Team Leader/Sewerage Planning	Mr. Keisuke Okazaki
2)	Organization Strengthening/Community Enlightenment	Mr. Sandeep Jagota
3)	Sewerage Facility Plan A (Sewerage Treatment Plant)	Mr. Kazuyoshi Takahashi
4)	Sewerage Facility Plan B (Sewerage and Drainage Facility)	Mr. Isao Tanabe
5)	Site Condition Survey	Mr. Taisuke Watanabe
6)	Electrical/Mechanical Facility Planning	Mr. Kenichiro Sugiura
7)	Procurement Planning and Cost Estimate	Mr. Hidehisa Tamura
8)	Economic and Financial Analysis	Mr. Takeshi Murakami
9)	Operation and Maintenance Planning/Public Health	Mr. Masahide Hanabusa
10)	Environmental and Social Considerations	Mr. Shinsuke Sato

CHAPTER II EXISTING CONDITIONS OF THE PROJECT SITE

2.1 Natural Conditions of the Study Area

Ranchi City, the capital city of the newly formed Jharkhand State, is known for its rich deposits of mineral, water falls, rivers, streams, lakes, dams, and forests. Ranch City is situated on the Chotanagpur Plateau located at 23° 22' north latitude and 85° 20' east longitude.

As per the census survey of India 2011, Ranchi City has a population of 1,073,440, making it the 37th largest urban city in India and third largest city in Jharkhand after Jamshedpur and Dhanbad. The city witnessed a sudden surge in population after the declaration of the new state of Jharkhand in 2000.

In order to investigate the natural conditions of the study area, the JICA Study Team reviewed the existing data and conducted field surveys including topographic, geotechnical, meteorological, hydrological, and water quality surveys.

2.1.1 Topographic Conditions

The general topography of Ranchi City, which is spread over an area of 175 km^2, is sloping from west to east-southeast. The city's altitude varies from MSL+640 m in the east-southeast to +700 m MSL in the west-northwest.

Many hills in the study area have altitudes above +700 m MSL, and two hills, which are conspicuous in a position of superior prominence of Ranchi City, are the Tagore and Morabadi hills on the northern margin and western margin of the city, respectively. The other major hills in the city are Bariatu Hill in the north-east and Gonda Hill in the northern margin of the city.

The area is dissected by rivers with various segments. The southern and eastern boundaries follow the shape of the Subarnareka River flowing towards the north. The north part of project area which accounts for 20% of the area slopes towards the north leading to the Potpoto River.

2.1.2 Meteorological Conditions

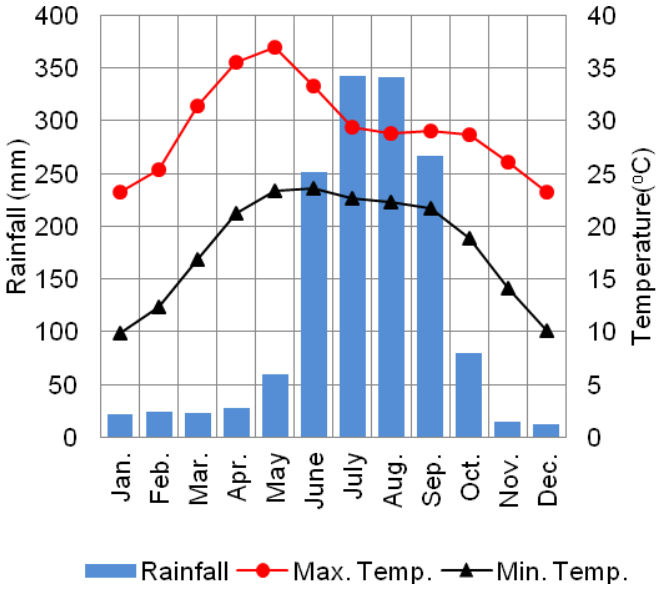
Ranchi City is located in a subtropical zone that experiences three seasons, i.e., monsoon season from June to September, winter season from October to February, and summer season from March to May.

(1) Temperature

The temperature during monsoon ranges from 21 ℃ to 34 ℃. With the onset of winter in

October, the temperature falls continuously till February recording a minimum of 10 ℃. December and January are the coldest month. March onwards summer season starts and the temperature rises recording a maximum temperature of 37 ℃.

The mean annual rainfall is around 1,500 mm. About 80% of the annual rainfall is recorded during the monsoon season due to the strong effects of monsoons, while about 20% of the total annual rainfall is observed during the summer and winter seasons. The mean monthly rainfall is about 340 mm in July and 12 mm in December. The mean monthly maximum and minimum temperatures and the mean monthly rainfall are shown in Figure 2.1.1.



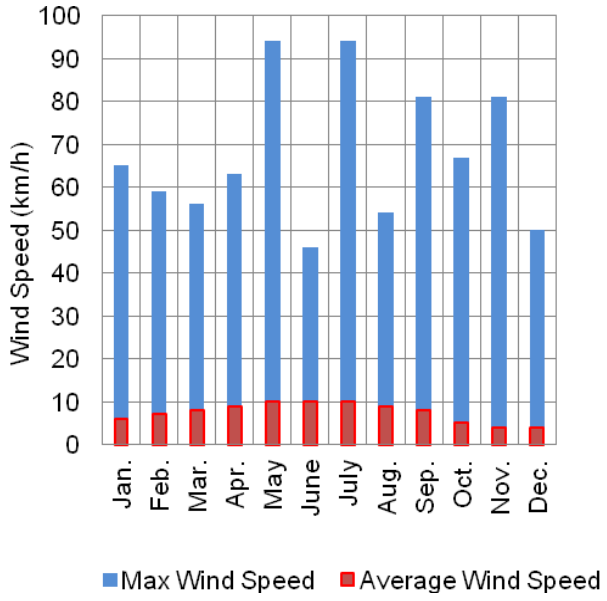
Source: Ministry of Earth Sciences, Government of India

Figure 2.1.1 Mean Monthly Maximum and Minimum Temperatures and Total Rainfall

(2) Humidity, Wind Speed

The relative humidity is generally high in the monsoon season with the maximum humidity of 85%, while the rest of the year, the air is generally dry and the summer season is the driest season with the minimum humidity of 27%.

The annual average of wind speed is 6.4 km per hour. Even in the monsoon season, winds are normally light to moderate with wind speed of 8.1 km per hour and wind direction from northwest to west. The average daily wind speed and maximum recorded sustained wind speed for each month are shown in the figure below.



Source: DPR

Figure 2.1.2 Average and Maximum Wind Speed

2.1.3 Geology and Geography

Ranchi City is located in the Ranchi Plateau, which is a part of Chota Nagpur Plateau. It is composed of Precambrian rocks formed over 600 million years ago. It has vast mineral resources like mica rock, bauxite, copper, limestone, iron ore, and coal.

Archean metamorphic rocks have been formed into lateritic soil due to exposure to high temperature and rainfall. Therefore, the two main soil structures below ground surface are laterite and Archean schists.

(1) Existing DPR Data

According to the DPR, a total of 20 boreholes were drilled on layers of rock fragments in all parts of Ranchi City. In addition, standard penetration and sampling tests were also conducted. The location map, borehole log, and sampling test result are shown in Appendix A1.

In general, the surface layer in Ranchi City, from GL 0 m to GL -4 m, is composed of yellowish silty clay/clayey silt where the N-value is less than 5. The second layer, which is yellowish red silty clay/clayey silt with gravel/clayey silt with rock, lies within GL -10 m. N-value varies from 10 to over 50 in proportion to the gravel or rock content.

(2) In-situ Test Result

Standard penetration and sampling tests was conducted by the JICA Study Team at the proposed construction site of Pumping Station No.1 with two boreholes, Pumping Station

No.2 with two boreholes, railway crossing with two boreholes, and at the Sewage Treatment Plant for Zone II (STP-II) with four boreholes. Location map, boring log, and sampling test result are shown in Appendix A1.

At Pumping Station No.1 site, stratum is mainly composed of three layers such as clayey sand, silty sand, and weathered rock. The undisturbed sample was taken in clayey sand layer (γ =2 g/cm^3, C= 0.4 kg/cm^2, ϕ =15°). From the result, it was found that the Pumping Station No.1 site is located in the stiff ground in which the rock layer with N-value over 100 spreads under 3 m and suitable for the planned construction site.

At Pumping Station No.2 site, stratum is mainly composed of four layers such as surface soil, clayey silt, clayey sand, and weathered rock. The undisturbed sample was taken in clayey silt layer (γ =2 g/cm^3, C= 0.3 kg/cm^2, ϕ =17°). From the result, it was found that the Pumping Station No.2 site is located in the stiff ground in which the rock layer with N-value over 100 spreads under 11 m and suitable for the planned construction site.

At the railway crossing, stratum is mainly composed of four layers such as surface soil, clayey silt, silty sand, and weathered rock. The undisturbed sample was taken in clayey silt layer (γ =2 g/cm^3, C= 0.4 kg/cm^2, ϕ =13°). From the result, it was found that the railway crossing site is located in the stiff ground in which the rock layer with N-value over 100 spreads under 7 m and groundwater level is under 9 m. The pipeline is planned to be constructed under the railway with trenchless method by vertical shaft burrowing through 6 m. Therefore, it is immune to water immersion in the shaft and minimize the construction cost without sheet pile driving and soil improvement work.

At the STP-II site, stratum is mainly composed of two layers such as clayey silt and weathered rock. The undisturbed sample was taken in clayey silt layer (γ =1.9 g/cm^3, C= 0.3 ～1.0 kg/cm^2, ϕ =2～18°). From the result, it was found that STP-II site is located in the stiff ground in which the rock layer with N-value over 100 spreads under 5 m and suitable for the planned construction site.

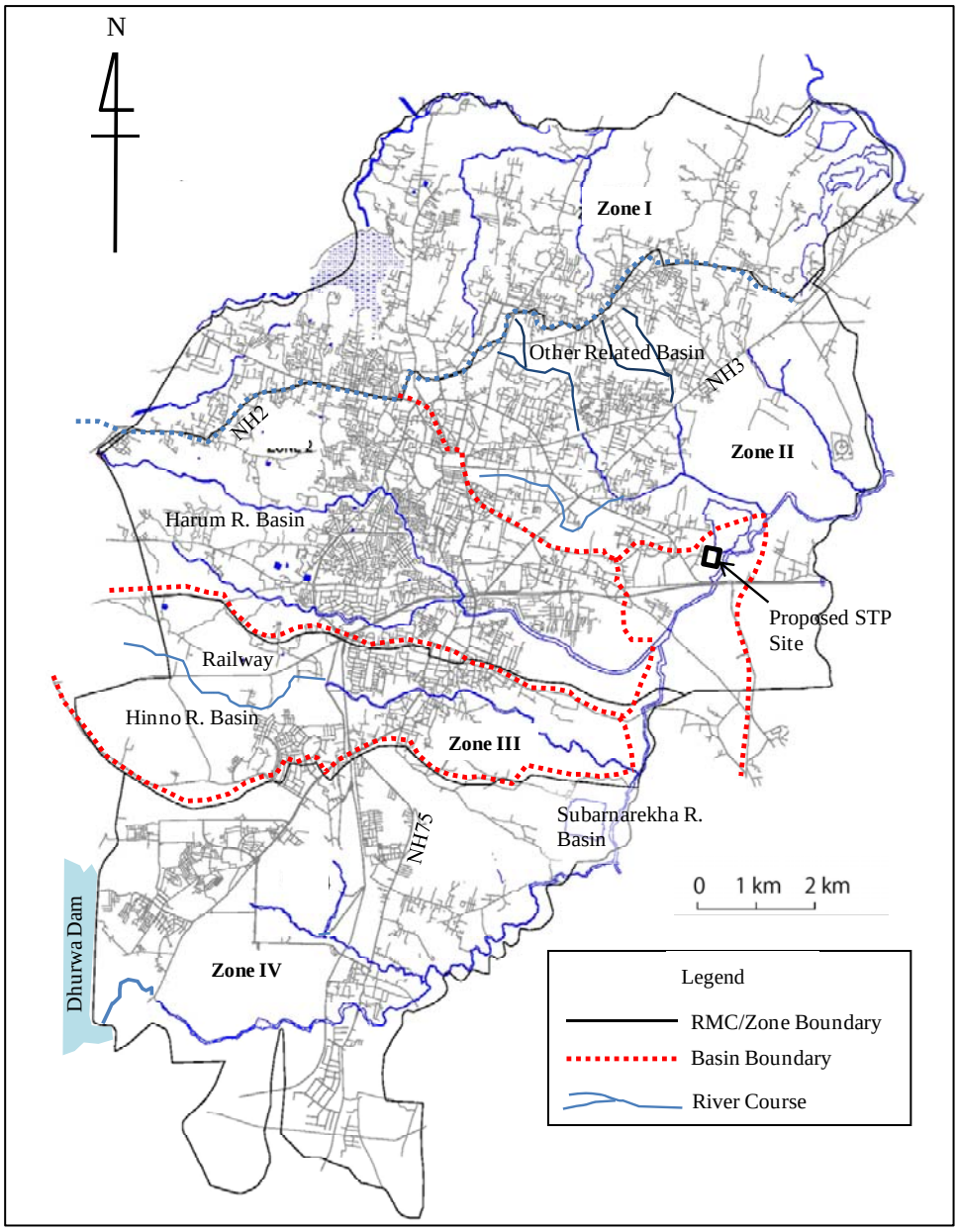
2.1.4 River, Hydrology, and Hydrogeology

(1) River and Hydrology

The main three rivers in Ranchi City are the Harum River, Hinoo River, and Subarnareka River that run in parallel from west to east. Both the Harum and Hinoo rivers join the Subarnareka River in the downstream. The catchment areas of the Harum River and Hinno River are 35 km^2 and 31 km^2 at their confluences with the Subarnarehka River, respectively. The catchment area of the Subarnarehka River is 153 km^2 at the proposed STP-II. The longitudinal slope of the Harmu River and Hinno River varies from 1/100 to 1/200 and that of the Subarnarekha River is approximately 1/300. The major river basin areas are shown in

Figure 2.1,4.

Almost all the main roads in Ranchi City are located on the hill crest of the watershed. Therefore, the water on the road generally drained smoothly. However, moderate to high floods occasionally occur in some areas of the riverside due to heavy rain, and there are some puddles of wastewater and rain water in the depressed areas.



Source: DPR

Figure2.1.3 River Basin in the Study Area

(2) Hydrogeology

The geology of Ranchi City is of lateritic terrain and granite gneiss terrain. In these terrains, two types of aquifers are found, namely, weathered aquifer and fractured aquifer. Groundwater occurs under unconfined conditions in weathered aquifers and under confined

conditions in fractured aquifers.

There are also shallow and deep aquifers. Shallow aquifers are tapped through dug wells and hand pumps. The thickness of aquifers varies from 5 m to 20 m. However, many dug wells in lateritic terrain dry up during the summer season and hand pumps are generally used to tap first fractured aquifers that are found at depths of 30 m-40 m. In granitic gneiss terrain, the first fractured aquifer is found between depths of 50 m and 70 m while the second fractured aquifer is found between the depths of 100 m and 120 m.

Ranchi City falls on an area categorized as moderate to limited yield prospect. The groundwater level of deep aquifers in Ranchi City is in a decreasing trend. On the other hand, groundwater is mainly used for domestic and irrigation purposes. Many households in the study area have their own wells as these are more reliable sources for domestic use than the public water supply system. The existing groundwater quality in Ranchi City is shown in Table 2.1.1. The groundwater quality is generally potable as per the drinking water specifications of the Bureau of Indian Standards (BIS 10500:2004).

Table 2.1.1 Existing Groundwater Quality in Ranchi City (2007)

Item	Unit	Detection Result	Desirable Limit (BIS 10500: 2004)
Electrical Conductivity	micro S/cm	325	-
pH	mg/l	8.1	6.5 -8.5
HCO_3	mg/l	79	-
Cl	mg/l	40	1000
SO_4	mg/l	25	400
NO_3	mg/l	20	100
F	mg/l	0.3	1.9
Ca	mg/l	33	200
Mg	mg/l	6	100
Hardness ($CaCO_3$)	mg/l	108	600
Na	mg/l	25	-
K	mg/l	1.5	-

Source: Ground Water Information Booklet 2009, Ministry of Water Resources

2.1.5 Water Quality of Rivers

River water is contaminated with wastes from residential areas, production factories, and so on. Water quality tests were conducted by the JICA Study Team on main rivers and canals in Ranchi City through sampling and laboratory tests twice a year in March, which is the end of summer season, and June, which is the onset of monsoon season. The sampling point is shown in Appendix A1.

The surface water standards are shown in Tables 2.1.2. Water quality levels are classified into five classes depending on water use and type of treatment.

Location map of the water sampling point and water sampling test results in March and June are shown in figure 2.1.4, Tables 2.1.3, and Table 2.1.4, respectively. In general, the water sampling test result in monsoon season is relatively smaller than the summer season. However, the actual results show some values in monsoon season higher than the rainy season and does not show any clear trend between these two seasons due to delay in the approach of monsoon from June to July.

The values of the test results exceeded those in the standard levels for several test items such as BOD, coliform bacteria count, total nitrogen, ammonia nitrogen, oil, and grease.

Table 2.1.2 Surface Water Quality Standards

No.	Item	Unit	Surface Water Quality Standards (IS 2296)				
			A	B	C	D	E
1	Temperature	Degree	-	-	-	-	
2	pH	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
3	BOD	mg/l	2	3	3	-	-
4	COD	mg/l	-	-	-	-	-
5	Total Suspended Solid (SS)	mg/l	-	-	-	-	-
6	Coliform Bacteria Count	-	50	500	5000	-	-
7	Normal Hexane Extract	mg/l	-	-	-	-	-
8	Total Nitrogen	mg/l	20	-	-	-	-
9	Ammonia Nitrogen	mg/l	-	-	-	1.2	-
10	Phosphorous	mg/l	-	-	-	-	-
11	Phenol Content	mg/l	0.002	0.005	0.005	-	-
12	Copper	mg/l	1.5	-	1.5	-	-
13	Iron	mg/l	0.3	-	50	-	-
14	Chromium	mg/l	0.05	1	0.05	-	-
15	Cyanide	mg/l	0.05	0.05	0.05	-	-
16	Cadmium	mg/l	0.01	-	0.01	-	-
17	Arsenic	mg/l	0.05	0.2	0.2	-	-
18	Mercury	mg/l	0.001	-	-	-	-
19	Hydrocarbon	mg/l	0.2	-	-	-	-
20	Chloride	mg/l	-	-	-	-	600
21	Sulphate	mg/l	400	-	400	-	1000
22	Nitrate	mg/l	20	-	50	-	-
23	Lead	mg/l	0.1	-	0.1	-	-
24	Nickel	mg/l	-	-	-	-	-
25	Oil and Grease	mg/l	-	-	0.1	0.1	-

Source: JICA Study Team, Indian Surface Water Quality Standards, IS: 2296-1982

Note:

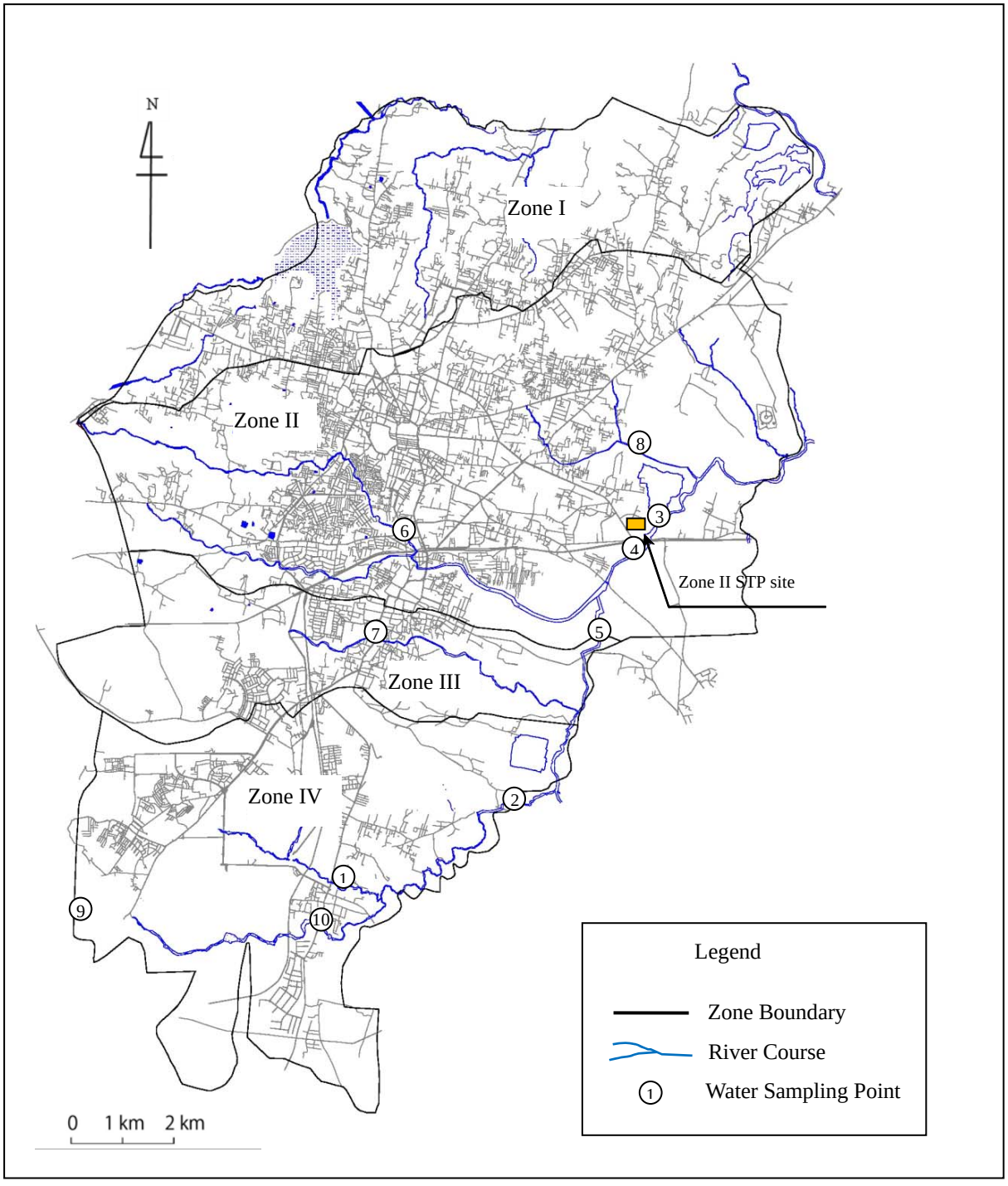
Class A: Drinking water source without conventional treatment but after disinfection

Class B: Outdoor bathing

Class C: Drinking water source with conventional treatment

Class D: Fish culture and wildlife propagation

Class E: Irrigation, industrial loading, or controlled waste disposal



Source: JICA Study Team

Figure 2.1.4 Location Map of Water Sampling Point

Table 2.1.3 Water Sampling Test Results in March (Summer Season)

Sample No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Location	Bridge near NIFT	Zone III&IV STP Site	Zone II STP Site Upstream	Zone II STP Site Downstream	Maua Toli Bridge	Bridge near Raddison Hotel	Bridge near Hotel Emerald	Lowadi Basti	Dhurwa Dam	Hatia Bridge
Temperature	20	20	20	21	20	21	21	20	20	20
pH	6.94	6.93	7.34	7.39	7.33	7.05	7.25	7.34	7.8	6.92
BOD	9.4	4.7	14	6.5	5.2	226	26	22	2.3	4.2
COD	37.8	16.8	54.6	25.2	21	756	105	88.2	8.4	16.8
Total Suspended Solids	28	34	14	18	12	192	68	47	< 5.0	86
Coliform Bacteria Count	1200	1260	4200	2600	1800	13400	8200	6200	120	1200
Normal Hexane Extract	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	14.96	18.02	21.08	18.02	10.88	68	44.8	35.02	< 1.0	6.12
Ammoniacal Nitrogen	6.16	7.84	11.76	10.08	5.04	44.8	31.92	25.76	< 1.0	2.8
Phosphorous	3.9	4.2	3.5	4.5	3.7	6.3	5.9	5.3	< 0.1	2.6
Phenol content	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Iron	0.35	0.48	0.75	0.82	0.42	1.05	0.78	0.95	0.11	0.13
Chromium	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cyanide	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cadmium	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Hydrocarbon	-	-	-	-	-	-	-	-	-	-
Chloride	30.4	60.8	95.3	97.3	50.7	212.9	81.1	170.3	16.2	14.2
Sulphate	21.5	38.6	59.8	73.6	43.2	172.3	64.3	110.8	9.8	11.7
Nitrate	3.8	5.9	4.2	6.3	4.5	15.7	7.3	12.7	0.64	0.83
Lead	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oil and Grease	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	11	5.2	< 4.0	< 4.0	< 4.0

Source: JICA Study Team

Note: Unit of test result is mg/L

Table 2.1.4 Water Sampling Test Results in June (Monsoon Season)

Sample No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Location	Bridge near NIFT	Zone III&IV STP Site	Zone II STP Site Upstream	Zone II STP Site Downstream	Maua Toli Bridge	Bridge near Raddison Hotel	Bridge near Hotel Emerald	Lowadi Basti	Dhurwa Dam	Hatia Bridge
Temperature	26	26	26	26	26	26	26	26	26	26
pH	7	6.84	6.85	6.8	6.84	6.99	6.92	7.37	7.54	6.6
BOD	25.99	30	30	28	21	26.51	24	20	4.2	21.83
COD	89.28	93	96.72	93	70.68	85.56	78.12	66.96	14.88	70.68
Total Suspended Solids	98	210	196	190	202	70	54	24	<10	66
Coliform Bacteria Count	1800	2600	4900	3100	2000	14500	9800	7400	1600	1800
Normal Hexane Extract	19	12	11	20	-	23	17	16	-	12
Total Nitrogen	1.42	3.12	33.6	2.86	8.4	4.18	3.25	4.38	2.8	2.8
Ammoniacal Nitrogen	0.81	1.32	5.21	1.14	3.24	2.16	1.81	2.62	0.64	0.76
Phosphorous	0.06	0.13	0.21	0.14	0.14	0.66	0.37	0.36	0.02	0.27
Phenol content	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	<0.03	<0.003	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Iron	0.97	2.27	8.115	8.115	4.16	0.53	3.09	0.85	0.33	0.83
Chromium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Cyanide	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cadmium	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hydrocarbon	21.41	15.2	19.24	24.28	4.6	24.77	21.3	18.22	-	13.33
Chloride	27.4	21.52	26.48	27.4	17.61	67.51	28.37	98.82	1.54	24.47
Sulphate	24	29.13	34.62	37.36	37.36	32.56	28.45	57.41	2.06	20.57
Nitrate	7.44	2.53	4.85	5.87	<2	4.97	5.27	5.08	2.2	<2
Lead	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	21	16	20	23	3.2	25	22	17	2.11	14

Source: JICA Study Team

Note: Unit of test result is mg/L

2.2 Existing Economic and Financial Conditions

2.2.1 General Economic Conditions in India and Jharkhand State

(1) Historical Trend of Gross Domestic Product (GDP)

The economic conditions in India and Jharkhand State are examined in this section to determine the external conditions of the project. The historical trend of GDP growth rate of each sector during the last five years is summarized in Table 2.2.1. The GDP of entire India at current prices, as of August 2013, was Rs.94,610 billion, while that of Jharkhand State was Rs.1,626 billion, which corresponds to 1.7% of that of the entire country. The average growth rate of GDP at constant 2003-04 prices for the last nine years was 8.0% at the national level and 7.0% at the state level, which shows the recent robust economic strength in the region.

Table 2.2.1 Historical Trend of GDP in India and Jharkhand State

(Unit: Rs. in billions)

Indicators	2004-05	2009-10	2012-13	Average Growth Rate 2004-05 to 2012-13	
				At Current Price	At 2004-05 Price
GDP at Current Price					
Whole India	29,715	61,089	94,610	15.6%	8.0%
Jharkhand State	598	1,006	1,626	13.3%	7.0%
Share of Jharkhand State	2.0%	1.7%	1.7%		

Source: Planning Commission of the Government of India, 2014

Historical trend of sector-wise GDP is shown in Table 2.2.2. The share of the services sector is 46% followed by the industry sector (21%), and manufacturing sector (12%). In the comparison of sector-wise data for the entire country with the Jharkhand State, the sectors of industry, mining and quarrying, and manufacturing have comparatively higher share in Jharkhand State. It indicates that the industrial sector takes important role for the development in the region.

Table 2.2.2 Historical Trend of Sector-wise GDP

Sector	Entire India		Jharkhand	
	Share in 2012-13	Average Growth Rate, 2004-05 to 2012-13	Share in 2012-13	Average Growth Rate, 2004-05 to 2012-13
Agriculture and Allied	10.6%	3.7%	9.3%	5.5%
Agriculture	9.1%	3.8%	7.2%	5.8%
Industry	20.8%	7.4%	**29.1%**	4.1%
Mining and Quarrying	1.5%	3.0%	**7.9%**	7.6%
Manufacturing	11.7%	7.9%	**15.1%**	1.4%
Services	46.3%	9.6%	31.4%	11.4%
Total	100.0%		100.0%	

Source: Planning Commission of the Government of India, 2014

(2) Poverty Conditions

The trend of the percentage of population living below the poverty line and Gini coefficient are summarized in Tables 2.2.3 and 2.2.4, respectively. The percentage of population living below the poverty line decreased by approximately 7% in the entire country, and 6% in Jharkhand State, from year 2004-05 to 2009-10. It shows a significant improvement of livelihood in the area. Whereas, the Gini coefficient figure increased slightly in the same period, which means there is an increase of inequity in terms of household income.

Table 2.2.3 Historical Trend of "Below Poverty Line" (Tendulkar Methodology)

Year	1993-94	2004-05	2009-10
India	45.3%	37.2%	29.8%
Jharkhand State	-	45.3%	39.1%

Source: Planning Commission of the Government of India, 2014

Table 2.2.4 Historical Trend of Gini Coefficient

	1993-94		2004-05(MRP)		2009-10(MRP)	
	Rural	Urban	Rural	Urban	Rural	Urban
India	0.282	0.340	0.266	0.348	0.276	0.371
Jharkhand State	0.222*	0.307*	0.199	0.326	0.212	0.343

Source: Planning Commission of the Government of India, 2014
Note: * The figures in 1993-94 refer to the one of Bihar State before the separation of Jharkhand State.

2.2.2 Livelihood Conditions and Industrial Conditions in Ranchi City

Ranchi City has been playing an important role as the capital city of Jharkhand State since 2001 in the local society, as it was the center of commercial and industrial activities in the area. The overall living conditions and industrial conditions are explained hereinafter.

(1) Livelihood Conditions

The basic livelihood conditions in India, Jharkhand State, and Ranchi District are summarized in Table 2.2.5. The electrification rate in Ranchi District is 63%, and households with water supply and latrine facility are 36% and 41%, respectively. These rates show higher coverage rates than the state level, but these are 4%-8% below the national level.

The extension of coverage of basic utilities such as electricity, water supply, and drainage is inevitable for the improvement of livelihood and sustainable economic development of the local society. To enhance the coverage rate, further investments on infrastructure in Ranchi City are needed in the future, with support from the central and state governments.

Referring to the Annual Health Survey (AHS) 2011-12, which studied the education and health conditions in Jharkhand State (2,109 samples) and Ranchi District (137 samples), the results showed better conditions in the health sector compared with the national level. The infant mortality rate (IMR) is 32 out of 1,000 births which is approximately 30% lower than the national level.

Table 2.2.5 General Livelihood Conditions in Ranchi District

Indicator	Data Source	Whole India	Jharkhand State	Ranchi District
1) General Information				
- No. of Household	Census 2011	330,835,767	6,181,607	569,444
- Population	Census 2011	1,210,193,422	32,966,238	2,914,253
- Average Household Income	*IHDS 2004-05	Rs. 47,804/year	Rs. 42,022/year	N.A.
2) Available Facility in the House				
- Electricity	Census 2011	67.2%	45.8%	63.0%
- Bathroom	Census 2011	42.0%	16.5%	32.2%
- Water Service within Premises	Census 2011	43.5%	23.2%	35.8%
- Drainage	Census 2011	51.1%	29.5%	39.8%
- Latrine Facility within Premises	Census 2011	46.9%	22.0%	40.9%
3) Housing Conditions				
- Own house	Census 2011	86.6%	89.3%	82.9%
- Rented house	Census 2011	11.1%	7.7%	14.3%
4) Banking Service	Census 2011	58.7%	54.0%	65.3%
5) Education				
- Literacy Rate	Census 2011	73.0%	66.4%	65.6%
- School Attendance Rate (Age 6-17 years)	AHS 2011-12	-	91.0%	92.4%
- Work Participation Rate (15 years and above)	AHS 2011-12	-	47.8%	51.1%
6) Health Conditions				
- Infant Mortality Rate (IMR: number of deaths out of 1,000 births)	AHS 2011-12	47 (MOHFW, 2011)	38	32
- Under Five Mortality Rate (U5MR: number of deaths before age 5 out of 1000 births)	AHS 2011-12	59 (MOHFW, 2011)	55	50

Source: Census 2011, AHS (Annual Health Survey) 2011-12, IHDS (Indian Human Development Survey) 2004-05, Annual Report to the People on Health (MOHFW, 2011)

Note: * Comprehensive survey of household income has not been conducted after the IHDS 2004-05
Estimated average number of members per household in Ranchi District is 5.1, referring data of population and number of household in the Census 2011.

(2) Industrial Conditions

The area surrounding Ranchi City is famous for its natural resources like the minerals and forests. The abundance of natural resources provided support in the development of related industries in the Ranchi City area.

Under the management of the Ranchi Industrial Area Development Authority (RIADA), the development of industrial area is conducted through the provision of social utilities, arrangement of loans, selection of location, etc.

Popular companies such as Heavy Engineering Corporation (HEC), MECON, SAIL's R&D Facility, High Tension Insulator Factory, CCL, CMPDI, IICM, Usha Martin, and Usha Beltron Shipping Corporation have invested in the development of Ranchi City area, and these companies are playing an important role in the local economy.

2.2.3 Financial Conditions of Jharkhand State Government and RMC

(1) Financial Conditions of Jharkhand State Government

At present, the accounting system of Jharkhand State government is managed by cash basis and not by accrual system. The revenue and expenditure for "capital related" and "non-capital related" items are managed separately, as the amount of capital related revenue and cost tend to fluctuate each year, influenced by the progress of the infrastructure construction works.

The past financial conditions of Jharkhand State are summarized in Table 2.2.6. Out of the average total revenue amounted to Rs.194,430 million, 58% of the amount is a grant from the central government by two pipelines, namely, "Fixed Share in Central Taxes" in the "Tax Revenue" category and "Grants from the Government" in the "Non-tax Revenue" category. This indicates the high dependency of the state budget on subsidy granted by the central government.

During the fiscal year from 2008-09 to 2012-13, the average deficit of the total revenue and expenditure was Rs.35,990 million. The deficit is 12% of the total revenue. The deficit is expected to be reduced in order to achieve healthier financial conditions in the long term.

Table 2.2.6 Financial Conditions of the Jharkhand State Government

(Unit: Rs. in millions)

Items	2008-09	2009-10	2010-11	2011-12	2012-13	Average
Revenue	Actual	Actual	Actual	Actual	Actual	
(1) Tax Revenue	**91,450**	**100470**	**118,700**	**141,220**	**173,800**	**125,130**
State's Own Tax Revenue	37,460	45000	57,160	69,530	89,040	59,640
Fixed Share in Central Taxes	53,990	55470	61,540	71,690	84,760	65,490
(2) Non-tax Revenue	**40,670**	**50700**	**69,100**	**82,950**	**99,750**	**68,630**
State's Own Non-tax Revenue	19,50*	22540	28,020	30,380	34,700	28,910
Grants from the Government	21,150*	28160	41,070	52,570	65,040	46,710
(3) Non-debt Capital Receipts	**180**	**200**	**240**	**230**	**2,500**	**670**
Total Receipts (Revenue)	**132,300**	**151370**	**188,040**	**224,400**	**276,050**	**194,430**
Expenditure						
(4) Revenue Expenditure	**12,8,750**	**151270**	**179,430**	**209,910**	**277,530**	**189,380**
Plan Expenditure	38,120	37580	60,030	76,460	112,530	64,940
Non-plan Revenue Expenditure	90,630	113690	119,400	133,450	165,000	124,430
(5) Capital Expenditure	**34,690**	**30220**	**29,710**	**33,760**	**76,850**	**41,050**
Capital Outlay	30,510	27030	26,640	31,590	68,560	36,870
Loans and Advances	4,180	3190	3,070	2,170	8,290	4,180
Total Expenditure	**163,440**	**181490**	**209,140**	**243,670**	**354,380**	**230,420**
(6) Fiscal Deficit (Revenue-Expenditure)	**-31,140**	**-30120**	**-21,100**	**-19,270**	**-78,330**	**-35,990**
(7) Total Revenue Receipts (1)+(2)	**132,120**	**151180**	**187,810**	**224,190**	**273,550**	**193,770**
(8) Revenue Deficit (4)-(7)	**3,370**	**-90**	**8,380**	**14,280**	**-3,980**	**4,390**

Source: Planning Commission of the Government of India, 2014

Note: The terminology in the financial items follows the Indian accounting regulations.

* Figures do not match the total "Non-tax Revenue" as the original data has error.

The outline of the subsidy provided for infrastructure projects from the central government to

the local government in Jharkhand State is summarized in Table 2.2.7. The average subsidy to Jharkhand State from 2008-09 to 2012-13 was Rs.100 trillion. The implementation rate, which shows the rate of actual granted amount out of the whole planned budget, was 62% from 2008-09 to 2010-11. The detailed breakdown is shown in Appendix A2.1.

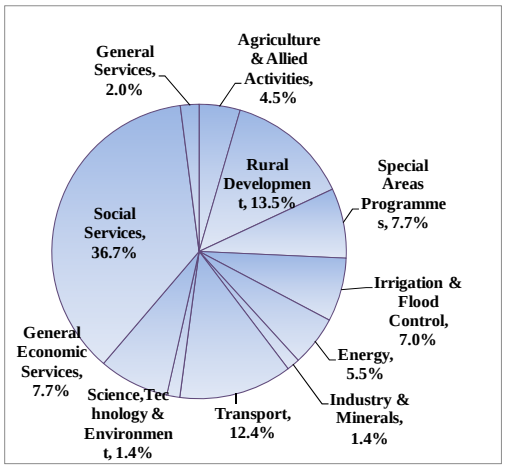
Table 2.2.7 Outline of Annual Subsidy Granted to Jharkhand State

(Unit: Rs. in millions)

No.	Sector of Development	2008-09	2009-10	2010-11	2011-12	2012-13	Average for 5 years	Share
		Actual	Actual	Actual	Revised Budget*	Approved Budget*		
	TOTAL	**68,662**	**65,290**	**82,678**	**122,329**	**162,999**	**100,392**	**100.0%**
	Implementation Rate (Actual/Approved)	**56%**	**59%**	**72%**	-	-	**62%**	-
I	Agriculture and Allied Activities	2,835	2,516	4,162	6,494	6,574	4,516	4.5%
II	Rural Development	10,282	10,750	12,517	17,365	17,077	13,598	13.5%
	- Other Rural Development Programs	7,737	8,324	8,519	13,495	12,973	10,210	(10.2%)
III	Special Areas Programs	5,220	2,267	8,617	10,975	11,474	7,711	7.7%
IV	Irrigation and Flood Control	4,023	2,918	3,267	7,050	17,864	7,024	7.0%
	- Flood Control（includes flood protection works）	451	83	120	3,690	220	913	(0.9%)
V	Energy	2,999	5,319	3,597	4,000	11,780	5,539	5.5%
VI	Industry and Minerals	974	1,351	1,182	1,740	1,940	1,437	1.4%
VII	Transport	6,760	9,244	9,895	14,750	21,750	12,480	12.5%
VIII	Science, Technology, and Environment	1,549	902	1,325	1,440	1,961	1,435	1.4%
IX	General Economic Services	2,366	2,234	5,525	12,624	15,976	7,745	7.7%
X	Social Services	29,600	26,343	31,282	43,484	53,532	36,848	36.7%
	- Water Supply and Sanitation	2,333	2,558	2,225	2,700	3,500	2,663	(2.7%)
	- Urban Development (incl. State Capital Projects and Slum Area Development)	3,409	2,768	1,859	4,959	9,980	4,595	(4.6%)
XI	General Services	2,054	1,446	1,309	2,407	3,071	2,057	2.1%

Source: Planning Commission of the Government of India, 2014

Note: * The figures for fiscal years 2011-12 and 2012-13 are the revised budget amount and approved budget amount.



The subsidy is spent more on the social services sector (37%), followed by the rural development (14%), and transport (12%) sectors. The subsidy for the O&M of water supply and sanitation services is included in social services, which has a 2.7% share (Rs.2,663 million/year) of the whole subsidy.

Source: Planning Commission of the Government of India, 2014

Figure 2.2.1 Share of Subsidy for Each Sector

(2) Financial Conditions of RMC

The financial condition of RMC is summarized in Table 2.2.8. The detailed information is attached in Appendix A2.2.

Table 2.2.8 Outline of Annual Revenue and Expenditure of RMC

(Unit: Rs. in millions)

Items	2008-2009 Actual	2009-2010 Actual	2010-2011 Actual	2011-2012 Actual	2012-2013 Actual	Average
Revenue						
1) Receipt	**169**	**251**	**257**	**334**	**494**	**301**
Implementation Rate (Actual/Approved)	50%	71%	60%	67%	86%	69%
- Tax revenue and misc.	96	94	134	217	305	169
- Government grant/loan	73	158	123	117	189	132
2) Capital Receipts (Loans, Grants from State Government)	**109**	**753**	**144**	**111**	**751**	**374**
Implementation Rate (Actual/Approved)	13%	52%	8%	5%	35%	22%
Total Receipt (Revenue)	**277**	**1,004**	**401**	**445**	**1,245**	**675**
Expenditure						
3) Expenditure	**197**	**253**	**284**	**241**	**460**	**287**
Implementation Rate (Actual/Approved)	73%	89%	102%	82%	102%	91%
- Labour Cost	152	193	216	232	311	221
- Other Operating Cost	45	61	67	9	149	66
4) Capital Expenditure	**106**	**162**	**991**	**543**	**667**	**494**
Implementation Rate (Actual/Approved)	6%	14%	20%	32%	16%	18%
Total Expenditure	**303**	**416**	**1,274**	**785**	**1,127**	**781**
Deficit	**-26**	**588**	**-873**	**-340**	**118**	**-106**
Deficit excluding Capital Expenditure and Receipt	-28	-2	-27	93	34	14

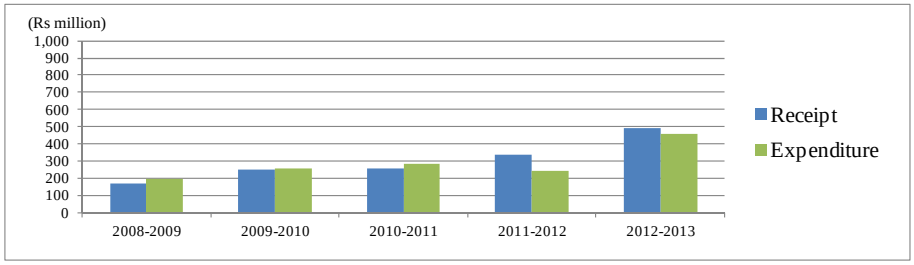
Source: RMC

Note: Terminology of financial items follows the Indian accounting regulations.

RMC receives subsidy from the central and state governments for both non-capital revenue and capital revenue. The former subsidy is categorized as “Government Grant/Loan” and the latter one is “Capital Receipts (revenue)” as shown in Table 2.2.8. The average annual subsidy amount of these categories was Rs.506 million from 2008-09 to 2012-13. The said amount corresponds to 75% of the total revenue, and it clearly shows the high dependency of RMC financing on the subsidy from the central and state governments.

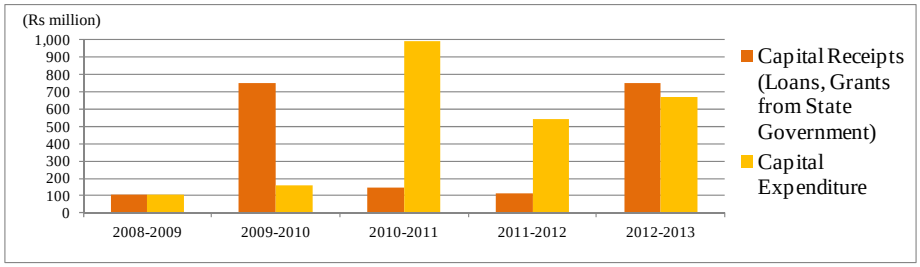
The implementation rate, which shows the percentage of actual expenditure out of the approved budget amount for the year, is at 69% and 91% for non-capital revenue and expenditure, respectively. While the one for capital revenue and expenditure amounted to as low as 22% and 18%, respectively. Based on the RMC accounting rule, the unspent budget can be carried forward to the next fiscal year. Several major projects, such as the Jawaharlal Nehru Nation Urban Renewal Mission (JNNURM), have been delayed and it made the implementation rate kept low in recent years.

The trend for non-capital revenue/expenditure is shown in Figure 2.2.2, while the trend for capital revenue/expenditure is shown in Figure 2.2.3.



Source: RMC

Figure 2.2.2 Historical Trend of Non-capital Related Revenue and Expenditure



Source: RMC

Figure 2.2.3 Historical Trend of Capital Related Revenue and Expenditure

The non-capital revenue and expenditure remain rather stable, and the revenue (receipts) exceeds the expenditure amount by Rs.14 million/year on average during the latest five years.

Regarding the accounting method of capital cost, the project based budget (such as JNNURM) is provided to RMC at the beginning year and spent based on the project implementation in the following years. Due to this system, the capital revenue and expenditure fluctuate each year.

The balance of capital revenue and expenditure shows the negative flow during the latest five years. RMC has kept the sufficient budget for the expenditure beforehand, and the financial condition is basically secured.

i) Proposed Programs for Improvement of Accounting in City Development Plan (CDP)

In the Ranchi City Development Plan (CDP) completed in 2011, the following programs were proposed to improve the financial conditions of RMC. The RMC has implemented some of the proposed activities and the revenue has increased for the fiscal year 2012-13.

- Improve the accounting system from cash basis to accrual basis. (Developing an inventory of assets and liabilities);

- Strengthen ULB's own revenue sources (Increase the collection of property tax, revision of service charges including water charge); and
- Utilize funds from international aid agencies, and introduction of the PPP scheme.

ii) Ongoing Outsourcing Work of Revenue Collection

Furthermore, RMC is planning to outsource the collection work of taxes and charges to a private company to increase the collection rate and enhance efficiency. The tendering process has finished, and the three-year concession is supposed to start by the end of 2014. Outlines of the concession are as follows:

- Outsourced items for collection: Holding tax, trade license fee, water user charge;
- Project period: Three years (can be extended);
- Outsourced work: Renew the household collection database, update the software system, collect the taxes and the charge, setup the on-line help desk, arrange the SMS system for payment activities, meter reading of water user charge; and
- Remuneration policy: Fixed percentage of the total collected amount (output-based).

Payment to the concessionaire will be made based on the amount of collected revenue, and hence, a significant improvement in collection rate and amount is expected, which will result to the reduction of the financial deficit of RMC.

2.2.4 Revenue and Expenditure of Water and Sanitation Services

(1) Revenue Related to Water and Sanitation Services

The revenue from water and sanitation services is composed of the items below:

- Water tax collected as part of the withholding tax
- Sanitation tax collected as part of the withholding tax
- Water charge from users
- Water charge by water tankers
- Latrine cleaning charge

The outlines of each revenue item are summarized in Table 2.2.9.

Table 2.2.9 Outline of Charge Related to Water Supply and Sanitation Services

Indicators	Responsible Section of Tariff Collection	Number of Users (Usage)	Tariff Rate
i) Water tax collected as part of the withholding tax	Revenue Department of RMC	Approx. 90,000 (April 2014)	House with water connection: 12.5% of ARV*, House with hand pump/post within 300 yards: 7.5% of ARV* House without hand pump/post within 300 yards: No charge
ii) Sanitation tax collected as the part of the withholding tax			7.0% of ARV* (Annual Rental Value)
iii) Water charge	Revenue Department of RMC	30,260 (March 2013)	Connection charge: Summarized in Table 2.2.10 Consumption Charge: Charged by either fixed cost or consumption amount, summarized in Table 2.2.10
	Hatia, Gonda and Buty Division of DWSD	54 (Main Bulk Users)	
iv)Water charge by tankers	Water Board of RMC	Request Basis 81 times (2m^3) 55 times (5 m^3) 16 times (9 m^3) (2010-11)	Dry Season (15 April – 30 June): For free Other Period: Rs.300 for 2 m3 tanker Rs.750 for 5 m3 tanker Rs.1250 for 9 m3 tanker
v) Latrine cleaning charge (conservancy charge)	Health Department of RMC	n.a.	Domestic: Rs.1,250/time Commercial: Rs.2,500/time

Source: RMC, compiled by the JICA Study Team

Note: * ARV (Annual Rental Value) is calculated based on the location (zone), building area, classification of building (by roof material), and purpose of usage. For example, ARV of the residential house with R.C.C. roof in Zone 2 becomes Rs.1.6/ft^2 (rented) and Rs.1.36/ft^2 (owned).

As it is clearly observed, multiple organizations and departments are in charge of related tariff collection. The integration of the collection measures is needed to enhance the responsibility on financial management of water and sanitation services of RMC.

The collected revenue during the last five years is summarized in Table 2.2.10. The total revenue becomes Rs.93 million on average. Further detailed figures including billed amount and collected amount are shown in Appendix A2.3. The whole income of RMC, which includes water tax, sanitation tax, water charge, water charge by tankers, and latrine cleaning charge takes a share of 42% of the total revenue amount. The remaining 58% is collected by the Drinking Water & Sanitation Department (DWSD).

Table 2.2.10 Collected Revenue Related to Water and Sanitation Services

(Unit: Rs. in thousands)

Revenue Items (Collecting Organization)		2008-09	2009-10	2010-11	2011-12	2012-13	Average	Share	Collection Rate
Water Tax (RMC)		12,776	11,443	12,176	10,693	10,075	11,433	12%	58%
Sanitation Tax (RMC)		12,308	9,737	11,379	9,018	8,703	10,229	11%	64%
Water Charge	(RMC)	5,548	9,535	16,614	12,128	31,161	14,997	16%	34%
	(DWSD - Hatia Division)	*14,916	16,016	14,750	12,091	16,807	14,916	16%	85%
	(DWSD – Booty Distribution Division)	*36,077	18,038	30,430	31,472	30,373	36,077	38%	82%
	(DWSD - Booty Head works Division)	2,153	2,651	3,779	4,139	4,440	3,432	4%	**90%
Water Charge by Tankers (RMC)		*587	*587	*587	519	654	587	1%	100%
Latrine Cleaning Charge (RMC)		*1,798	*1,798	*1,798	1,794	1801	1,798	2%	100%
Total		**86,161**	**69,804**	**91,512**	**81,806**	**138,055**	**93,468**	100%	59%

Source: RMC and DWSD, compiled by the JICA Study Team
Note: * Data is not available, and the average figure of available period is used for calculation
Note: ** Collection rate of Booty Head Works Division is assumed by the interview with workers in the division office. The billed amount is estimated by the collected amount and collection rate.

1) Water Tax and Latrine Tax

The “water tax” and “latrine tax” are levied on every household as part of the property tax based on Section 204 of the RMC Act. The revenue department of RMC, composed of 48 workers, charges and collects the property tax every year from approximately 90,000 households, which are recorded in the RMC registration list. The collection rate is ranging from 58% to 64%.

2) Water Charge

“Water charge” is collected by RMC and DWSD based on the tariff rate stipulated in the regulation of Section 592 of the Jharkhand Municipal Act, as shown in Table 2.2.11. The tariff will be revised every three years in corporation to the wholesale price index. The tariff revision is planned by the water council, and approved by the board of RMC before implementation. When the users start using the water supply service from RMC/DWSD, the connection charge (shown in Table 2.2.11) is also levied on the users. Installation of water meter is obliged to the new users at their own expense after 2006.

The tariff is calculated by either “per consumption tariff” or “fixed cost” depending on the condition of meter installation. The majority of houses connected before 2006 do not have installed water meters and are charged by fixed cost. Users connected after 2006 is charged by consumption tariff.

Table 2.2.11 Outline of Water Charge (from June 2013)

Type of Users		Connection Charge	Water Charge with Meter	Water Charge without Meter
Domestic	- Pure Domestic	Built -up area of -100 m^2: Rs.200, 101-200 m^2: Rs.500, 201-400 m^2: Rs.700, 401 m^2: Rs.1,000	Rs.6.0/m^3	Built -up area of -100 m^2: Rs.200/month 101-200 m^2: Rs.300 /month 201-400 m^2: Rs.500/month 401 m^2: Rs.700/month
	- with Business	Built -up area of -100 m^2: Rs.1,000, 101-200 m^2: Rs.1,200, 201-400 m^2: Rs.1,500., 401 m^2: Rs.2,000		
Institutional/Public		Rs.2,000	Rs.10.0/m^3	Average consumption is set by RMC or DWSD based on their assumption
Commercial		Rs.3,000	Rs.15.0/m^3	
Industrial	- Small Scale Industry (SSI) unit	Rs.3,000	Rs15.0/m^3	
	- Others	Rs.10,000	Rs.20.0/m^3	

Source: RMC and DWSD

RMC is collecting the charge through their own employees from users, which is composed of 30,260 connections, as of March 2013, including domestic, institutional, and commercial users. Total revenue summed up to Rs.15.0 million, which takes a share of 17% of the whole revenue related to water and sewerage services. Owing to the lack of manpower of the Revenue Department of RMC, billing frequency of water charge, which is supposed to be conducted every month, is conducted from every several months to one year. The stoppage of water supply, which ought to be done after the delay of payment for three months, has not been conducted. Under such condition, the collection rate of water charge is retained for as low as 34%. The details of the connection number and metered rate are shown in Appendix A2.4.

A part of the "water charge" of bulk water supply users is collected by Hatia, Gonda, and the Booty Distribution Division of DWSD through their own employees. The collected revenue is pooled in the Jharkhand State's account, and spent on the expenses of the state government. The average revenue of the three divisions becomes Rs.49 million and it composes 55% of total revenue. The collection rate of the three divisions of DWSD retained from 82% to 90%. The rate is retained high as the majority of users are large-scale bulk water users, and the collection work is easier.

3) Water Charge by Tankers

RMC is providing water through 23 water tankers. The water charge is free during dry season (15 Apr. – 30 June). In other periods, the water is provided based on the request from users, and Rs.300 – Rs.1,250 is charged for every delivery depending on the size of tankers. The annual revenue amount is Rs.587,000 on average.

4) Latrine Cleaning Charge

Latrine cleaning charge is collected each time the cleaning machine works as requested by

latrines users. The average revenue amount is Rs.1.8 million/year.

(2) Expenditure of Water and Sanitation Services

The O&M cost and capital investment cost of water and sanitation services during the last five years are summarized in Tables 2.2.12 and 2.2.13.

The O&M cost summed up to Rs.298 million on average during the last five years. As DWSD is in charge of O&M of main facility of water supply service except for final connection to users, the cost of DWSD domains 94% of the total cost.

The capital cost amount varies depending on the progress of project implementation.

Table 2.2.12 O&M Cost of Water Supply and Sanitation Services

(Unit: Rs. in thousands)

	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Average	Share
O&M Cost of RMC	**21,563**	**14,806**	**19,143**	**11,792**	**17,308**	**16,922**	**6%**
-Water Sector	15,434	8,677	13,014	6,893	9,950	10,794	4%
- Sanitation Sector	*6,129	*6,129	*6,129	4,899	7,358	6,129	2%
O&M Cost of DWSD **	**107,828**	**177,950**	**386,460**	**317,370**	****415,555**	**281,033**	**94%**
Total	**129,391**	**192,756**	**405,603**	**329,162**	**432,863**	**297,955**	

Note: * Data is not available for three years, and the average amount of two years has been adopted.
** O&M cost of DWSD is provided through RMC. The figures in 2012-13 are assumed by RMC based on the past trend.
Source: RMC and DWSD

Table 2.2.13 Capital Cost of Water Supply and Sanitation Services

(Unit: Rs. in thousands)

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Average
Capital Cost of RMC	43,682	45,076	817,866	320,183	407,947	n.a.	328,085
- JNNURM	0	0	716,727	250,721	353,000	n.a.	264,090
- Others	43,682	45,076	101,139	69,462	54,947	n.a.	63,995
Capital Cost of DWSD (excl. JNNURM)	n.a.	n.a.	n.a.	210,211	183,713	366,738	273,917

Source: RMC and DWSD

The average capital cost of RMC is Rs.328 million/year including the project cost of JNNURM amounting to Rs.264 million/year. The capital cost of DWSD is not available before the year 2010-11. While the one for the latest three years from 2011-12 to 2013-14 amounted to Rs.274 million/year on average excluding the project cost of JNNURM.

(3) Balance of Revenue and Expenditure

The balance of total revenue and O&M cost of water supply and sanitation services conducted by RMC and DWSD is shown in Table 2.2.14. The coverage rate of O&M cost

became 27% on average during the last three years.

Table 2.2.14 Balance of Revenue and O&M Cost of Water Supply and Sanitation Services Conducted by RMC and DWSD

(Unit: Rs. in thousands)

Year	2010-11	2011-12	2012-13	Average
Total Revenue	91,512	81,806	138,055	103,791
Total O&M Cost	-405,603	-329,162	-432,863	-389,209
Balance	-314,147	-247,356	-294,808	-285,418
Coverage Rate of O&M Cost	22.6%	24.9%	31.9%	26.7%

Source: RMC and DWSD

(4) Estimation of Revenue Water Rate

The revenue water rate of water supply service conducted by RMC and DWSD in the fiscal year of 2012-13 is estimated to use it as one of important service indicators. As it has been explained in the former chapter 2.3.1, no meter is functioning in three major water treatment plants, and the installation rate of meters is only 16% of RMC collection area. Hence, the produced water amount and revenue water amount is assumed based on rough assumptions.

The produced water amount is assumed to be the same as the designed treatment capacity of three major water treatment plants supplying water in RMC service area. The amount becomes 90,082 thousand m^3/year in total as explained in the chapter 2.3.1 (1).

The revenue water amount for RMC and DWSD is calculated separately as using the revenue data mentioned in the former Table 2.2.10 and the average tariff rate of each part. The total revenue water amount becomes 14,445,000 m^3 in 2012-13.

Table 2.2.15 Estimation of Revenue Water Amount in 2012-13

Year	Revenue Amount (Rs./year)	Average Tariff (Rs./m^3)	Revenue Water Amount (m^3/year)
DWSD collection part	85,661,000	10.0	8,566,000
RMC collection part	31,161,000	* 5.3	5,879,000
Total	-	-	14,445,000

* Average tariff rate of RMC collection part is assumed by using the estimation of water consumption in each category provided by RMC.
Source: RMC and DWSD

From the above assumptions, the revenue water rate is estimated at 16% in RMC service area. The figure should be reviewed in the further technical study as using the reliable measured water amount data of both production and consumption sides.

2.3 Existing Water Supply System

2.3.1 General Conditions of Water Supply System in Ranchi City

(1) Existing Water Supply Systems

The existing water supply system in Ranchi City consists of three systems, namely: Gonda Water Supply System (in Kanke), Hatia Water Supply System, and Booty Water Supply System (in Rukka).

The Gonda Water Supply System, which was commissioned in 1956, has a treatment capacity of 19.5 MLD. Its water source is near the Kanke Reservoir at 611 m above MSL with a basin area of 19.3 km^2 located in Gonda in the northern part of Ranchi City. The catchment area of this reservoir covers a residential area and the wastewater from the residential area drains into the reservoir resulting in water contamination of the reservoir. In order to address the source water contamination, RMC decided in 2005 to construct a sewage treatment plant in the vicinity of the Kanke Reservoir with a capacity of 4,000 m^3/d.

The Hatia Water Supply System has a treatment capacity of 56.8 MLD and its water is sourced from the Harita Dam with a catchment area of 47.9 km^2 located in the Suvarnarekha River, which is southwest of Ranchi City. It was commissioned in 1963 to serve water to the HEC industrial area and the population in the southern part of the city. The water is drawn to the water treatment plant on alternate days due to insufficient water in the reservoir and treatment capacity to meet the water demand for HEC industrial zones and surrounding residential areas.

The Booty Water Supply System, having a treatment capacity of 170.5 MLD, was commissioned in 1971 with water source from the Rukka Reservoir, which was constructed on the Subarnrekha River, 12.5 km northeast of Ranchi City. The reservoir was constructed for dual purpose, namely, for water supply to Ranchi City and for generating hydropower. The dam is at a lower altitude compared with the city area and the drainage pattern is such that the wastewater from the domestic areas of RMC joins the reservoir at the upstream side; hence, the treatment at the water treatment plant requires additional treatment technique such as removal of ammonia nitrogen.

After the Booty Water Supply System was set up, the existing Gonda and Hatia systems were connected with the Booty system to provide flexibility to transfer and supply water to Ranchi City.

(2) Existing Service Levels

With the implementation of ongoing projects financed by Jharkhand State and the JNNURM scheme, the service coverage within RMC is envisaged to be significantly improved in the future. The JNNURM scheme is currently under preparation for selection of the contractors. However, some parts of the area such as Zone Nos. 5, 39 to 45, 50, and 55 are not sufficiently

covered under the present water supply system and are suffering from water rationing and low pressure on the distribution pipes. Meanwhile, approximately 65% to 70% of the whole city area is being served through a pipe network, while the remaining area is covered by tube wells, dug wells, public stand posts, and water tankers.

Within the RMC area, there is a sizeable variation in daily and hourly supply of water between one to several hours. Out of 26 water supply zones, 21 zones are reported as so called water rationing areas in the range of one to three hours. Due to this situation, citizens of the city tend to exploit underground water, although potential quantity of groundwater is not so large and the aquifer depth is more than 30 m below the ground surface.

(3) Non-Revenue Water (NRW)

There is no bulk meter installed to measure gross water supply at the water treatment plants, distribution reservoirs, and pumping stations. In addition, there are very limited consumer water meters and bulk users. Regarding the NRW, there is no specific study carried out by RMC or the Jharkhand State government.

Some consultants engaged in the planning and design of water supply schemes estimated the NRW ratio at about 90% while DWSD assumed that the ratio is 70% to 80%. However, no practical investigation has been done by any organization due to lack of quantitative data on water charge collection and accurate registration records.

This extraordinarily high ratio reflects the fact that the water charge is not being appropriately collected from all the consumers based on the consumer water meters as well as bulk users. It is reportedly said that one of the major reasons of the high ratio is the water consumption of bulk water users in and out of the RMC boundary. Needless to say, water meters for such bulk water use are not sufficiently provided.

(4) Operational Problems

The major operational problems on the existing water supply system in Ranchi City is firstly, lack of measurement of flow at the pumping stations, water treatment plants, and service reservoirs as well as the consumer flow measurement. The lack of metering system is described in detail in the following subsections.

Secondly, the water pumps at the water distribution reservoir are not functioning appropriately and the size of reservoir is not also sufficient to reserve sufficient water flow in the tank. The tank size should at least retain water for six hours or hopefully 12 hours.

Thirdly, the distribution system is not adequately operated. The water is supplied to the distribution network by a combined system of ground water and treated water from the treatment plant near the reservoir. In such a case, pumping operation and pressure control valves are not appropriately functioning resulting in extremely high or low pressures in the distribution networks. In addition, constant power supply is not expected for 24 hours and

power failure is often experienced for more than ten times in a day.

Fourthly, distribution networks have not been constituted with adequate pipe sizes and the network itself is not forming appropriate reticulation giving dead end of the network without loops. Such missing link problems should be solved as soon as possible. When designing pipe networks, appropriate network analysis should be carried out to bring about suitable hydraulic flow.

(5) House Connection

As per RMC, the number of legal connections as of March 2014 was more than 39,260 and further house connections are reported to have increased in recent days. In addition, the connections of government institutions at 56, apartments with single point at 228, commercial at 222, and institutional at 162 were also reported by RMC, as of March 2014.

Meanwhile, it is reported that there are many illegal house connections and this is said to be one of the reasons for the high NRW ratio. Thus, bulk water consumption out of Ranchi City, illegal connections, water leakage, and non-metered water consumption are assumed to be the major causes of high NRW ratio in Ranchi City.

Apart from direct connections, RMC also provides water supply through an array of other sources including 3,284 hand pumps, 315 stand posts, and water tankers (2 m^3, 5 m^3 and 9 m^3 capacity for 16 vehicles, 4 vehicles, and 1 vehicle, respectively) as of March 2014. The water delivery by tankers is done by RMC free of charge.

(6) Metering System

As mentioned above, there is no bulk meter at all the water supply systems in the water treatment plant, pumping stations, and distribution reservoirs in Ranchi City. The flow rate is basically calculated based on the pump operation time. Only limited metering system is provided for the private consumers and bulk users.

According to DWSD, it is reported that out of 54 bulk consumers, only two consumers have bulk meters. As for commercial consumers, only 10 out of 73 consumers have meters and all ten meters are not functional. Furthermore, only 10% of about 25,000 registered domestic consumers have been provided with meters, but nearly almost all of them are not functional or inaccurate without calibration. As for institutional consumers, there are 81 existing institutional consumers reported; however, no meter has been reported so far.

2.3.2 Ongoing Water Supply Schemes

A new water supply project is being implemented by RMC under JNNURM assistance, which was actually expected to be completed by the end of 2012. However, it is not yet completed and has been suspended since September 2012 due to inappropriate performance of the contractor. The current rate of achievement is reported to be around 45% based on the reports of DWSD.

Since suspension of the construction, bidding was carried out three times and currently, the fourth bidding is being carried out. Prior to the newest bidding, DWSD reassessed the cost estimation resulting in Rs.373 crore, which is Rs.85 crore higher than the previous estimation of Rs.288 crore. The budget for the remaining works is estimated by DWSD at Rs.231 crore. However, the fourth bidder's cost proposal was Rs.293 crore, i.e., Rs.62 crore higher than the budget.

The various components of the project include expansion of existing sources, increase of storage capacity, treatment and pumping capacity, and strengthening of existing distribution network. The development project under JNNURM assistance is planned to be implemented in two phases, in which Phase I is currently suspended as mentioned above.

The following Table 2.3.1 shows the estimated project cost of major items of Phase I project funded under JNNURM applied for the first bidding. The remaining component to be carried out by the fourth bidding, with the budget of Rs.231 crore, has not been officially informed to the JICA Study Team so far.

Table 2.3.1 Estimated Project Cost of Phase I under JNNURM

S. No.	Components	Rs.100,000
1	Intake works	494.92
2	Raw water pumping equipment	233
3	Raw water mains	90.97
4	WTP in Rukka 172 MLD	815.22
5	Clear water pumping equipment in Rukka	733
6	Clear water transmission mains	15,136.89
7	Underground sumps	84.76
8	Distribution pump house and pumping equipment	822
9	Elevated storage reservoir	705.84
10	Distribution network	4,930.79
11	Metering	1,929
12	Electrical connection charges	100
13	Railway crossing	90
14	Desilting of dam	-
15	Replacement of transformer	-
16	Streamlining of house service connections	1,725
17	Consultancy charges	0
18	Land acquisition, site development, environmental compliance, utility shifting, rehabilitation, survey and investigation, etc.	
	Subtotal	27,871.39
	Contingency@ 3%	878.41
	Administrative cost @ 0.5%	139.39
	Interest	0
	Others	0
	Grand Total	**28,839.15 (Rs.288 crore)**

Source: Final Interim Report, PPP for Water Supply in Ranchi City, Nov. 2011

The ongoing JNNURM Water Supply Project for RMC (although actually suspended) covers the area under RMC jurisdiction and some areas outside RMC but limited to Ranchi City

urban agglomeration. The proposed supply area is divided into 38 water supply zones, including 11 existing RMC zones. The water supply project to be implemented under JNNURM is shown in Table 2.3.2.

Table 2.3.2 Ongoing RMC Water Supply Project Implemented under JNNURM

Zone No.	Zone Name	Zone No.	Zone Name	Zone No.	Zone Name
1 ●	Pisca More	14 △	Sector 2	27 ▲	Lodhma
2 ●	Hindpiri	15 ●	Doranda	28 ▲	Rapur
3 ●	Church Road	16 ○	Kusai	29 ▲	Barkumbha Toli
4 ●	Sriromtolli	17 △	Namkum	30 △	Taisilway
5 ●	Kantatolli	18 △	HEC	31 ○	Ranibagan
6 ●	Lapur	19 △	Khelgan	32 ▲	Bit Meshra
7 ●	Morahabadi	20 ▲	Kanke	33 ▲	NC Capital 1
8 ●	Ruta road	21 ○	Dibdih	34 ▲	NC Capital 2
9 ●	North office	22 ○	Pundag	35 ▲	NC Capital 1
10 ●	Hinoo	23 ▲	Lalgutua	36 ▲	NC Capital 2
11 ○	Kanke Road	24 ○	Hatia	37 ▲	Kmre
12 ○	Upper Bazar	25 ○	Tupudana	38 △	Kokar
13 ○	Harmu	26 ▲	Sithio		

Source: Final Interim Report, PPP for Water Supply in Ranchi City, November 2011

Note: ○ is 9 zones in total within RMC area covered by ongoing JNNURM (Phase I)

● is 11 zones in total within RMC area not covered by ongoing JNNURM (Phase I)

▲ is 12 zones in total outside RMC area covered by ongoing JNNURM (Phase I)

△ is 6 zones in total within RMC area covered by ongoing JNNURM (Phase I) being partially distributed outside RMC area

2.3.3 Water Consumption

According to the revised DPR prepared by RMC on July 8, 2012, the existing water consumption per capita per day was reported at 84 L/c/d and the average duration of continuous water supply is only about four hours in a day.

The revised DPR states that approximately 65% to 70% of the area is being served through pipe network, while the remaining area is covered by tube wells and hand pump wells. At the same time, per capita water consumption in the future is proposed at 135 L/c/d for the target year of 2041.

Taking these into account, the existing daily water consumption in Ranchi City would range from 100 to 115 L/c/d. This leads to the estimation of the future unit water consumption to be at most 135 L/c/d in compliance with the norm of CHPEEO for the target year of 2046 in this preparatory study.

2.3.4 Proposal on GIS and SCADA Control System on Water Supply System

As described in the above subsections, expansion and development of the existing water supply systems are currently being undertaken slowly and in a very small scale. After the completion of such expansion and development plan under JNNURM scheme and missing link expansion plan within ten years or so, RMC should control the operation and maintenance of the future water supply system with larger magnitude. One of the major items to be carried out, even immediately from now on, is the development using geographical information system (GIS) and supervisory control and data acquisition (SCADA) system.

In order to achieve effective and smooth operation and maintenance of water supply system, GIS system and SCADA system should be applied for such field as shown below:

a) Preparation of plan of water supply pipe network by compilation of the ledger using GIS system. The ledger contains the following: i) information of pipe construction year, ii) type and diameter of pipe, iii) type and location of valves, iv) depth of water pipes, v) location where leakage occurred and repair record, and vi) underground utilities, which are also indispensable to be shown on the same ledger.

b) Monitoring of i) dam and reservoirs, ii) water production at the three existing water treatment plants, and iii) transmission of water by conduction main or rising main to the distribution tank by using water gauge, flow meter, velocity meter, etc., should be managed by using GIS and SCADA systems. Particularly, SCADA system is indispensable to control the entire regime of water supply system in each division office as well as in the main building of RMC.

c) House connection to each household should be recorded in detail by using GIS system indicating the i) name of each household and household size, ii) existence of water meter and calibration record, iii) monthly consumption, and iv) water charge amount paid in each month. At the same time, v) illegal connection, vi) “non paying” or “payment refused” houses, etc., should also be monitored. The vii) bulk water consumption records of commercial and industries and their monitoring is also indispensable.

2.4 Existing Drainage System and Facilities

2.4.1 General Conditions of Drainage System in Ranchi City

(1) Overall Basin Features on Stormwater Drainage Aspect

As shown in Figure 2.1.4, Ranchi City is extended in the west basin of the Subarnarekha River and some major tributaries run through the city area from the west towards the east in parallel. The average longitudinal slope of these major tributaries varies approximately 1/100 to 1/200, which is a feature that provides a quite advantageous condition for stormwater drainage by gravity system. In addition, there are many small river basins in and around Ranchi City that constitute the catchment for offsite drainage in the area. Thus, Ranchi City by itself has good natural features that allow most of the city area to be properly drained. The city center is located on a plateau which slopes away in all four directions, more or less from the center, but predominantly towards the east and into the Subarnarekha River.

The stormwater runoff is mostly carried by roadside drains from the town, which find their way to various drainage channels (*nallahs*) and major tributaries of the Subarnarehka River such as the Harmu River, the Hinoo River and the Nati River which pass through the city before joining the Subarnarekha River.

(2) Stormwater Drainage Facilities

Stormwater drainage infrastructure in Ranchi City is maintained by RMC. The conditions of the existing drainage systems in many places are unsatisfactory. Most of the natural drainage channels and roadside drains are clogged with garbage and frequently used for solid waste disposal, besides gaps in harnessing the potential groundwater recharge.

The major issue to be addressed is the lack of drainage from the road network to the small drainage channel, which is usually located behind the built-up area and eventually connects to the river. In addition to this, the lack of maintenance, encroachment by illegal construction, and direct discharge of raw sewage into the rivers through drainage channels aggravate the problems. The problem is further complicated by poorly planned and constructed roads, water supply and power lines crossing streams suspended inside the drainage channels, sudden contraction in the section of river crossing culverts and bridges, undersized drain/culvert sections, indiscriminate dumping of construction materials, silting of drains, waste accumulation in drainage channels, and poor maintenance practices.

All the stormwater collected and conveyed through the above facilities eventually drain into the major tributaries of the Subarnarekha River. There are generally observed dense natural weeding and bushes inside the river course, while there are no major river structures such as bank revetment, bed protection, and other flood control structures. In addition, garbage dumping is observed in many locations especially at the bridge/culvert sites and it is

generally assumed that the preceding situation seriously reduces the river flow capacity.

The major deficiencies in the existing drainage system are listed below:

1) Deficiencies in Plan/Design

- Lack of interconnectivity between the drains;
- Restricted flow capacity of the drain/culvert sections;
- Irregular drain/culvert sections;

2) Deficiencies in Maintenance

- Drains/culverts with seriously damaged beds and side walls;
- Deposition of solid wastes, silt, and plant/weed growth;

3) Deficiencies in Installation System of Public Utility

- Many other services like water lines and telephone lines obstructing the waterway of the drains/culverts.

2.4.2 Current Inundation Conditions in Ranchi City

(1) Flood-Affected Areas Identified in the DPR

From the general topographical aspect mentioned in Section 2.4.1, Ranchi City has an advantage for stormwater drainage and it is generally said that there are no serious flooding problems in the city. However, local inundation or rainwater clogging due to poor drainage conditions as explained in the antecedent section is reported in several locations inside the city area. The locations and the inundation situations are shown in Table 2.4.1.

Table 2.4.1 Flood Affected Areas Identified in the DPR

No.	Location Name	Location/Inundation Situation	Conceivable Solution
1	Punchsheel Nagar	a. In the southern side of Ratu Road, Anand Nagar: Flooding due to construction works across the river channel. b. Culvert on Ratu Road: Flooding due to silting and improper maintenance of seven culverts with 1 m diameter pipe. c. Punchsheel Nagar: Flooding due to blockage in the existing culvert and the river channel obstructed by existing houses and roads.	Removal of all the unauthorized houses constructed along the river and desilting of the channel. Removal of all encroachments, desilting, and rehabilitation of channels to join the river on the downstream side.
2	Lower Koccha	Flooding due to construction of road ramps before the buildings; the drain channel is blocked leading to flooding in this area.	Removal of the ramp and reconsider the road ramp alignment.
3	Basar Toli	Flooding due to construction of houses across the existing drain channel obstructing the flow of stormwater.	Demolish unauthorized houses and restoration of the drain channel.

4	Azad Basti	Flooding due to lack of drainage along the Mission Ground Compound.	Provide drain along the road adjacent to the Mission Ground Compound.
5	Vidyapathi Nagar	Flooding due to the unauthorized building constructed in the drain channel, and the culvert beside the MOTIL apartment has inadequate flow capacity.	Removal of encroachment and provision of proper river channel and culvert with sufficient flow capacity.
6	Gosh Nagar	The flooding is mainly due to the houses being constructed below the MFL of Nalla.	River channel rehabilitation and desilting and removal of river side encroachment.
7	Ganapathi Colony	Flooding due to built-up structures in low-lying areas. The BT roads are laid recently by raising the road level.	No conceivable structural measure.
8	Akansha Enclave and Basundra Enclave	Flooding due to low-lying areas and no proper leading channel to drain off stormwater.	No conceivable structural measure.
9	Harihar Singh Road	Flooding due to lack of drains.	Provision of new drain channel.
10	Chutia	Flooding mainly due to lack of drains, inadequate size of drains, and improper maintenance.	Provision of new drainage system for the area.
11	Krishnapuri	Flooding due to discontinuity of drainage channel.	Provision of drainage channel.
12	Ratu Road	Flooding due to improper alignment of drains and inadequate flow capacity.	Provision of proper drainage system.

Source: DPR for Ranchi Sewerage Project

(2) Inundation Survey

During the preparatory survey period, an inundation survey was carried out for the purpose of obtaining information on local inundation features and some quantitative data related to the inundation condition. It was implemented through field reconnaissance and interviews with residents residing in the habitual inundation area.

Information on local inundation conditions was collected from local residents in 50 locations. Of the 50 locations, inundation problems seemed to occur due to heavy rainfall on 20 locations, while there are 30 locations where long-term stagnant water seemingly occurs due to normal sewage and stormwater flowing into low-lying pockets of the topography without a sewerage system and proper outlet drain channels. The survey points of the current inundation condition and the survey results are given in Appendices A3.1 and A3.2, respectively. The survey results are summarized below.

Table 2.4.2 Inundation Survey Results

Area Feature	No. of Location	Situation of Inundation	Major Cause of Inundation
Area without adequate drainage	20	Inundation depth: Generally less than 1 m Inundation period: Generally less than 10 hours	No drain channel, drain channel with insufficient flow capacity, no maintenance and blockage by road.
Low-lying topography	30	Inundation depth: Generally 1 to 2 m (including depth of low pocket/swamp area) Inundation period: Generally several months up to 12 months	Sewage and stormwater flowing into low-lying pockets, no sewerage system, and no outlet channel with sufficient flow capacity.

Source: JICA Study Team

(3) Inundation Due to River Crossing Structures

The major tributaries of the Subarnarekha River flow through the Ranchi City area and cross the roads and railways in many locations. Furthermore, small- to middle-scale natural drainage channels run through the built-up area of the city and connected to the rivers. According to DPR and the inundation survey result, the inundation problems are mainly observed at the existing river crossing structure sites such as bridges and culverts on the drainage channels and the rivers.

In the preparatory survey, the present conditions and approximate structural dimensions of river crossing structures were investigated. In addition, the current flow discharge capacity was preliminarily estimated based on the structural features and the river/channel conditions. The location map of the investigated structure sites and the inventory of the existing river crossing structure are given in Appendices A3.3 and A3.4, respectively. According to the survey result, the soffit levels of the bridges on the major roads in the city are generally assumed to be high enough for normal floods. However, it is observed at some major bridge sites that water supply trunk main(s) with its (their) own piers cross the river parallel to the bridge at a lower level. This condition may disrupt the smooth flow of the river. At most of the middle to small scale bridge/culvert sites on the rivers, the channel width is narrower compared to those at the upstream and downstream sections of the structure site and the soffit levels are not high enough. In addition, it is obvious that the flow capacity is further restricted due to the dense weed and serious garbage dumping.

2.4.3 Existing Drainage Plan in DPR

In the DPR, the city is divided into four zones and rectangular-shaped RCC precast drains with cover were proposed on almost all the roads in each zone. The concept called “a

distributed approach" was adopted for the drainage plan in DPR. It aims to install a number of small-scale rainwater disposal points throughout the catchment in order to minimize the structure size and the costs. The total length of the proposed drains is 970 km, comprising 952 km of RCC precast drains, 5 km of pipe drains, and 13 km of culverts.

2.5 Existing Sewage Treatment and Disposal System

2.5.1 Existing Sewage Management and Control System

(1) Existing Sewage Treatment and Disposal System in Ranchi City

1) General Circumstance of Sewage Treatment in Ranchi City

There is no centralized sewage treatment system in Ranchi City except for three existing sewage treatment plants (STPs). Kanke STP is managed by the Drinking Water and Sanitation Department (DWSD) under the State Government of Jharkhand. MECON and HEC STPs are owned by MECON Limited and HEC Limited, respectively. The sewage generated in households, offices, and hotels are treated by septic tanks with or without soak pits. About 31% of households in Ranchi District have septic tanks. The percentage of households with septic tanks in Ranchi District as of Census 2011 is shown in Appendix A4-1. The overflow from septic tanks and kitchen and bathroom wastes are lead to the existing drainage systems and then flow into the rivers.

Almost all the wastewater from the industries is not treated except for a factory of electronic product which has a chemical treatment facility with polymer, and the wastewater is discharged into the nearby rivers. The Jharkhand State Pollution Control Board (JSPCB) monitors the wastewater discharge qualities of the six industries and 12 large hotels through their own central laboratory as shown in Appendix A4.2.

2) Kanke Sewerage System

The Kanke STP located beside the Kanke Reservoir was constructed in 2005 in order to treat the sewage from nearby area to the reservoir, in which the water is used for the water supply in the northern part of Ranchi City. The capacity of Kanke STP is 4 MLD (4,000 m^3/day). The O&M work of the plant is carried out by the Gonda Division of DWSD, since commercial and industrial water supply is managed by DWSD. The O&M of water supply services is managed using the funds from the State Government of Jharkhand. Table 2.5.1 shows the information on Kanke STP. A photo of Kanke STP is shown in Appendix A4.3.

Table 2.5.2 shows the influent and effluent water qualities in Kanke STP which were examined in February 2014 according to the results of interview with DWSD. The BOD of the influent water is low and the SS is high. The BOD and SS of the effluent water also show the same trend. The BOD is monitored twice a day in the laboratory of Kanke WTP and SS is tested in other laboratory every one to two months.

Table 2.5.1 Information on Kanke STP

No.	Item	Contents
1	Year of construction	2005
2	Location	Northeast of Kanke Reservoir (Zone I)
3	Discharge point	Kanke Reservoir
4	Site area	100 m x 200 m (2 ha)
5	Design population	50,000
6	Design capacity	4 MLD (4,000 m^3/day)
7	Sewage treatment method	Aerated Lagoon (AL)
8	Civil structure	- 1 coarse screen - 1 sump and pump house - 2 aeration tanks - 1 final sedimentation pond - drying bed
9	Owner	DWSD (State Government of Jharkhand)
10	O&M work	Gonda Division, DWSD
11	Annual O&M cost	14 lakh rupees (Rs.1,400,000)
12	Annual chemical cost	4 lakh rupees (Rs.400,000)

Source: DWSD

Table 2.5.2 Water Qualities in Kanke STP

Water Quality	BOD (mg/L)	SS (mg/L)
Influent	50 to 100	480
Effluent	15 to 20	320

Note: Examined in February 2014
Source: DWSD

According to DWSD, the plant is managed by the staff shown in Table 2.5.3 and is operated manually. However, the actual working staff consists only of one or two operators and one guardsman as observed during the site visit to STP.

Table 2.5.3 List of Staff in Kanke STP

Position	Number
Senior Engineer	1
Junior Engineer	1
Operator	4
Other	12
Total	18

Source: DWSD

Deterioration of facilities has progressed much more than what can be expected from a plant used for nine years from 2005. At present, one aerator, out of four, has been removed, and only one aeration tank, out of two, is being operated. The final sedimentation pond has been corroded and it has not been operated for a long time. The effluent from the aeration tank is discharged into the river.

The STP has no operation and maintenance manual but a manual for testing of BOD exists.

3) MECON Colony Sewerage System

MECON Limited, formerly known as “Metallurgical & Engineering Consultants (India) Limited”, is an enterprise which was established by the Ministry of Steel in the Government of India. MECON Colony is located in a residential area which is called as “Shymali

Township" and most of the residents are MECON employees. The colony has its own STP and sewerage system. The total length of main sewers is approximately 16 km.

The general information on MECON STP obtained from the interview with MECON is shown in Table 2.5.4. The photos of MECON STP are shown in Appendix A4.3.

Table 2.5.4 Information on MECON STP

No.	Item	Contents
1	Year of construction	1977
2	Location	South of MECON colony (Zone III)
3	Discharge point	Hinno River
4	Treated population	Around 8,000 (2004 households at present)
4'	Facilities other than households (sewage inflow to STP)	- 1 hospital - 1 school - 1 community hall - MECON Offices
5	Capacity	STP: 45 m^3/hr (1,080 m^3/day) Pumps: 83 m^3/hr (1,990 m^3/day)
6	Sewage treatment method	Aerated Lagoon (AL)
7	Civil structures	- 1 sump and pump house - 2 aeration tanks (W50 m x L90 m x D4.5 m) - 1 final polishing pond
8	Owner	MECON Limited
9	Number of staffs	Four
10	O&M cost	Rs.2.0 lakhs/month Include: - Labor cost excluding MECON staff - Bleaching powder - Aerator oil - Other small items Exclude: - Electricity cost - Civil repairs

Source: MECON

The STP is managed by the Sanitation Department of Town Administration, MECON along with the O&M works of sewers and drains. The supervisor of the STP operation has been a MECON staff but operators and maintenance/repair workers are outsourced.

The lift pumps of STP have been deteriorated and are not operational, but temporary submersible pumps are being used for lifting the sewage to the inlet channel. Two aeration tanks are alternately used and intermittent aerations for each tank are carried out. Algae are found in the water surface of the tanks and weeds are observed inside the final polishing pond.

After the construction in 1977, the drying of the tanks was carried out only once. No major rehabilitation of civil structures and equipment in STP has been carried out so far.

The influent and effluent water qualities of MECON STP are shown in Table 2.5.5. BOD of treated sewage is higher than the norm of the Central Pollution Control Board (CPCB).

Table 2.5.5 Influent and Effluent Water Qualities of MECON STP

Parameter		Influent	Effluent	Norms
pH		6.9-7.1	7.0-7.2	5.5-9.0
BOD	mg/L	70-86	40-54	30
TSS	mg/L	86-106	48-55	100
Oil & Grease	mg/L	<2.0	<2.0	10

Source: MECON
Note: Samples of 4, 11, 18, and 26 December 2013

4) HEC Colony Sewerage System

The HEC Colony was developed by the Heavy Engineering Corporation (HEC) Limited, a public sector enterprise under the Ministry of Heavy Industry in the Government of India. HEC area has its own localized STP and sewerage system. But the HEC sewerage system is very old and the STP located in Tonko, which is outside of Ranchi City and was constructed in the late 1960s, is in a dilapidated state. The STP has not been operational for more than 20 years. (See Figure-3 in Appendix A4-3)

HEC has recently started to construct a new STP in 2012 to treat industrial wastewater and around 30% has been completed. Table 2.5.6 shows the outline of the new STP for industrial wastewater.

Table 2.5.6 Outline of New STP for Industrial Wastewater

No.	Item	Contents
1	Commencement of construction	2012
2	Location	Industrial area in HEC Colony (Zone IV)
3	Capacity	1.1 MLD
4	Treatment method	Chemical (polymer) and filter
5	Owner	HEC Limited

Source: HEC

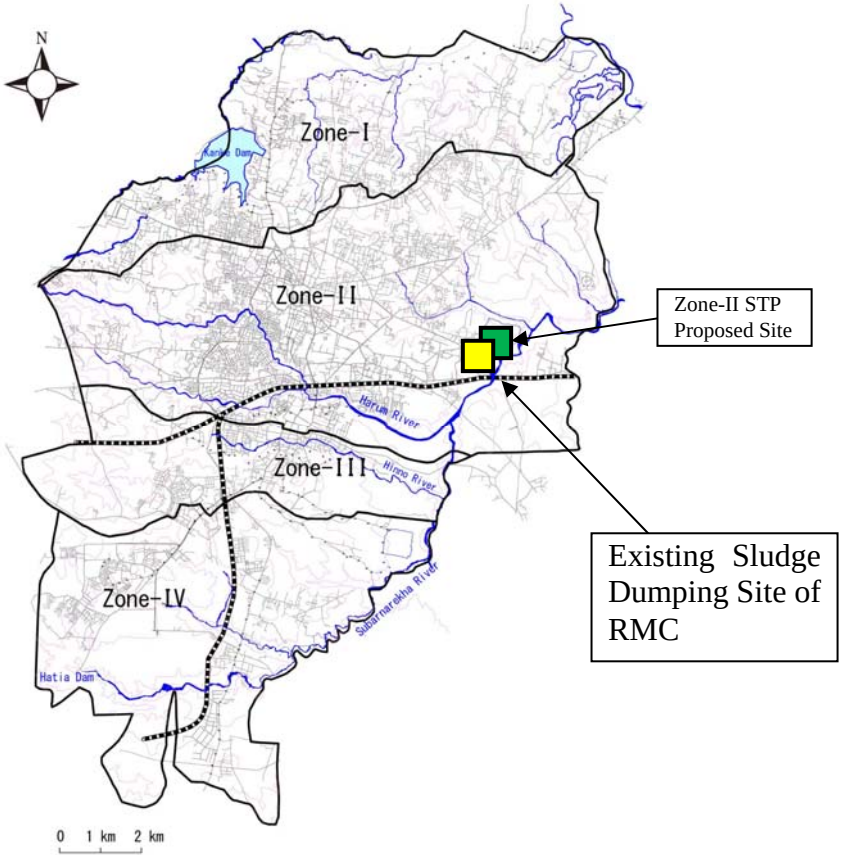
(2) Current Status of Night Soil and Sludge Disposal

1) Collection and Disposal of Night Soils in Septic Tanks

The Health Section of RMC collects the night soils in the septic tanks of households and the public toilets by vacuum trucks. The section also handles the collection of solid wastes and the cleaning of roads and drains. The position of the Health Section in the whole RMC organization is shown in Appendix A4.4 and the staff list of the Health Section is shown in Appendix A4.5. Health Section owns four vacuum trucks with a capacity of 4 m^3. The night soils are collected based on the requests of the households and SISS who has operated the public toilets.

The dumping site of night soils is located adjacent to the power substation and the Subarnarekha River in Zone II. The location of the site is shown in Figure 2.5.1. All the night

soils collected from the whole Ranchi City are conveyed and dumped to the site. Drain and leachate treatment, which are required for the dumped sludge as per the notification by Ministry of Environment and Forests (MOEF) as of 25th September 2000 (Municipal Solid Wastes Management and Handling Rules), do not exist in the site.



Source: JICA Study Team

Figure 2.5.1 Existing Sludge Dumping Site of RMC

2) Sludge Management in Kanke STP

There is a small drying bed in Kanke STP but it is rarely used. According to DWSD, the sludge is extracted from aeration tanks every 2 to 3 months and is directly dumped to the backyard agricultural field near the STP.

2.5.2 Existing Sanitary Conditions and Facilities

(1) Household Toilets

RMC has a plan to increase the number of septic tanks and has constructed the household toilets including septic tanks with full subsidy by RMC and the cost is around Rs.35,000 per household. The number of household toilets installed from 2001 is shown in Table 2.5.7.

Table 2.5.7 Number of Household Toilets Installed through RMC Funds in Recent Years

Sl No	Financial Year	Number of Household Toilets Newly Installed
1.	2001-2002	277
2.	2003-2004	300
3.	2004-2005	154
4.	2005-2006	150
5.	2006-2007	58
6.	2008-2009	99
7.	2009-2010	103
8.	2010-2011	97
9.	2011-2012	68
Total		1,306

Source: RMC, as of March 2013

(2) Public/Community Toilets

RMC who manages the public and community toilets calls all these toilets as "public toilets". However, in this preparatory survey, these toilets were categorized. 'Public toilet' means a toilet placed in public places such as bus stations and markets where the toilet users are not limited to the neighbors. Meanwhile, 'community toilet' means a toilet mainly installed in slum areas for the benefit of the local people.

1) Number and Types of Existing Public/Community Toilets

Based on the interview with RMC and the site surveys conducted by the JICA Study Team for the detailed locations and categorizations, there are 27 public toilets and 17 community toilets (44 in total) constructed by RMC from 2002 to 2013 in Zones II, III, and IV. A summary of existing public and community toilets based on the zones in the study area is shown in Table 2.5.8 and a detailed list is provided in Appendix A4.6. The location of public toilets in Zone II and Zones III and IV are shown in Appendices A4.7 and A4.8. Old public toilets which were constructed before 2002 are not in use in Ranchi City.

Table 2.5.8 Summary of Existing Public and Community Toilets by Zones in the Study Area in Ranchi City

Zone	II		III		IV		Total
Type	Public	Community	Public	Community	Public	Community	
Number	19	13	4	2	4	2	44

Source: RMC

There are several types of public/community toilets in Ranchi City. The typical designs of public/community toilets with 20, 10, and 5 seats are shown in Appendices A4.9 to A4.12.

2) Financial Source of Public/Community Toilets

The Urban Development Department of State Government (hereinafter "UD") has funded the construction of public/community toilets in Ranchi City through RMC, as part of their statewide sanitation improvement programme. All the existing public/community toilets have been financed by RMC with the UD fund, except for one toilet in Birsa Bus Stand which was constructed by Ranchi Regional Development Authority (RRDA) under UD. After the land acquisition by RMC, the toilets have been constructed by nationwide private NGO, named Sulabh International Social Service (SISS) Organisation, which specialized in the construction and maintenance of public toilets.

The locations of the existing public/community toilets were planned based on the past study by RMC before 2002 in the random interviews with the citizens. The priority was put in public places and poor areas in general.

Due to the delay of land acquisition and so on, all the toilets which were planned before fiscal year 2008 were finally constructed and started operation in the beginning of 2014. With regard to the recent year, RMC prepared the budget of Rs.16.9 million for seven toilets in fiscal year 2011 and Rs.11.0 million for five toilets in fiscal year 2012. After the delay, one toilet is now under construction and 11 toilets will be started within fiscal year 2014. RMC prepared a list of 17 alternative sites all over the city and 11 sites would be selected by UD in July 2014. The list is shown in Appendix A4.13.

3) Operation and Maintenance (O&M) of Public/Community Toilets

a) Contract

The O&M works for public/community toilets have been conducted by SISS from 2002, under the supervision of the Engineering Section of RMC. However, the O&M contracts between UD and SISS are for 30-year period from the initiation of toilet use in each toilet. Obviously, it is a bad way of management.

b) User Charge

Most of the public/community toilets impose charges of Rs.2 for toilet use and Rs.3 for bath use which are collected by SISS staff at the entrance of the toilets. The basic charge was proposed by SISS and approved by RMC. However, six public/community toilets are used without charges.

c) Cost

Operation costs such as wages for daily workers and power cost, and small renovations, e.g., repainting of walls, repair of seat, plaster, tiles, have been handled by SISS using the collected charges. When large repairs such as reconstruction of drains and septic tanks are

necessary, SISS can claim RMC to fund for the works.

d) Working Staff

The number of staff varies from 0 to 5 but majority, there are 2 workers, which consist of one bill collector and one cleaning staff. SISS employs daily wage workers in general but local families work for the toilets in some community toilets.

e) Water Supply and Night Soil Management

Out of the 44 public/community toilets, the groundwater is supplied to 37 toilets with small lift pumps in each site and the surface water is supplied to seven toilets by public water supply system. The water is lifted to overhead tanks of the public/community toilets and stored in the tanks. The wastewater is stored in the septic tanks beside the toilets and SISS requests the Health Section of RMC to collect the night soils. The time interval of collecting night soils varies from 10 days to 1 year depending on the number of toilet users and size of septic tanks. Meanwhile, the collection of night soil is rarely conducted in some toilets.

f) Repair Work

The time interval of small repair works varies from 6 months, 1 year, to 2 years. However, out of the 44 toilets, there have been no repairs after the construction and there are no periodical plans of repairs in 19 public toilets.

g) Current Conditions

Around 23 toilets are in good condition and 16 toilets are in bad condition. The remaining five toilets were closed when the JICA Study Team visited the toilets. Since the condition is not closely related to the toilets with/without charges, scale of toilets, and number of staff, it appears that the condition of the toilets depends on the qualities and awareness of staff.

h) Monitoring Framework for SISS

Periodical reports done by SISS do not exist at present. When SISS wants to claim for something such as construction or rehabilitation works to RMC, SISS send the letters to both UD and RMC. The frequency of sending letters varies from 1 to 3 months.

2.6 Existing Organizations and Institutions

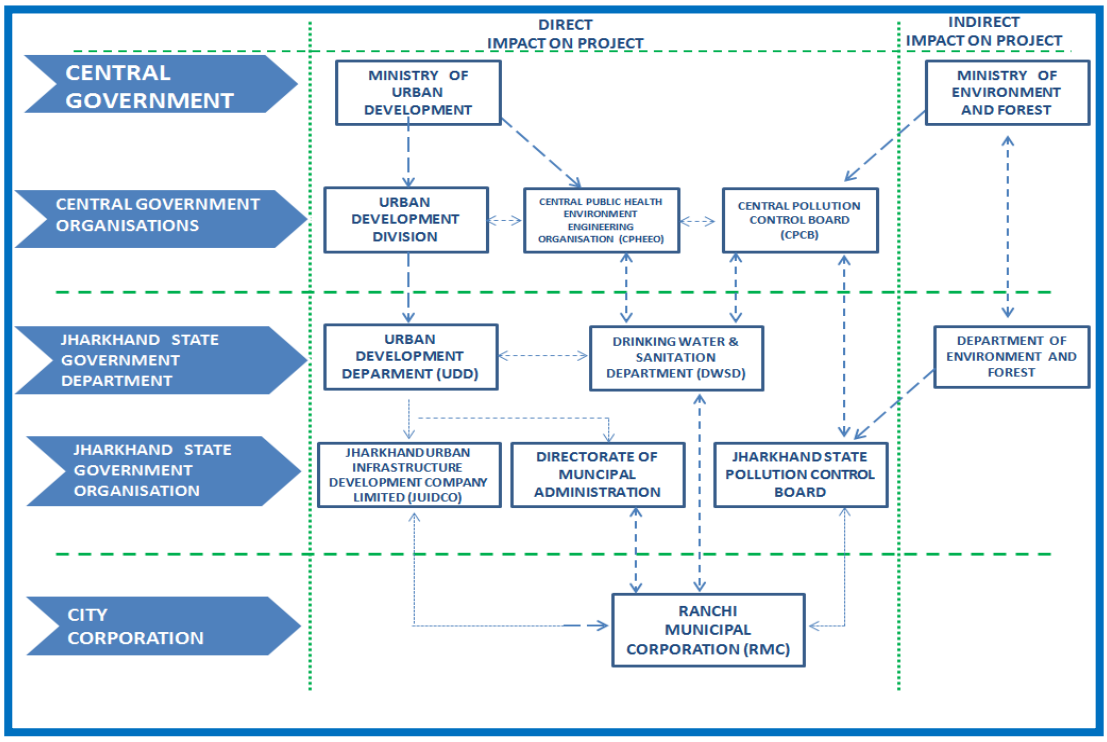
2.6.1 General

Governance being practiced in India follows a three-tiered system, viz. at the central government, state government, and local government levels. The State Government of Jharkhand is headed by the Chief Minister and is the head of the council of ministers. The central government provides policy guidelines and implementation support, and also acts as an intermediary in mobilizing external assistance in the water supply and sanitation sector and links the assistance via the state plans. The executive arm executes or enforces the law, and is vested with the authority and responsibility for the day-to-day administration of the state, divided into administrative blocks.

The Federal Constitution of India treats water supply and sanitation (drainage, sewerage, and solid waste management) as a state subject, where the states are vested with the constitutional right per the 74th Constitutional Amendment Act (1992) to plan, implement, operate, and maintain the needed infrastructure. The states are allowed to recover the costs incurred on related projects and the infrastructure developed. At the local level, this responsibility is entrusted by legislation to the urban local bodies (ULBs), i.e., the municipal corporation.

For governance at the local level, Ranchi City is divided into wards represented by their respective ward councilors, headed by a mayor, who are elected by the residents. The mayor and ward councilors are supported by a chief executive officer (CEO) and his team, which form the "executive" arm of the local government.

Figure 2.6.1 presents institutional linkages among the central, state, and city governments.



Source: JICA Study Team

Figure 2.6.1 Institutional Linkages between Governments at Different Levels

The central government provides policy guidelines and implementation support for specific

laws. It also acts as an intermediary in mobilizing external assistance in the water supply and sanitation sector and links the assistance via the state plans. For example, the Ministry of Urban Development formulates policy guidelines with respect to the urban water supply and sanitation sector and provides technical assistance to the states and ULBs, wherever needed. The expenditure on water supply and sanitation is meted out of block loans and grants disbursed as plan assistance to the states, as well as out of loans from financial institutions.

The target is to establish a system that can function across the linkages that exist among the stakeholder-institutions and aim for the successful implementation of the plans.

2.6.2 Key Institutions/Stakeholders

(1) Central Level

1) Ministry of Urban Development (MoUD)

The Ministry of Urban Development is the apex national authority that formulates policies, sponsors and supports programmes, coordinates activities of various central ministries, state governments and other nodal authorities, and monitors programmes concerning all the issues of urban development in the country.

Of the thirty-three subjects allocated to the MoUD, the ones vital to the preparatory survey and are handled by the Urban Development Division of MoUD are the following:

- S.No.13: Town and country planning.
- S.No.19: Local government, that is to say, the constitution and powers of municipal corporations, municipalities, and other local self-government administrations.
- S.No.21: All matters relating to water supply, sewage, drainage, and sanitation relating to urban areas and linkages with allocated water resources; International cooperation and technical assistance in this field.
- S.No.22 Central council of local self-government.

Urban Development Division of MoUD: Key works assigned include:

- Establishment matters pertaining to Town and Country Planning Organization (TCPO).
- World Bank - assisted urban development projects (other than Jawaharlal Nehru National Urban Renewal Mission (JNNURM)) - Review of loan documents/technical assistance (TA) reports, etc.
- Asian Development Bank (ADB) - assisted urban development projects (pertaining to state governments) - review of loan documents/TA reports, etc.
- ADB -Assisted North Eastern Region Urban Development Programme (NERUDP).
- Issuance of tax-free municipal bonds.
- Pooled Finance Development Fund Scheme.
- Indo-Japan Working Group on Urban Development.
- Foreign direct investment (FDI) matters relating to the urban sector.
- Strategic plan of the ministry.

Central Public Health and Environmental Engineering Organization (CPHEEO)

The CPHEEO is the technical wing of MoUD and is constituted to deal with matters relating to urban water supply and sanitation including solid waste management. Although water supply and sanitation is a state subject, the policies, strategies, and guidelines are being provided by CPHEEO to the states and union territory governments including municipal corporations and committees. CPHEEO plays a vital role in processing the schemes posed for external funding agencies including the World Bank, Japan International Cooperation Agency (JICA), ADB, and other bilateral and multilateral agencies. CPHEEO acts as an 'advisory body' at the central level in giving advice to concerned state agencies and ULBs in implementation, operation, and maintenance of urban water supply, sanitation, and solid waste management projects.

2) Ministry of Environment and Forests (MoEF)

The Ministry of Environment and Forests (MoEF) is the nodal agency for planning, promoting, coordinating, and overseeing the implementation of India's environmental and forestry policies and programmes. While implementing these policies and programmes, the ministry is guided by the principle of sustainable development. Among the key objectives of the ministry are "prevention and control of pollution" and "protection of the environment".

The 'Notification on Environmental Clearance (2006)' requires project implementing agencies to approach MoEF for environmental clearance while the State Environment Impact Assessment Committee clears the environmental impact assessment reports of projects.

3) Central Pollution Control Board (CPCB)

The Central Pollution Control Board (CPCB) provides technical services to MoEF. The principal functions of CPCB are: (i) to promote cleanliness of streams and wells in different areas of the states by prevention, control, and abatement of water pollution; and (ii) to improve the quality of air and prevent, control, or abate air pollution in the country.

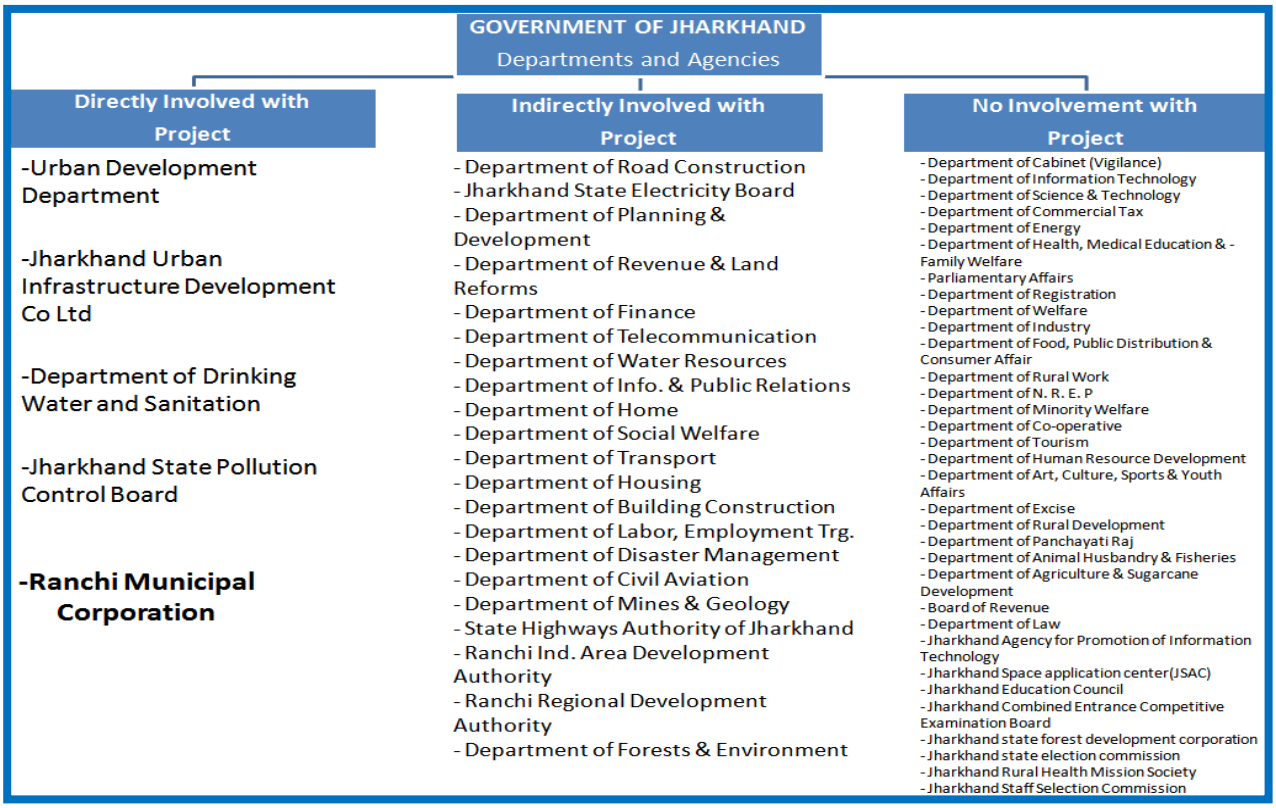
The Parliament of India in its wisdom enacted the Water (Prevention and Control of Pollution) Act, 1974 with a view to maintaining and restoring the wholesomeness of water bodies. The key functions of CPCB are as follows:

- To plan and execute a nationwide program for the prevention, control, or abatement of water and air pollution;
- To coordinate the activities of the state board and resolve disputes among them;
- To provide technical assistance and guidance to the state boards, and carry out and sponsor investigation and research relating to problems on water and air pollution; and
- To lay down, modify, or annul, in consultation with the concerned state governments, the standards for streams or wells, and lay down standards for air quality.

(2) State Level

The State Government of Jharkhand comprises multiple departments and agencies dealing with respective subjects entrusted to them. The overall structure is presented in Figure 2.6.2, divided into three categories, i.e., having direct, indirect, or no involvement with the Ranchi

Sewerage Project.



Source: JICA Study Team

Figure 2.6.2 Departments and Agencies under the State Government of Jharkhand

1) Urban Development Department (UDD) of the State Government of Jharkhand

The UDD provides civic amenities to urban areas in the entire Jharkhand State as per the provision of Municipal Corporation/Municipality Act. The responsibilities of ULBs have increased manifolds in recent past after the enactment of the 74th Constitutional Amendment Act (1992) (*refer to Appendix A5.1*). The constitution envisages ULBs as being fully responsible for all aspects of development, civic services, and environment in the cities. At present, UDD implements its development programmes through three municipal corporations, 14 municipal councils, 19 *nagar panchayats* and two notified areas committees (NAC) with one municipality in Jharkhand State.

The key objective of UDD is to plan for various infrastructure facilities and essential services being implemented by various agencies for works such as water supply, sewage disposal and sanitation, transportation, solid waste management, urban poverty alleviation, and various municipal services within Jharkhand State.

The Urban Development Minister is the political head of the department. The UDD is headed by a secretary who is supported by a director (municipal administration), joint secretary, and three deputy secretaries, apart from other officials. The secretary is also supported by an engineering and technical unit, which has a total of 11 staff, to provide technical functions.

i) Directorate of Municipal Administration of UDD

The Directorate of Municipal Administration was constituted in UDD for creating a linkage

between ULBs of Jharkand State and the State Government of Jharkhand. The directorate's roles and responsibilities are as follows:

- To exercise administrative control over officials belonging to municipal subordinate and municipal supporting (centralized) services;
- To release of funds received from the government and other sources and monitors the expenditure;
- To examine the budget of every municipality and forward the budget of the indebted municipality to the government for sanction;
- To monitoring the collection of taxes, fees, tolls, etc. of municipalities;
- To prepare draft rules, etc. for municipalities;
- To conduct legislative works (e.g., framing of acts/rules/laws); and
- To assist urban local authorities in preparing city plans, etc.

The directorate has three units: 1) Administrative, 2) Finance and Budgeting, and 3) Technical Unit. The administrative and finance and budgeting units are headed by a director (municipal administration) with the support of one deputy director and two assistant directors along with accounting and support staff (20 staff). The technical unit is headed by the chief engineer, with the support of one superintending engineer, two executive engineers, two assistant engineers, and five junior engineers.

ii) Jharkhand Urban Infrastructure Development Company Limited (JUIDCO)

The State Level Steering Committee, which is constituted for the approval, review, and monitoring of JNNURM schemes in Jharkhand State, decided to constitute JUIDCO under the administrative control of UDD. The proposal was approved by the 'Advisory Council' as per item number 12 deliberated and agreed during the meeting in July 2013. Jharkhand Urban Infrastructure Development Company Limited was registered on 19 November 2013.

The organization's key mandate is to plan, implement, and monitor urban infrastructure developmental schemes. Moreover, it shall enhance the capacity/capability of the municipalities established by the state government to implement their respective responsibilities.

Currently, there are seven active directors, with a principal secretary of UDD as the managing director. For JUIDCO's proposed staff (*refer to Appendix A5.2*), the managing director has invited applications for eight management positions and 24 staff to man various technical and non-technical functions, respectively.

Recruitment was initiated in February 2014 and was to be carried out by March 2014 and the top management staff was expected to be in position by the end of May 2014. However, as informed by Secretary UDD, due to poor candidate response, no staff has been put in position till date.

2) Drinking Water and Sanitation Department (DWSD) of the State Government of Jharkhand

The DWSD is the nodal department of the State Government of Jharkhand entrusted with the responsibility of providing water supply and drainage facilities in Jharkhand State. The

department manages water supply schemes and networks in different parts of the state, including Ranchi City. Among the key objectives of DWSD are: i) to mitigate problems of quality drinking water; ii) to increase the coverage of safe drinking water; iii) to maintain and recharge the quality of U/G water; iv) to convert individual household service latrines into septic latrines; and v) to provide community latrines for those who use the open field. While the 74th Constitutional Amendment envisages transfer of water supply function to local bodies, DWSD continues to play a key role in water supply service delivery in Ranchi City. DWSD's Urban Circle (Ranchi) (*refer to Appendix A5.3*) comprising a team of 40 engineers under a superintending engineer, continue to be responsible for planning and operations and maintenance (O&M) of the water supply network in Ranchi City.

The devolution of the water supply function to Ranchi Municipal Corporation (RMC) is limited to providing water connections and levy/collection of 'user charges' from individual households in Ranchi City and bulk users located under Gonda Division of DWSD only. DWSD continues to collect user charges from bulk users in Booty and Hatia divisions; thus there is duplication of effort with respect to water supply function.

The DWSD is implementing the water supply project and sewerage project (only in Zone 1) under the JNNURM for RMC. All funds for executing the said works are routed through RMC for DWSD to implement the projects on its behalf because the former does not have the necessary capacity/capability.

3) Forest and Environment Department of the State Government of Jharkhand

The Forest and Environment Department is entrusted with the custody and management of forest lands and natural resources borne on the lands in Jharkhand State.

Although the name may suggest active involvement in environmental aspects, 'prevention' and 'control' measures for environmental safeguard are under the independent purview of the Jharkhand State Pollution Control Board (JSPCB). The department's role is limited to granting permission to cut trees within the project area.

4) Jharkhand State Pollution Control Board (JSPCB)

The JSPCB is a statutory authority constituted under the aegis of the Forest and Environment Department to ensure proper implementation of the statutes, and judicial and legislative pronouncements related to environmental protection within Jharkhand State. JSPCB is entrusted with the task of applying the following:

i. Water (Prevention and Control of Pollution) Act, 1974;
ii. Water (Prevention and Control of Pollution) Cess Act, 1974;
iii. Air (Prevention and Control of Pollution) Act, 1981; and
iv. Environment (Protection) Act, 1986.

Rules framed by the state government under the first and third acts and those framed by the central government under the second and the fourth acts are in effect within the state. During project implementation, three key clearances among others, viz. i) consent to establish, ii) consent to operate, and iii) clearance for use of hazardous substances are granted by JSPCB.

(3) City Level

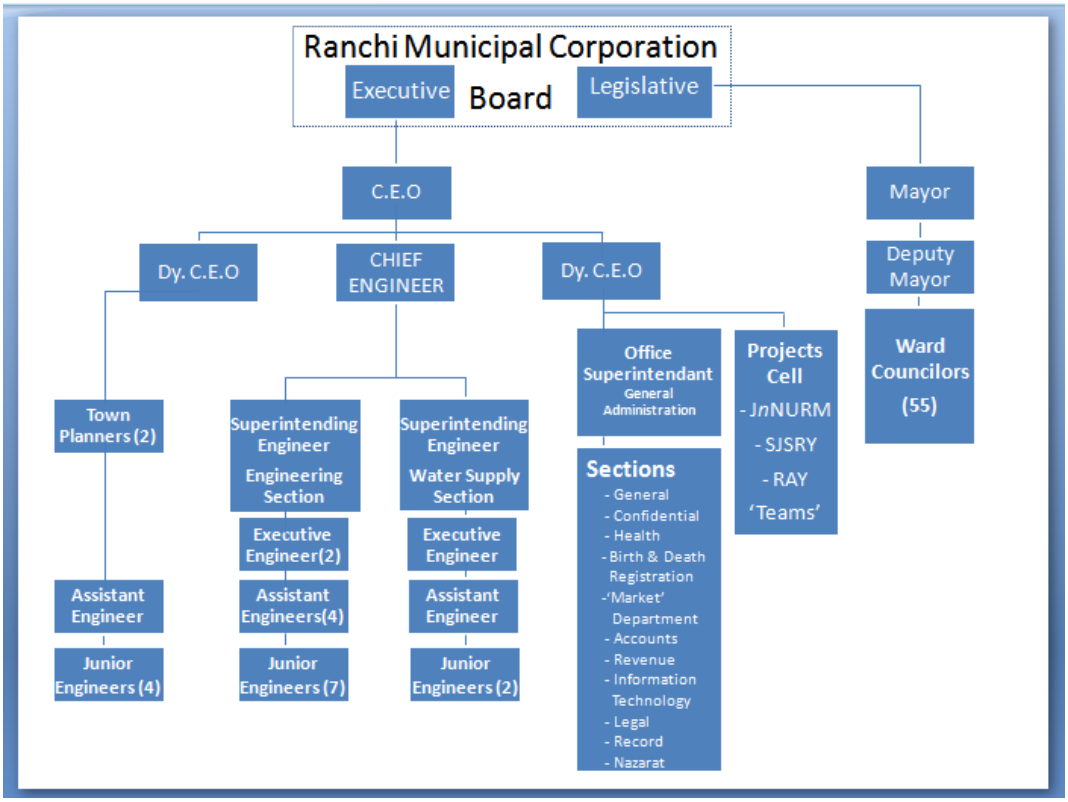
1) Ranchi Municipal Corporation (RMC)

RMC is entrusted with the task of providing essential services to the citizens of Ranchi City. The main functions of RMC as defined in the Jharkhand Municipal Act (2011) are as follows:

- Provision of sanitation facilities;
- Supply of water;
- Construction of roads, drains, etc.;
- Provision of urban amenities such as bus stands for commuters, upkeep of playgrounds, maintenance of parks and other infrastructural development; and
- Administering central and state government urban poverty alleviation (UPA) schemes.

With respect to the project, the key sections to refer to in the Jharkhand Municipal Act (2011) are Clauses 196 to 218 (pages 508-519) and Clauses 219 to 250 (pages 519-535).

The abovementioned list is just a part of the overall responsibility. RMC has to function and be guided by the 'Twelfth Schedule of the 74th Constitutional Act', as presented in Appendix A5. RMC was established on 15 September 1979 vide Government Notification No. 1406 by merging erstwhile Ranchi Municipality, Doranda Municipality, and Ranchi Doranda Joint Water Board. RMC houses 55 ward councilors, which are headed by a mayor. The mayor and the ward councilors are supported by a CEO and his team forms the executive arm. The 55 ward councilors then elect one from amongst themselves as the deputy mayor. Both, the elected and the executive work in tandem to manage the administrative affairs of Ranchi City. The constitution and function of the RMC Board are presented in *Appendix A5.4*. The organogram presented in Figure 2.6.3 below demonstrates the organizational structure of RMC.



Source: JICA Study Team

Figure 2.6.3 RMC Organogram

The key details of RMC sections, i.e., functions performed, hierarchy, and key contact person, are presented in *Appendix A5.5*. At present, RMC has a total of 706 staff; of these, only 25 are engineers (15 in the engineering section, five in water supply section, and five in town planning). With focus on water supply, drainage, and sewerage, salient facts about quantum and type of work done by the Engineering Section, Water Supply Section, and Health and Sanitation Section are elaborated in *Appendix A5.6.*

Other Organizations:

2) Ranchi Regional Development Authority (RRDA):

The RRDA covers an area of 6,12,340 hectares, out of which 15,914 hectares are covered by urban centers collectively known as Ranchi Urban Complex, which is the urban agglomeration of Ranchi, Doranda, Namkum, Hatia, Kanke, Jagannath Nagar, and a few smaller towns. The main functions of RRDA include preparation of master plans, development plans, and action plans for cities/towns in the Ranchi Urban Complex; acquisition and development of government lands for projects; design, construction, and O&M of market complexes, bus stands, night shelters, etc; and approval of building plans.

3) Ranchi Industrial Area Development Authority (RIADA):

The RIADA is an autonomous body playing an important role in the industrial development of seven tribal districts of Jharkhand. Entrusted fundamentally with the task of establishing industrial areas, RIADA has also taken the responsibility of providing continued assistance to units that come up in these industrial areas.

4) Heavy Engineering Corporation (HEC):

The HEC was established as an integrated engineering industrial complex with design, engineering, and manufacturing base. This public sector company, under the Ministry of Industries of the Government of India, is engaged in the manufacture and supply of capital equipment, machine tools, and spares needed for the core sector industries. Six wards (i.e., Wards 39 to 44) of RMC fall in the land under HEC's control, where HEC is responsible for infrastructure development and maintenance in the area.

5) MECON Limited

The MECON is a public sector undertaking under the Ministry of Steel of the Government of India, and is an engineering, consultancy, and contracting organization. The headquarters falls under Ward 46 of RMC but is a restricted area controlled by MECON. The organization operates an STP plant catering to the needs within its vicinity.

2.6.3 Laws and Regulations related to Sewerage and Drainage System

Multiple policies, laws, and regulations would have a bearing on the sewerage project, as tabulated in Table 2.6.1 below.

Table 2.6.1 Laws and Regulations related to Sewerage and Drainage

	Policies and Legal Framework	**Concerned Organization/Authority**
1.	National Urban Sanitation Policy (2008)	MoUD/UDD (GoJ)
2.	74th Constitutional Amendment (1993)	MoUD, UDD (GoJ), and RMC
3.	Jharkhand Municipal Act (2011)	UDD (GoJ) and RMC
4.	Water (Prevention And Control Of Pollution) Act (1974) and its Amendments	CPCB and JSPCB
5.	Water (Prevention And Control Of Pollution) Cess Act (2003)	MoEF, CPCB, and JSPCB
6.	Environment (Protection) Act (1986)	MoEF and CPCB
7.	National Environmental Tribunals Act (1995)	MoEF, and State Forest Department, CPCB, and JSPCB
8.	Hazardous Waste (Management And Handling) Rules (1989)	MoEF, CPCB, and JSPCB
9.	Designated-Best-Use By Central Pollution Control Board (1981)	CPCB, JSPCB
10.	General Standards for Discharge of Environmental Pollutants under the Environmental Protection Rules (1989)	MoEF, CPCB, and JSPCB
11.	Land Acquisition Act (2013)	Revenue Department GoI, Department of Revenue and Land Reforms (GoJ)
12.	National Resettlement and Rehabilitation Policy (2007)	MoRD,
13.	Jharkhand State Resettlement and Rehabilitation Policy (2008)	UDD (GoJ), RMC, Revenue Department
The following would have indirect impacts on the project		
14.	Public Liability Insurance Act (1991)	MoEF, CPCB, and JSPCB
15.	Air (Prevention and Control of Pollution) Act and Subsequent Amendments (1981)	CPCB, JSPCB, and Transport Department
16.	Noise Pollution (Regulation and Control) Rules and Amendments (2000)	MoEF, CPCB, and JSPCB
17.	Factories Act (1948)	Ministry of Labour and Employment
18.	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act (1996)	Ministry of Labour and Employment
19.	Easements Act (1882)	MoUD/UDD (GoJ)

	Policies and Legal Framework	**Concerned Organization/Authority**
20.	Ranchi Planning Standards and Building Bye-Laws (2009)	UDD (GoJ) and RMC
21.	National Building Code 2005-Part 9 Plumbing Services (Section 1 Water Supply, Drainage, and Sanitation)	UDD (GoJ) and RMC
22.	Manual Scavenging Act (1993)	MoUD, UDD (GoJ), RMC
23.	Notification on Environmental Clearance (2006)	MoEF, CPCB, JSPCB, and State Environmental Impact Appraisal committee
24.	Municipal Solid Wastes (Management and Handling) Rules (2000)	MoEF, CPCB, and JSPCB
25.	Bio-Medical Waste (Management and Handling) Rules and Amendments (1998)	MoEF, CPCB, and JSPCB
26.	E-waste (Management and Handling) Rules (2011)	MoEF, CPCB, and JSPCB
27.	Plastics (Manufacture, Usage, and Waste Management) Rules (2009)	MoEF, CPCB, and JSPCB
28.	Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules (1996)	MoEF, CPCB, and JSPCB
29.	Forest (Conservation) Act (1980)	MoEF, and State Forest Dept
30.	Wildlife Protection Act (1972)	MoEF, and State Forest Dept
31.	Fly Ash Notification (2007)	MoEF, CPCB, and JSPCB
32.	Ancient Monuments and Archaeological Sites and Remains Act (1958)	Archaeological Department, Government of India

Source: JICA Study Team

All the above listed relevant rules, regulation, and acts have been tabulated along with their respective salient features in *Appendix A5.7.*

2.6.4 Permissions and Authorizations

(1) Project Acceptance Process

The consultant will submit the draft detailed project report (DPR) to CEO RMC; draft DPR will then be forwarded to the Directorate of Municipal Administration of UDD. The DPR is vetted by Housing and Urban Development Corporation Limited (HUDCO), a corporation owned by the Government of India that has been appointed as the appraisal agency by the State Government of Jharkhand.

After the appraisal, the draft DPR will be submitted to CPHEEO of MoUD under the Government of India for technical acceptance. After the technical acceptance has been granted, the DPR will be submitted to the Ministry of Economic Affairs and Ministry of Finance (both under the Government of India) for financial sanction.

(2) Project Authorizations

As a prerequisite, the social impact assessment (SIA) and environmental impact assessment (EIA) must be carried out before the project can commence because the results of SIA and EIA will form the contractual obligation of the project executing agency. These aspects have been further detailed in Section VI titled 'Environmental and Social Considerations' of this report. Monitoring of the compliance falls under the purview of the Deputy Commissioner of Ranchi.

During project implementation, the following three key clearances will have to be sought from JSPCB:

i. Consent to establish,

ii. Consent to operate, and

iii. Clearance for use of hazardous substances.

Similarly, the Forest and Environment Department has to grant permission to cut trees within the project area.

(3) Interdepartmental Coordination during Implementation

By law, for all development project activities executed within the jurisdiction of RMC, the permission has to be granted by the CEO of RMC, as RMC is the custodian of all state government-owned land in Ranchi City. As a practice, the following three actions are taken whenever a new development work is initiated:

The head of the project implementing agency officially informs about the project details, especially the commencement date of the project, to all stakeholders who are directly or indirectly connected with the project. The list of concerned organizations includes (but not limited to):

- State Electricity Board
- Telephone Agencies (Public and Private)
- Department of Home (City Police)
- Railways (South-Eastern Railways)
- Department of Water Resources
- State Pollution Control Board
- Department of Transport (Traffic)
- Department of Road Construction
- Airports Authority of India
- Drinking Water and Sanitation Department

The head of the project implementing agency presents the project details during the monthly meeting, convened under the chairmanship of the Deputy Commissioner of Ranchi (the Deputy Commissioner of Ranchi is the District Administrator, which is equivalent to a District Magistrate). The objective of the meeting is to review and coordinate all development works in the district and is attended by the heads of all organizations concerned with Ranchi City.

Unresolved coordination issues are taken up during the monthly meeting of secretaries of the State Government of Jharkhand.

2.7 Existing Environmental and Social Conditions

2.7.1 Environmental and Social Conditions based on the Baseline Survey

(1) Objectives of the Social Baseline Survey

The objectives of the social baseline survey are:

- To collect baseline information of the socioeconomic conditions of the project area by sample survey of the households, for financial and economical evaluation of the project. In addition, the sewerage and drainage conditions are also addressed through a specially designed questionnaire,
- To confirm current status of land availability for the project and the necessity of land acquisition/resettlement and to collect data/information for preparing preliminary resettlement plan, if necessary.

(2) Survey Area

The survey area covers Zones II, III, and IV. These zones are created purely on the basis of a study and execution purpose.

(3) Methodology of the Survey

A questionnaire survey to households in the survey area has been conducted. Items/issues collected by the questionnaire survey are as follows:

- Demographic characteristics;
- Socioeconomic characteristics;
- Existing water sources and problems of quantity and quality;
- Details of household water usage;
- Common hygiene practices and cultural beliefs;
- Capacity and willingness of the community to pay for improvement water quality;
- Existing sewerage system and public community toilets;
- Capacity and willingness of the community to pay for the improvement of the system; and
- Sanitation provisions, latrine coverage, and usage.

(4) Sample Size

Since the target of the project are urban households residing in the RMC service area, the sample was selected from 45 wards out of 55 wards falling under Zones II, III, and IV. The sample population was selected proportionally to the overall urban population. The sample was also taken on the basis of the respondents' economic conditions, i.e., low-income, middle-income, and high-income groups. Total size of the sample was 120 households through Zones II, III, and IV. Sample size is summarized in Table 2.7.1 below.

Table 2.7.1 Number of Samples by Zone and by Income Group

Zone	Total No. of Wards Surveyed	Total No. of Household Surveyed		LIG(Note)		MIG(Note)		HIG(Note)	
		No	%	No	%	No	%	No	%
Zone II	31	68	56.7	28	23.3	20	16.7	20	16.7
Zone III	11	30	25.0	7	5.8	14	11.7	9	7.5
Zone IV	3	22	18.3	5	4.2	8	6.7	9	7.5
Total	**45**	**120**	**100**	**40**	**33.3**	**42**	**35.0**	**38**	**31.7**

Source: JICA Study Team
Note: LIG: Low-income group, MIG: Middle-income group, HIG: High-income group

(5) Results of the Survey

The following are the major results of the survey.

1) Source of Water Supply

55% of the people rely on private wells because the current water supply system from RMC is not satisfactory at all. Table 2.7.2 shows that 29.2% of the households have water supply connections. As shown in the table, people in the high-income group use private wells more than those in the middle and low-income groups. This means that the current condition of water supply managed by RMC is not reliable mainly due to water rationing and low water pressure.

Table 2.7.2 Source of Water Supply

Source	LIG		MIG		HIG		Total	
	No	(%)	No	(%)	No	(%)	No	(%)
Household connection	11	27.5	14	33.3	10	26.3	35	29.2
Private well (ground water)	20	50.0	20	47.6	26	68.4	66	55.0
Public well/tap (water supply)	3	7.5	2	4.8	1	2.6	6	5.0
Public well/tap (ground water)	6	15.0	6	14.3	1	2.6	13	10.8
River or canal	0	0.0	0	0.0	0	0.0	0	0.0
Total	**40**	**100**	**42**	**100**	**38**	**100**	**120**	**100**

Source: JICA Study Team

2) Availability of Toilets

83.3% of the households have toilets in their home. The percentage in each group is 65% for the low-income group, 85.7% for the middle-income group, and 100% for the high-income group, as indicated in Table 2.7.3.

Table 2.7.3 Availability of Toilet at Home

	Available (%)	Not Available (%)
Overall	83.3	16.7
LIG	65.0	35.0
MIG	85.7	14.3
HIG	100.0	0.0

Source: JICA Study Team

Majority of the population, which is 76.7%, relies on septic tank, followed by 3.3% on

sewer connection and 2.5% on pit latrine, as indicated in Table 2.7.4. Most of the people are not satisfied with the current provision of sanitary facilities.

Table 2.7.4 Disposal System of Household

Kind of Disposal System	Total (n=120)		LIG (n=38)		MIG (n=42)		HIG (n-40)	
	No	(%)	No	(%)	No	(%)	No	(%)
Sewer connection	4	3.3	0	0.0	3	7.1	1	2.5
Septic tank (connecting with a soak pit or trench)	92	76.7	21	55.3	33	78.6	38	95.0
Pour-flush latrine (using water)/Barapali	0	0.0	0	0.0	0	0.0	0	0.0
Pit latrine (not using water)	3	2.5	2	5.3	1	2.4	0	0.0
No toilet is provided	21	17.5	15	39.5	5	11.9	1	2.5
TOTAL	**120**	**100**	**38**	**100**	**42**	**100**	**40**	**100**

Source: JICA Study Team

3) Preferences on Sanitation

63.3% of the households made water supply as their first priority while the other 20% made sewerage system as their first priority. 72.3% of the households made drainage as their second priority while 55.1% chose sewerage system as their third priority, as shown in Table 2.7.5.

Table 2.7.5 Water Supply and Sanitation Priorities of the Households

Sanitation Item	1st Priority		2nd Priority		3rd Priority	
	No	(%)	No	(%)	No	(%)
Water supply	76	63.3	9	7.6	24	20.3
Drainage	19	15.8	86	72.3	11	9.3
Sewerage system	24	20.0	17	14.3	65	55.1
Public/community toilet	1	0.8	2	1. 7	2	1.7
Solid waste collection and disposal	-	-	5	4.2	12	10.2
Washhouse (wash space)	-	-	-	-	4	3.4
Others	-	-	-	-	-	-
Total	**120**	**100**	**119**	**100**	**118**	**100**

Source: JICA Study Team

4) Willingness to Connect to the Sewerage System

Those households who are not connected to the sewerage system shared their views on willingness to connect to the sewerage system. According to Table 2.7.6, in total, 96.6% are willing to connect to the sewerage system, where 25% came from low-income group (LIG), 34.1% from middle-income group (MIG), and 37.5% from high-income group (HIG).

Table 2.7.6 Willingness to Connect to the Sewerage System

Opinion	Total (n=88)		LIG (n=22)		MIG (n=32)		HIG (n-34)	
	No	(%)	No	(%)	No	(%)	No	(%)
Yes	85	96.6	22	25.0	30	34.1	33	37.5
No	3	3.4	0	0	2	2.3	1	1.1
TOTAL	**88**	**100**	**22**	**25.0**	**32**	**36.4**	**34**	**38.6**

Source: JICA Study Team

5) Willingness to Pay

As elaborated in Table 2.7.7, only 7.1% of the households are willing to pay the installation charges of more than Rs.1,000 in total. However, 36.5% households are comfortable paying Rs.500-1000. All the three income groups followed the same pattern regardless of the economic condition.

Table 2.7.7 Willingness to Pay for Installation of Sewer Connection

Charges	Total (n=85)		LIG (n=22)		MIG (n=30)		HIG (n-33)	
	No	(%)	No	(%)	No	(%)	No	(%)
Less than Rs.100	24	28.3	7	31.8	10	33.3	7	21.2
More than Rs.100 to less than Rs.500	20	23.5	7	31.8	5	16.7	8	24.2
More than Rs.500 to less than Rs.1,000	31	36.5	7	31.8	11	36.7	13	39.4
More than Rs.1,000	6	7.1	1	4.6	1	3.3	4	12.1
As prescribed by the government (depending on the distance to the main sewer pipe)	2	2.4	0	0.0	2	6.7	0	0.0
Do not want to pay	2	2.4	0	0.0	1	3.3	1	3.1
Total	**85**	**100**	**22**	**100**	**30**	**100**	**33**	**100**

Source: JICA Study Team

6) Sewer Charges

As indicated in Table 2.7.8, 62.4% of the households agreed to pay Rs.20-60 a month for sewer charges.

Table 2.7.8 Willingness to Pay for Monthly Sewer Charges

Charges	Total		LIG		MIG		HIG	
	No	(%)	No	(%)	No	(%)	No	(%)
Less than Rs.20/month	20	23.5	6	27.3	7	23.3	7	21.2
More than Rs.20 to less than Rs.40/month	31	36.5	15	68.2	12	40.0	4	12.1
More than Rs.40 to less than Rs.60/month	22	25.9	1	4.6	11	36.7	10	30.3
More than Rs.60 to less than Rs.80/month	6	7.1	0	0.0	0	0.0	6	18.2
More than Rs.80 to less than Rs.100/month	5	5.9	0	0.0	0	0.0	5	15.2
More than Rs.100/month	1	1.2	0	0.0	0	0.0	1	3.0
Total	**85**	**100**	**22**	**100**	**30**	**100**	**33**	**100**

Source: JICA Study Team

2.7.2 Environmental Regulations/Guidelines of India and JICA

The Environmental Impact Assessment (EIA) is an important tool for integrating the objectives of environmental management into the decision making process to ensure environmentally sound and sustainable development. In India, EIA was started in the latter half of the 1970s to examine the river valley projects from environmental angle. On January 1994, EIA notification was issued by the Ministry of Environment and Forest (MoEF) by which the EIA process became a “statutory requirement” rather than an “administrative requirement” for a number of projects/activities likely to have significant environmental impacts and health implications. After that the EIA notification has undergone several

amendments incorporating provisions for "public hearing" and bringing in several important projects/activities into the purview of EIA. In order to further improve the EIA procedure, the EIA notification was revised on September 14, 2006. At present the EIA in India has been regulated by this notification, i.e., EIA Notification-2006.

One of the salient features of the EIA in India is that an EIA will be conducted as part of the prior Environmental Clearance (EC) obtaining process. The EC is a kind of environmental permission to be required before the commencement of any construction work, or preparation of land by the project management except for securing land. The EIA Notification-2006 has compelled 39 types of projects/activities, which belong in eight groups of industrial sectors, to obtain EC from either the central or state government depending on their categorization given in the schedule attached in the EIA Notification-2006.

Another aspect of the environmental management for new projects/activities in India is the Social Impact Assessment (SIA). In case EIA is implemented, SIA is also implemented as part of the EIA process in general. The SIA in India is regulated by the "National Rehabilitation and Resettlement (R&R) Policy" issued in 2007 (NRRP-2007). The NRRP-2007 provides the basic requirements of R&R which are needed with the acquisition of lands for the implementation of project/activities. Together with the NRRP-2007, the land acquisition involving involuntary displacement is regulated by the act entitled "The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013", so called New Land Acquisition Act. This act replaced the Land Acquisition Act, 1894, a nearly 120-year old law enacted during British rule. The act regulates land acquisition and provides laid down rules for granting compensation, rehabilitation, and resettlement to the affected persons. One of the salient features of the New Land Acquisition Act is the public concern on land acquisition is heightened compared with the old land acquisition act. Rules of holding of public hearing/consultation to the affected people are provided as a mandatory issue in the New Land Acquisition Act.

Apart from the laws and regulations on the environmental issues in India mentioned above, the "Guidelines for Environmental and Social Considerations, April 2010", or the so called JICA guidelines, will be applied to yen loan projects. The JICA guidelines classifies the project into four categories according to the extent of environmental and social impacts, taking into account an outline of the project, scale, site condition, etc. As for the sewage project, Appendix 3 of the JICA guidelines mentioned sewage and wastewater treatment that have sensitive characteristics or are located in sensitive areas or in their vicinity as sensitive sector. Considering the potential negative environmental impacts on the estimated amount of land acquisition, this project is considered under Category B of the JICA project categorization. The JICA guidelines requires Category B project to implement an EIA

including the SIA issues. Table 2.7.9 below summarizes the major points of the Indian environmental regulations and JICA guidelines for Category B projects.

Table 2.7.9 Comparison of Major Points of Indian Regulations with JICA Guidelines in Terms of Environmental and Social Considerations

Item	JICA Guidelines	Indian Regulations
Project categorization	Four categories: Categories A-D	Two categories: Categories A and B Category B is further divided into Category B1 and Category B2
EIA	Required for Category A project	EIA is conducted as part of the EC obtaining process, if necessary. EC is required for 39 activities/projects listed in the Schedule of EIA Notification-2006. Categories A and B1 projects are compelled to carry out EIA.
SIA	Included in EIA	When EIA is conducted, SIA is also conducted as part of EIA in general. But EIA and SIA are basically separated activities. Main legislation for EIA is EIA Notification-2006, those of/for SIA are New Land Acquisition Act and NRRP-2007, respectively.
Public consultation	Required	To be conducted as part of SIA.
Land acquisition	In case the projects resulted in a large-scale involuntary resettlement, a resettlement action plan (RAP) will be prepared. Land acquisition is dealt with in RAP.	Lands for projects of "public purpose" are acquired by the state/district government for Category B project based on the New Land Acquisition Act. The act also regulates issues of compensation, rehabilitation, and resettlement.

Source: JICA Study Team

2.7.3 Responsible Organizations of the National and State Government

(1) Ministry of Environment and Forest (MoEF)

The MoEF is the principal environmental regulatory agency in the central level of India. MOEF formulates environmental policies and issues environmental clearances for Category A projects.

(2) Central Pollution Control Board (CPCB)

The CPCB is a statutory organization under the MoEF. It was established in September 1974, and is entrusted with the powers and functions under the Water Prevention and Control of Pollution Act, 1974 and the Air Prevention and Control of Pollution Act, 1981. It serves as a field formation and also provides technical services to the MoEF in compliance with the Environment Protection Act, 1986. It coordinates the activities of the State Boards by providing technical assistance and guidance and resolve disputes among them. It is an apex organization in the country in the field of pollution control, as technical wing of MoEF.

(3) Jharkhand State Pollution Control Board

As per the policy decision of the Government of India, the CPCB has delegated its powers and functions under the Union Territories to the respective local administrations.

The Jharkhand State Pollution Control Board implements the provisions of these acts and rules in the state. The functions of the board are provided under Section 17 of the Water Prevention and Control of Pollution Act 1974 and the same section of the Air Prevention

and Control of Pollution Act 1981 and under the remaining acts and rules.

(4) Department of Forest, Jharkhand State

The Department of Forest in Jharkhand State takes care of the forest resources in the state. It provides the support in forest land acquisition and tree cutting, and compensatory afforestation.

2.7.4 Existing Environmental Impact Assessment Report Prepared in DPR

The Environmental Impact Assessment (EIA) study which included the social impact assessment study was conducted in 2006-2007 by Meinhardt, the DPR consultant, in order to provide inputs in the preparation of detailed project report (DPR) covering the general guidelines of the EIA Notification-2006. The EIA study was conducted for the entire RMC area, i.e., Zone I, Zone II, and Zones III and IV. The study method adopted for this EIA study complies with the provision of the EIA Notification-2006. The study method can be broadly divided into following three phases:

Phase-1: The first phase involves identification of significant environmental components and assessing their baseline (Pre-project or existing) status within the study zone.

Phase-2: The second phase involves prediction of impacts on various significant environmental parameters due to the proposed project. Data regarding the proposed construction activities, design capacity of facilities, water consumption, surplus soil generation, sewage generation, characteristics of disposal medium, and topography of the impact zone.

Phase-3: The third phase includes evaluation of impacts and preparation of an Environmental Management Plan (EMP) to mitigate adverse impact on the physical and non-physical environment. The EMP will be prepared based on the major impact extracted in Phase-2 above.

(1) Situation of EIA Required for Sewerage Project

Although the EIA report of DPR meets the requirements of the EIA Notification-2006, such as form and contents of the report, the EIA report is lacking in quantification of the impacts in general. The baseline data is more than five years old and needs to be updated. According to the EIA Notification-2006, an EIA is carried out as part of the prior environmental clearance (EC) process in India. However, the EIA study of DPR was not carried out for obtaining the prior environmental clearance either from the central government or the state government.

Considering the above situation of the EIA in India, the EIA study in DPR was not conducted in the course of the prior EC obtaining process. The EIA report of DPR has been prepared with regard to the sewage project which falls under Group 8 (b) of the schedule of the EIA Notification-2006, i.e., “Townships and Area Development Project”. Besides, the

EIA report has been prepared considering the environmental consciousness of RMC.

(2) Environmental Management Plan (EMP)

Preparation of EMP has been made mandatory by the EIA Notification-2006. The EIA Notification-2006 mentioned that the mitigation measures to be implemented to avoid or minimize the adverse environmental impacts should be described in the EIA report. Description of the mitigation measures is an indispensable part of EMP. The EMP is described in Chapter 6 of the EIA report based on the project description (Chapter 21), Baseline Environment Status (Chapter 3 [1]), and Environmental Impact Assessment (Chapter 5 [1]). In Chapter 5, several items/issues for the environmental management are selected considering the project description and the current environmental and social conditions. The EMP in Chapter 6 has been described focusing on these environmental components.

All of the environmental items/issues and mitigation measures included in the EIA report are applicable to the EMP of the Ranchi Sewerage Project.

(3) Environmental Monitoring Plan

An environmental monitoring plan is required to manage the effectiveness of the mitigation measures and to report to the regulatory authorities. The monitoring plan will be prepared on the basis of the EIA and EMP. Therefore, the environmental monitoring plan should be prepared for items/issues which have potential adverse impacts on the environment mentioned in the EPM. In general, the environmental impacts from the sewage project are minor. Simple sets of mitigation measures, dealing mostly with good design and competent contract management will eliminate or reduce significantly all possible problems. Key actions for preparation of the environmental monitoring plan are shown below.

- Assist in detecting the development of any unwanted environmental situation, and thus, provide opportunities for adopting appropriate control measures;
- Define the responsibilities of the project proponents, contractors, and environmental monitors and provide the means of effective communication among them;
- Define monitoring mechanism and identify monitoring parameters;
- Evaluate the performance and effectiveness of mitigation measures proposed in the EMP and suggest improvements if required; and
- Identify training requirements at various levels.

Based on the above, the environmental monitoring plan is summarized in the EIA report. Terms of monitoring in the EIA report, which complies with the JICA monitoring form, is shown below:

- Project phase (Construction, Operation),
- Mitigation measures to be taken such as dust control methods,

[1] Chapters of the EIA report of DPR

- Parameters to be monitored such as SPM[2], BOD,
- Location of monitoring,
- Frequency of monitoring such as twice a year, once a month, and
- Responsible organization/unit/person such as contractor, PMU.

2.7.5 Investigation of the Land Acquisition and Resettlement Conditions

In order to avoid or minimize huge land acquisition and resettlement, the sewer trunk, the location of sewage pumping stations, and sewerage treatment plant were examined during the second field survey starting in May 2014.

Table 2.7.10 summarizes the areas of land to be acquired in Zone II.

Table 2.7.10 Land to be Acquired in Zone II

Facility	Route/(Location)	Current Conditions	Area to be Acquired (Ha)	No. of Resettlement Families
Sewer Trunk	(Zone II)	Public land	0	0
PS 1	TR-1/(Vidya Nagar)	Private land, vacant grassland	0.12	0
PS 2	TR-1/(Kadru)	Private land, vacant grassland	0.17	0
PS 3	TR-2/(Krishnapuri)	Private land, vacant grassland, few electric poles	0.10	0
PS 4	TR-3/(Disnery Pool)	Private land, vacant grassland	0.14	0
PS 5	TR-4/(Sarnatoli)	Private land, vacant grassland	0.12	0
PS 6	TR-2/(Tata Road)	Land not yet confirmed because of a newly proposed pump station	0.17	-
STP II(Note2)	(Namkum/Tonko)	Agriculture land (cultivation of wheat, maize, etc.)	6.00 (Including access road)	0
Total			**6.75**	**0**

Source: JICA Study Team
Note: PS: Pumping Station, STP: Sewage Treatment Plant

As for the Zones III and IV, the JICA Study Team reviewed the locations of the pumping stations and sewage treatment plant in order to minimize the project affected people and areas. As for the land for the sewage treatment plant for STP III and IV, land acquisition is not needed because the planned land is owned by the state company. Table 2.7.11 summarizes the conditions of land acquisition in Zones III and IV as of the end of June 2014.

[2] Suspended particulate matter

Table 2.7.11 Land to be Acquired in Zones III and IV

Facility	Route	Area to be Acquired(Note) (Ha)	No. of Displaced Families
Sewer trunk	(Zones III and IV)	0	0
PS 1	TR-1	0.10	0
PS 2	TR-1	0.10	0
PS 3	TR-1	0	0
PS 4	TR-1	0.17	0
PS 5	TR-1	0.17	0
PS 6	TR-3	0.12	0
STP	HEC (State company owned land)	0	0
Total		**0.66**	**0**

Source: JICA Study Team

CHAPTER III PLAN AND DESIGN OF STORMWATER DRAINAGE AND SEWEREAGE SYTEM

3.1 Setup of Planning and Design Conditions

This preparatory survey was supposed to be carried out basically in compliance with the technical strategy of the existing DPR prepared in 2007 and subsequent revised version in 2013. However, a lot of modifications have been made by the JICA Study Team because the captioned DPR contained many critical problems on the design conditions. The following are major planning and design conditions newly set up for this preparatory survey in order to improve the previous DPR seeking for the possibility of implementing JICA's yen loan scheme.

3.1.1 Target Year of the Project

The target year in the DPR was set at 2046, 30 years after the commencement of operation in 2016 for sewers, while the intermediate target year was set at 2031, 15 years after the commencement of operation for pumping machinery, rising mains and sewage treatment plant in accordance with the design manual of CPHEEO.

In this preparatory survey, the same target year was set at 2046 and 2031 for respective sewerage facilities as above mentioned.

3.1.2 Service Area of the Proposed Sewerage System

According to the existing zoning established in the DPR, the service area of the sewerage system is divided into four zones, namely: Zones I, II, III, and IV. Based on the prior discussions between JICA and the Jharkhand State government, the sewerage system of Zone I together with the drainage system was agreed to be carried out under the JNNURM scheme in the future under the management of Jharkhand State government.

Zone II located in the central part of the city has the largest population and highest population density (658,000 persons, 93 persons/ha) as of 2011 census compared to Zone III (169,000, 55 persons/ha) and Zone IV (133,000, 31 persons/ha). In this regard, it is worth carrying out the sewerage project in Zone II preferentially in view point of cost-benefit performance.

Meanwhile, the future total population in Zones III and IV will only be 480,189, which is approximately half of the future population of Zone II at 813,355, in 2031 as shown in the existing DPR. The land use of Zones III and IV is mainly for agricultural purpose, although the MECON colony is located in Zone III and the HEC colony is located in Zone IV and both colonies are famous for heavy industrial areas in Ranchi City. The sewerage system of each colony has been established independently under their own finance and management. The urgency of providing the sewerage system in Zones III and IV will not be so high as in Zone II.

Therefore, Zone II has been designated as the first priority and possible target zone in case the yen loan project will be applied in the near future. Meanwhile, Zones III and IV, as a combined area in the same way as DPR, are recognized as the secondary priority zones for establishing sewerage systems under the yen loan scheme.

3.1.3 Population Projection

The total population in Ranchi City as per the census survey in 2011 is 1,073,470. Based on this census survey, future population was projected in the DPR as shown in Table 3.1.1 and the projection was approved by RMC and CPHEEO of the central government.

Table 3.1.1 Future Population Projected in DPR

Year / Zone	2011	2016	2031	2046
Zone I	197,911	245,164	309,680	502,710
Zone II	592,304	679,292	813,355	949,869
Zones III and IV	283,255	373,122	480,189	587,758
Total	**1,073,470**	**1,297,518**	**1,603,224**	**2,040,337**

Source: DPR

The ward-wise population projections of Zone II for the base year 2016, and target years 2031 and 2046 are shown in Table 3.1.2.

Table 3.1.2 Population Projection of Zone II Carried Out in DPR

Ward No.	2016	2031	2046	Ward No.	2016	2031	2046	Ward No.	2016	2031	2046	Ward No.	2016	2031	2046
6	16,696	22,895	28,035	15	17,265	20,938	24,723	24	16,067	18,908	22,016	37	31,507	39,607	47,372
7	38,004	51,994	63,606	16	16,729	18,411	20,507	25	30,112	31,519	33,445	47	22,287	28,158	33,729
8	44,013	49,271	55,613	17	15,403	17,777	20,477	26	15,869	16,948	18,371	48	24,728	30,247	35,836
9	13,397	18,325	22,416	18	8,887	10,649	12,509	27	17,457	19,504	21,983	49	28,053	36,881	49.281
10	16,894	21,027	25,069	19	20,412	23,335	26,720	28	23,297	26,047	29,372				
11	21,935	28,025	33,677	20	14,237	17,056	20,032	29	33,491	37,088	41,518				
12	16,015	21,368	25,952	21	15,843	19,494	23,147	30	24,234	25,884	28,059				
13	17,623	21,248	25,027	22	15,886	20,664	24,947	31	39,031	39,840	40,999				
14	24,199	27,698	31,741	23	10,792	13,527	16,164	36	28,929	39,022	47,525	**Total**	**679,292**	**813,355**	**949,869**

Source: DPR

3.1.4 Water Supply Projection

According to the DPR prepared in April 2013 (revised version by Meinhardt), the present water supply level within the RMC area is around 75 L/c/d, which is considerably below the standard national norm. The norms for water supply facilities in urban areas are given in Table 3.1.3.

Table 3.1.3 Norms of Unit Water Demand

Classification of Towns/Cities	Recommended Maximum Water Supply Level (L/c/d)
Towns provided with piped water supply but without sewerage system	75
Cities provided with piped water supply where sewerage system exists or is contemplated	135
Metropolitan and mega cities provided with piped water supply where sewerage system exists or is contemplated	150

Source: CPHEEO

The existing DPR proposes to adopt 150 L/c/d for the base year (2016), intermediate year (2031), and ultimate design year (2046). However, in the current water supply situation as described in Section 2.3, only 65% of the population is provided with piped water as of 2014, and 30% of the piped-water area suffers from low pressure and water rationing. The remaining 35% is provided with water rationing by public posts, tankers, and tube or dug wells where people should come to these water sources to get water. In addition, the current water supply system is inefficiently managed and controlled by two organizations, namely, RMC and DWSD, having non-revenue water (NRW) ratio of 70 to 90%.

In order to cope with this poor situation, the DWSD of Jharkhand State government is carrying out the water supply development project under JNNURM scheme as well as missing link projects under state governments finance. However, JNNURM scheme has been suspended for a long time since September 2012 due to malfunctioning of contracts, and the missing link project is not proceeding effectively either.

Therefore, supply ratio will not easily reach 100% for the time being. In this context, it will be preferable to apply a lower level of unit water consumption per capita per day, i.e., between 100 L/c/d and 135 L/c/d at most.

Meanwhile, there is no reliable data concerning industrial, institutional, and commercial water uses. In this study, the Final Interim Report on PPP for Water Supply in Ranchi City prepared by RMC and DWSD in November 2011 was utilized as reference. According to the said report, the major industrial, institutional, and commercial water demand was calculated at about 20% of the total domestic water demand.

3.1.5 Sewage Generation Projection

Sewage generation calculation in the DPR was executed by multiplying a unit water demand of 150 L/c/d, a higher scenario based on the CPHEEO design manual, to the projected future population and applying a water supply coverage ratio of 100% and sewage collection ratio of 80%. Meanwhile, domestic sewage generation in this preparatory survey was proposed with a unit water demand of 135 L/c/d, a medium scenario based on the CPHEEO design manual and expecting existing water supply projects and the water supply coverage ratio (or

achievement ratio of 135 L/c/d) in the target year was determined at 80% taking into account the possible achievement of water supply system development by the target year.

Against the future probable water consumption, sewage collection ratio was set at 80% taking into account the possible achievement of house connection to all the households by the target year. The ratio of provision of house connection is totally depending upon the financial condition of individual houses, awareness campaign and provision of subsidy.

In addition to the domestic sewage, the wastewater which will be brought from the industrial, institutional, and commercial water uses was calculated at an amount of 20% of the domestic sewage referring to the captioned Final Interim Report on PPP for Water Supply in Ranchi City, 2011. Furthermore, groundwater intrusion was also calculated based on the CPHEEO design manual at 5,000 L/km/day for the proposed total pipe installation at around 400 km in Zone II and 150 km in Zone III and IV.

Table 3.1.4 and Table 3.1.5 show the domestic sewage projection in Zone II and Zones III and IV combined, respectively. As explained above, industrial, commercial, and institutional sewage and groundwater are added as presented in Table 3.1.6.

Table 3.1.4 Domestic Sewage Generation in Zone II in 2031 and 2046

Ward No.	Population Projection in 2031	Population Projection in 2046	Unit Water Demand in 2031, 2046 (L/c/d)	Sewage Generation in 2031 (m^3/d)	Sewage Generation in 2046 (m^3/d)
6	22,895	28,035	135	1,978	2,422
7	51,994	63,606	135	4,492	5,496
8	49,271	55,613	135	4,257	4,805
9	18,325	22,416	135	1,583	1,937
10	21,027	25,069	135	1,817	2,166
11	28,025	33,677	135	2,421	2,910
12	21,368	25,952	135	1,846	2,242
13	21,248	25,027	135	1,836	2,162
14	27,698	31,741	135	2,393	2,742
15	20,938	24,723	135	1,809	2,136
16	18,411	20,507	135	1,591	1,772
17	17,777	20,477	135	1,536	1,769
18	10,649	12,509	135	920	1,081
19	23,335	26,720	135	2,016	2,309
20	17,056	20,032	135	1,474	1,731
21	19,494	23,147	135	1,684	2,000
22	20,664	24,947	135	1,785	2,155
23	13,527	16,164	135	1,169	1,397
24	18,908	22,016	135	1,634	1,902
25	31,519	33,445	135	2,723	2,890
26	16,948	18,371	135	1,464	1,587
27	19,504	21,983	135	1,685	1,899
28	26,047	29,372	135	2,250	2,538
29	37,088	41,518	135	3,204	3,587
30	25,884	28,059	135	2,236	2,424

31	39,840	40,999	135	3,442	3,542
36	39,022	47,525	135	3,372	4,106
37	39,607	47,371	135	3,422	4,093
47	28,158	33,729	135	2,433	2,914
48	30,247	35,836	135	2,613	3,096
49	36,881	49,282	135	3,187	4,258
Total	**813,355**	**949,869**	-	**70,274**	**82,069**

Source: JICA Study Team

Table 3.1.5 Domestic Sewage Generation in Zones III and IV in 2031 and 2046

Ward No.	Population Projection in 2031	Population Projection in 2046	Unit Water Demand in 2031, 2046 (L/c/d)	Sewage Generation in 2031 (m^3/d)	Sewage Generation in 2046 (m^3/d)
Zone III					
38	44,435	53,980	135	3,839	4,464
43	27,455	32,278	135	2,372	2,789
44	21,261	24,786	135	1,837	2,142
45	27,560	30,748	135	2,381	2,657
46	14,240	15,691	135	1,230	1,356
50	34,275	42,330	135	2,961	3,657
51	10,187	12,031	135	880	1,039
52	50,279	62,166	135	4,344	3,571
Subtotal	229,692	274,010	-	19,845	23,674
Zone IV					
39	41,913	52,888	135	3,621	4,570
40	24,600	29,928	135	2,125	2,586
41	24,946	29,961	135	2,155	2,589
42	44,519	61,800	135	3,846	3,540
53	29,943	35,470	135	2,587	3,065
54	37,414	45,091	135	3,233	3,896
55	47,162	58,610	135	4,075	5,064
Subtotal	250,497	313,748	-	21,643	27,108
Ground Total	**480,189**	**587,758**	-	**41,488**	**50,782**

Source: JICA Study Team

Table 3.1.6 Sewage Generation Projection for Zone II and Zones III and IV

Zone	Domestic Sewage (m^3/d)		Industrial, Commercial, and Institutional Sewage (m^3/d)		Groundwater (m^3/d)		Ave. Daily Generation and Design Capacity of STP (m^3/d)	
	2031	2046	2031	2046	2031	2046	2031	2046
Zone II	**70,274**	**82,069**	**14,055**	**16,414**	**2,075**	**2,075**	**86,404 →86,000**	**100,557 →100,000**
Zone III & IV	**41,488**	**50.782**	**8,298**	**10,156**	**760**	**760**	**50,546 →50,000**	**61,699 →61,000**

Source: JICA Study Team

3.1.6 Design Parameters for the Drainage System

(1) Return Period

The return period of probable rainfall is a basic parameter in projecting the magnitude of stormwater runoff. In the DPR, a comparative analysis of several return periods, including half-year, 1-year, 2-year, and 5-year periods, was carried out.

Ranchi City has now become the capital city of Jharkhand State and rapid development of the city can be expected. Considering this aspect and the recommendation in the CPHEEO manual, the JICA Study Team proposed to adopt the 2-year return period uniformly for all areas of the city, which will yield an optimum system to drain stormwater.

(2) Runoff Discharge

1) Runoff Discharge Formula

The rational formula as shown below was selected as the most effective method from the viewpoint of simplicity of calculation, non-expectation of retention effect, and the topographic conditions of the sites.

$Q = 1/360 * CIA$

Where,

Q: Runoff discharge (m^3/sec)

C: Runoff coefficient

I: Rainfall intensity (2-year return period)

A: Area of drainage area (ha)

2) Runoff Coefficient

The runoff coefficient mainly depends on the land use pattern of the drainage basin area. Considering the recommendations of CPHEEO as well as the Indian Road Congress (IRC), and based on the detailed topographic and demographic study, the values given in Table 3.1.7 were applied to the Ranchi drainage system in this preparatory survey.

Table 3.1.7 Runoff Coefficient Applied for Design

Ward No.	Population Density in 2046	Runoff Coefficient
Nos. 7, 36, 37,38, 39, 42, 49, 50, 52, 54, 55	Less than 100/ha	0.4
Part of Nos. 26, 31, 46	More than 500/ha	0.8
Other wards	100/ha to 500/ha	0.6

Source: DPR

3.2 Plan of the Drainage System and Facilities

3.2.1 Establishment of Stormwater Drainage System

(1) Proposed Concept for Drainage Plan

Ranchi City is divided into four zones according to topographic configuration. These zones conform to the stormwater catchment basins. It is convenient to discuss the stormwater drainage plan based on this zoning. In the city area, two major branches of the Harum River, and the Hinno River, as well as two other major branches of the Subarnarekha River pass through the area in parallel from west to east. The longitudinal profile of these river courses show comparatively steep slopes varying from 1/100 to 1/200.

The major roads in Ranchi City run along the watersheds of the above catchment basins. Rainwater is assumed to be drained from the roadside toward the river through the minor road network between the major road and the river.

On the other hand, through the inundation survey carried out in this preparatory survey, it was discovered that local inundation problems due to clogging of rainwater exist at the sites surrounding the low-lying pockets/swamps scattered in the city area.

Considering the above situation, the JICA Study Team proposes to drain the rainwater through roadside drains into the nearest natural drainage channels/rivers in the shortest possible time.

(2) Design Parameters for Drainage Facilities

1) Flow Calculation Formula

The JICA Study Team proposes to use Manning's equation for flow calculation to determine the dimensions of drainage facilities as shown below.

$V = 1/n * I^{1/2} * R^{2/3}$ $Q = A * 1/n * I^{1/2} * R^{2/3}$

Where,

V: Flow velocity (m/sec)
Q: Flow discharge (m^3/sec)
I: Channel bottom gradient
A: Flow area (m^2)
R: Hydraulic radius (m)
n: Coefficient of roughness of channel

For the coefficient of roughness which depends on the construction material, the JICA Study Team proposes n = 0.013, assuming steel reinforced concrete channel.

2) Flow Velocity Inside Drain Channel

The JICA Study Team proposes to apply a minimum velocity of 0.6 m/s to maintain tractive

force inside the channel, and a maximum velocity of 3.0 m/s to avoid the scouring of drains. The channel width, height, and gradient will be determined so as to discharge at the required flow rate maintaining the required range of flow velocity.

3) Freeboard

Based on the recommendation of IRC, the JICA Study Team proposes to apply a freeboard of 15 cm for the drain channel, with the bottom width equal to or less than 900 mm and 30 cm for larger than 900 mm.

3.2.2 Stormwater Drainage Facilities

(1) Proposed Type of Facility

The right-of-way in most of the roads in the city is narrow. It is assumed that various underground utilities are located within the road right-of-way. Considering this situation, rectangular surface drain sections are adopted in this preparatory survey. Furthermore, in order to keep the drainage system clean and hygienic, covered drains are proposed. RCC box culvert or RCC pipe is applied for the location where road-crossing drainage is required. The total length of the proposed drain channels are given below.

Table 3.2.1 Features of Proposed Drain Channels

Zone	Length of RCC Precast Drain (km)	Length of RCC Pip Drain (km)	Length of Box Culvert (km)	Total Length (km)
Zone II	504.1	2.1	7.8	514
Zone III & IV	239.8	1.9	2.5	244

Source: DPR for Ranchi Sewerage and Drainage Project (2013)

(2) Structure and Material of Drains

The size of the drain depends upon the runoff discharge and slope of the ground surface. The JICA Study Team proposes a minimum drain size with 300 mm width and 200 mm depth for convenience in drain cleaning works. This minimum drain size has a sufficient capacity for the runoff discharge of the design rainfall (2-year probable rainfall) which will occur at the most upstream section of the highly built-up area. The JICA Study Team proposes to apply precast U-shaped RCC drain units in order to expedite the construction works and in-situ concrete structure for a road crossing culvert. The standard size is categorized in the Table 3.2.2 below.

Table 3.2.2 Standard Size of U-shaped Drain

Internal Width (mm)	300	350	450	500	600	To be increased in increments of 50 mm
Height (mm)	200	400	500	700	750	To be increased in increments of 50 mm

Source: CPHEEO Manual, India

The typical design of U-shaped RCC drain is given in Drawing No. A-36.

(3) Effluent Facilities

The JICA Study Team proposes to use an outlet chamber which connects the U-shaped drain on the road surface with RCC outlet pipe to the river. The rainwater flowing into the chamber through roadside drains will be discharged to the river through the RCC pipe connected to the chamber at the bottom. The typical design of U-shaped RCC drains and river outlet chambers is given in Drawing No. A-36.

3.2.3 Preliminary River Improvement Plan

(1) Requirement of Future River Improvement

Stormwater flows into the rivers in a shorter amount of time through the drainage system to be established in the project. In addition, stormwater retention in the paddy fields will be reduced in the future due to the expansion of the urban area. The changes in the city will bring about an increase in the peak flood discharge in the rivers and also high risks of flood damage to the urban areas.

The current river channels are natural rivers with weeds, silt, and dumped garbage. The current flow capacity at the major river crossing structure sites is preliminarily estimated as given in the Inventory of River Crossing Structures (ref. Appendix A3.4). The flood runoff in the future development condition is estimated for some major river crossing structure sites and the comparison is made in Table 3.2.3.

Table 3.2.3 Flow Capacity of River at River Crossing Structure Sites

No.	Location	River Name	Catchment Area (km^2)	Probable Runoff Discharge (m^3/s)				Current Flow Capacity (m^3/s)
				5-year	10-year	20-year	50-year	
1	PS-1 site	Harum River (north branch)	15.5	134	154	173	200	50
2	PS-2 site	Harum River (north branch)	20.0	166	192	216	249	140
3	Railway crossing near Argora Station	Harum River (south branch)	6.1	67	77	87	101	60
4	Bridge beside the flyover of Main Road	Harum River	28.2	226	261	293	338	150
5	Bridge on Harum Road near railway	Hinno River	20.4	182	210	237	273	140
6	Bridge on Hinno Road near A.G. Square	Hinno River	22.6	195	225	253	292	130

7	Bridge near Ranjan Nagar on Old Hazaribagh Road	No name	5.6	97	111	125	145	100
8	Bridge near Kokar on Old Hazaribagh Road	No name	4.2	78	90	101	118	100
9	Bridge on Tata Road near Kantatoli	No name	4.0	67	77	86	100	48
10*	Proposed STP site in Zone-II	Subarnareka River	153.4	737	850	957	1099	1340

Source: JICA Study Team
* : No existing river crossing structure

As shown in the above table, the current river flow capacity is not sufficient for the future increase of flow rate due to the rapid urban development.

The river improvement plan is not included in the scope of this preparatory survey. However, it will be necessary to establish a river improvement plan based on the detailed evaluation of the current river flow capacity and required protection level of the objective area, together with the establishment of the stormwater drainage system.

(2) River Improvement Measures

It is indispensable to consider the improvement of the flow capacity of existing river channels to safely convey the stormwater from the proposed drainage system. Based on the current condition of the rivers, the following river improvement measures may be required:

- Cleaning and removing the weeds, bushes, and dumped garbage, as well as accumulated sand and silt.
- Formation of proper cross-sectional area (rectangular or trapezoidal section) with bank/bed protection (gabion, concrete, or stone masonry protection).
- Removal of check dam inside the river course which was constructed for rainwater harvesting.
- Construction of flood regulation pond at the upstream reach of the rivers if expansion of the river section is difficult due to the restriction of land available in urban areas.

3.3 Plan of Sewerage System and Facilities

3.3.1 Selection of Sewage Disposal System

(1) Current Sewage Disposal

The current sewage disposal process totally relies on the existing stormwater drainage network, consisting of roadside U-shaped drains, small-scale drainage channels, and rivers. It was observed during site reconnaissance that small U-shaped drains were installed even on small roads and the sewage from households were directly discharged into the U-shaped drains.

(2) Sewage Disposal Plan in DPR

In DPR, the sewage pipes proposed to be installed are categorized according to their respective functions as listed below.

i) Lateral sewers: These form the basic sewerage network along the streets in residential areas to collect sewage from households and convey them to collector sewers.

ii) Collector sewers: These form the secondary network of sewers where a number of laterals will end into the collector sewers to be laid along major roads.

iii) Sub-trunk sewers: These form the tertiary network of sewers where a number of collectors will end into the sub-trunk sewers to be laid along major roads.

iv) Trunk sewers: These will be the principal sewers to which sub-trunk sewers are tributaries. Trunk sewers will transport sewage to the treatment facility.

A separate system was proposed in DPR as the sewage disposal system. The sewage from each household was planned to be discharged into the lateral sewer through house connection pipes and conveyed to the treatment plant through collector sewers, sub-trunk sewers, and trunk sewers. The system was planned to be separated from the stormwater drainage system.

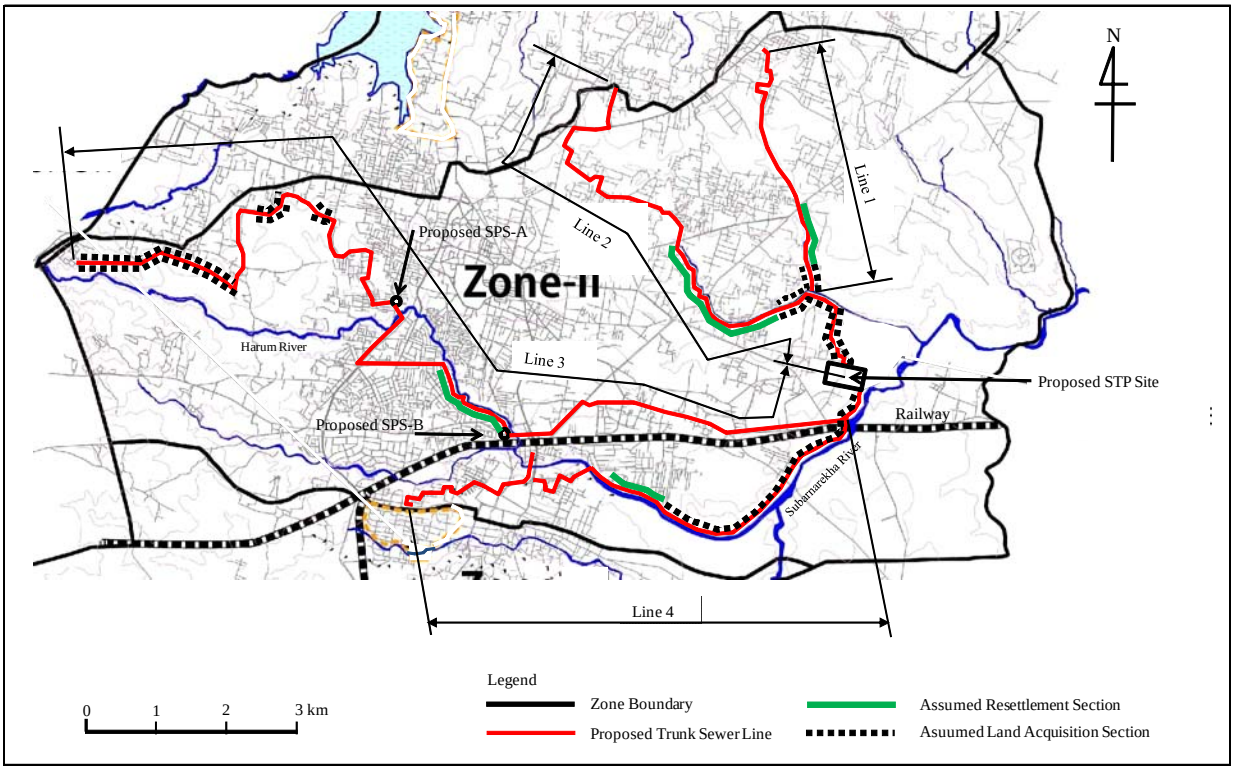
(3) Proposed Concept for Sewage Disposal System

Based on the current situation of sewage discharge in Ranchi City, the JICA Study Team made a comparative study between the separate system and combined system. As a result, the JICA Study Team proposed to apply a separate system. The proposed sewage collection method from each household is illustrated in Appendix B1.1.

3.3.2 Sewerage System Diagram

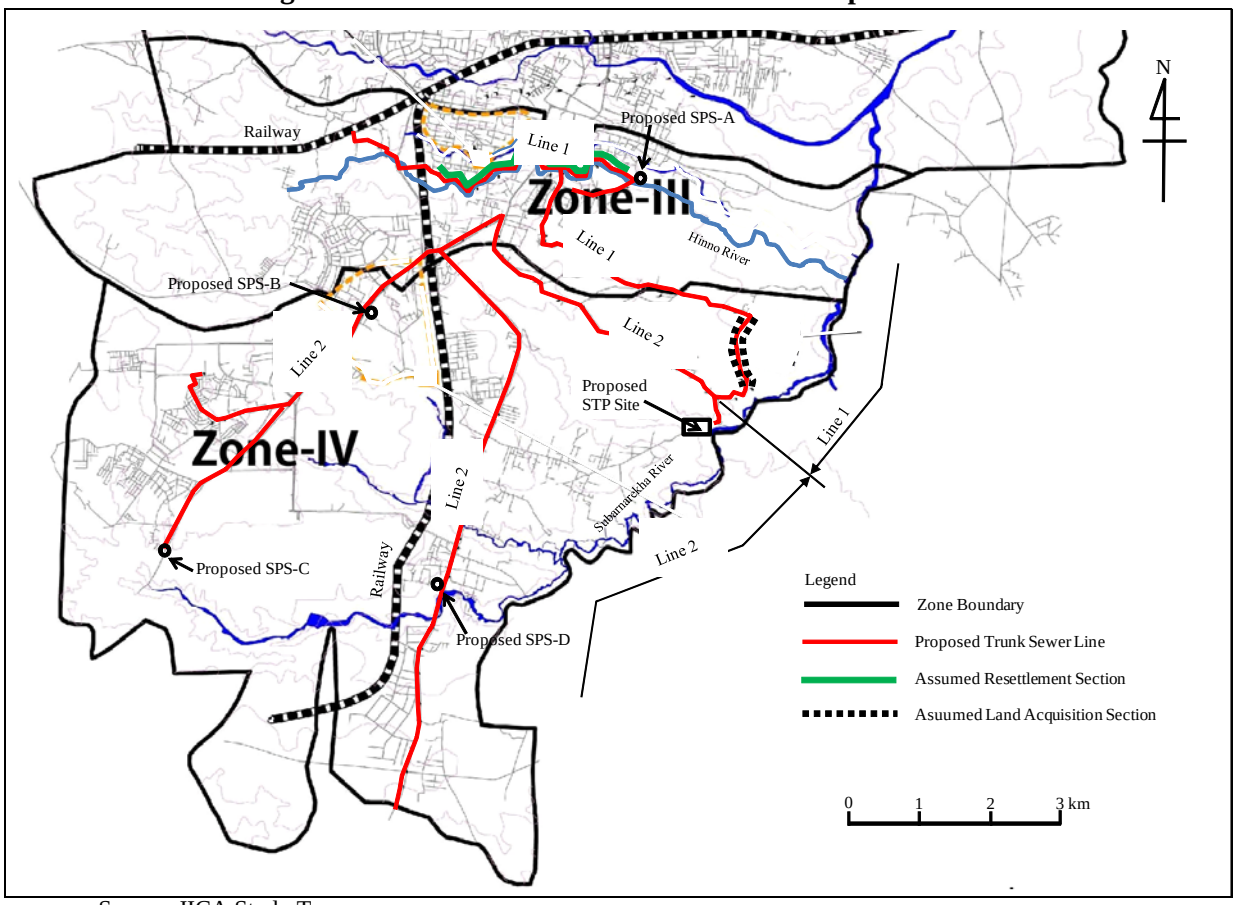
(1) Problem on System Diagram in Existing DPR

The JICA Study Team reviewed the trunk sewer routes proposed in DPR based on map study and site reconnaissance. The proposed trunk sewer routes of Zone II and Zones III and IV are shown in Figures 3.3.1 and 3.3.2 and the principal features are given in Table 3.3.1.



Source: JICA Study Team

Figure 3.3.1 Trunk Sewer Lines in Zone II Proposed in DPR



Source: JICA Study Team

Figure 3.3.2 Trunk Sewer Lines in Zones III and IV Proposed in DPR

Table 3.3.1 Principal Features of Trunk Sewer Lines Proposed in DPR

Line No.	Line Length (km)	Pipe Diameter (mm)	Remarks
Zone II (Total 34.6 km)			
Line 1	4.1	200 to 1200	Land acquisition and resettlement for a part of the route are assumed.
Line 2	8.8	200 to 1200	Land acquisition and resettlement for a part of the route are assumed.
Line 3	16.7	200 to 1600	Land acquisition and resettlement for a part of the route are assumed.
Line 4	5.0	150 to 450	Land acquisition and resettlement for a part of the route are assumed.
Zones III and IV (Total 34.0 km)			
Line 1	12.0	200 to 1400	Land acquisition and resettlement for a part of the route are assumed.
Line 2	22.0	150 to 1600	-

Source: DPR

After the review, it was found that some of the trunk sewer routes were proposed in private lands, including paddy fields and residential premises. The social survey executed by the JICA Study Team identified the necessity of acquisition of agricultural lands for 10 km and 1.5 km in Zone II and Zones III and IV, respectively. Furthermore, 113 houses in Zone II and 19 houses in Zones III and IV were identified along the trunk sewer routes. According to JICA's environmental criteria, the project which requires large magnitude of resettlement and land acquisition as in the above is environmentally categorized as class "A".

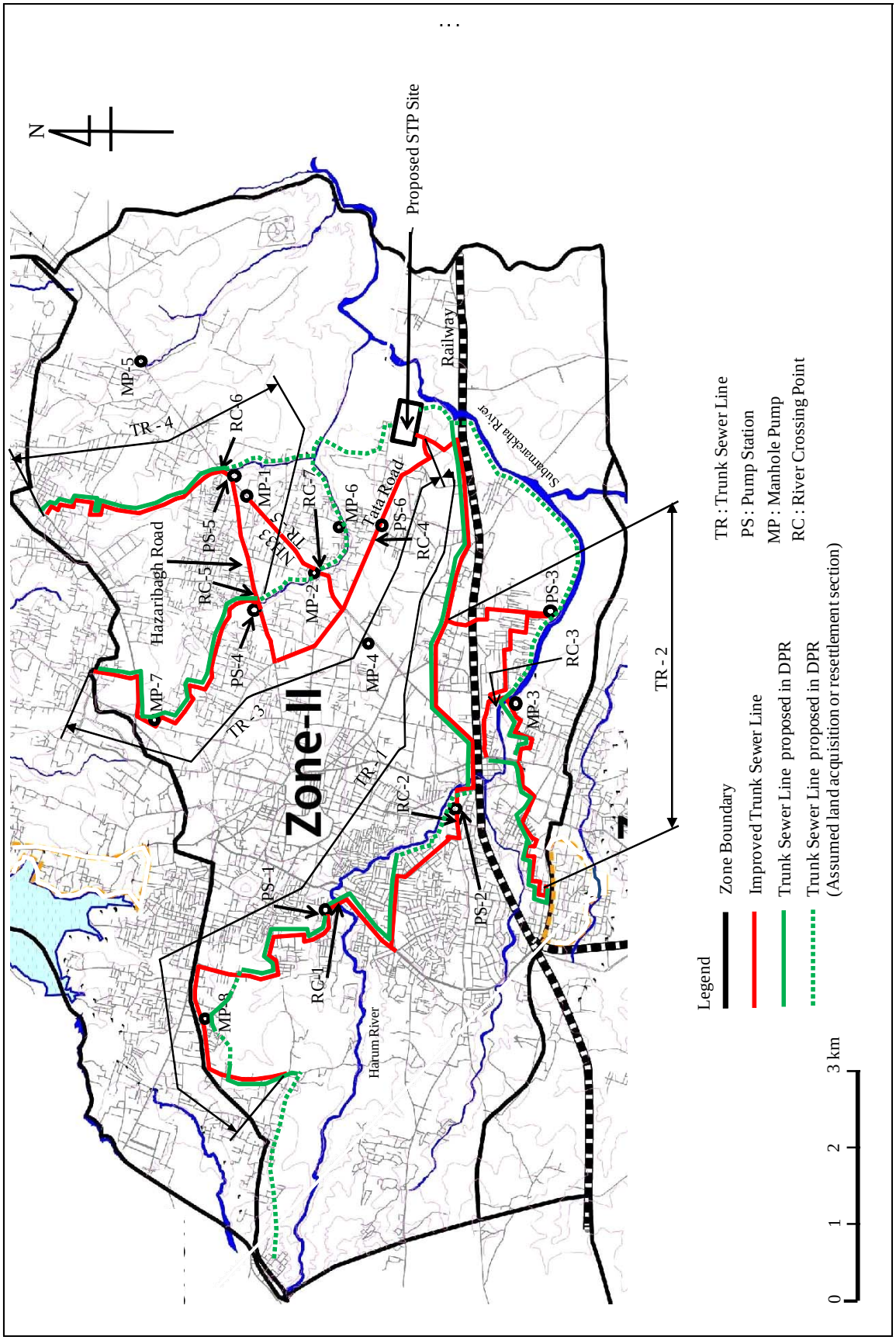
In addition, other technical constraints to be improved were also identified as follows:

- The STP in Zones III and IV was not proposed at the topographically appropriate site. Due to this reason, the trunk sewers could not necessarily be proposed by gravity system and inappropriately mixed with the pump system with long distance rising mains up to the proposed STP site.
- A part of Ward 54 having an area of approximately 140 ha and population of 13,500 (4.3% of the population of Zone IV in 2046) was not included in the future sewerage service area in DPR.

(2) Improvement of System Diagram

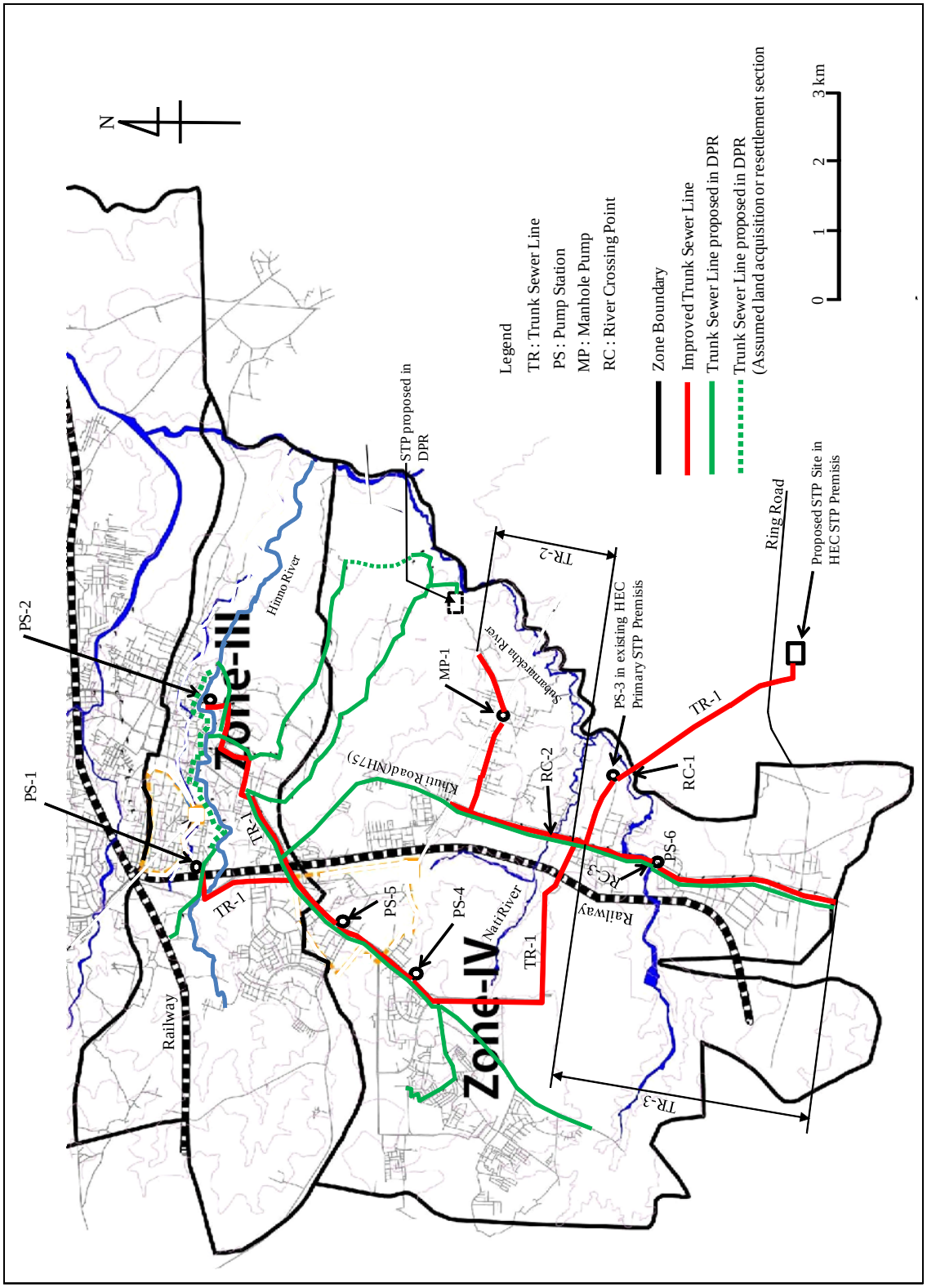
1) Trunk Sewer

For the purpose of avoiding the resettlement of households and minimizing land acquisition as well as solving technical problems in the existing DPR, the JICA Study Team proposed improved system diagrams. The diagrams for Zone II and Zones III and IV are shown in Figures 3.3.3 and 3.3.4, respectively.



Source: JICA Study Team

Figure 3.3.3 Improved Trunk Sewer Lines in Zone II



Source: JICA Study Team

Figure 3.3.4 Improved Trunk Sewer Lines in Zones III and IV

The improvement or realignment of the trunk route from DPR was carried out as follows:

a) Zone II

- For the trunk sewer route (TR-1), the upstream 1.3 km along the right bank of the Harum River was transferred to a public road to avoid land acquisition.
- For TR-2, the 6 km section along the left bank of the Harum River was moved to a new route starting from the flyover on the railway to the pump station (PS-3) to avoid land acquisition problems. Another new route near the fire department was also proposed up to the manhole pump (MP-3) to avoid resettlement problems.
- For TR-3, the route downstream of Hazaribagh Road to the proposed STP was moved to a new route on Hazaribagh Road through Tata Road to avoid land acquisition and resettlement problems.
- For TR-4, the route on National Highway (NH) 33 to the confluence with TR-3 was moved to a new route on Hazaribagh Road to avoid land acquisition and resettlement.

b. Zones III and IV

For Zones III and IV, the system diagram in DPR was extensively modified based on the discussion between the JICA Study Team and the Heavy Industry Company (HEC). The HEC premises, which was formerly used for HEC's own sewerage system, was recommended by the executive officer of HEC to be utilized for the new STP, pump station, and trunk sewer routes in this preparatory survey. The major modifications are as follows:

- The new trunk sewer (TR-1) starts from the railway crossing and runs to Dhurwa area through HEC Colony. In this section, the gravity and rising mains with two pump stations (PS-4 and PS-5) were proposed. TR-1 turns to the east of the State Government Office premises and reaches the proposed pump station (PS-3). The sewage was then pumped up to Kanto Village and conveyed to the STP by gravity.
- The trunk sewer (TR-2) was connected to TR-1 on NH 75. Another trunk sewer (TR-3) was proposed from the southern city boundary along NH75. The sewage conveyed to PS-6 by gravity was connected to TR-1 through the rising main.
- A branch line of TR-2 was proposed along Latma Road in Ward 54 to cover the missing sewerage service area in DPR.
- The pump stations SPS-A and SPS-C proposed in DPR were cancelled. New pump stations PS-5 and PS-6 were proposed at the locations of SPS-B and SPS-D proposed in DPR, respectively, in the improved system.

The principal features of the facilities in the improved system are given in Table 3.3.2.

Table 3.3.2 Principal Features of Trunk Sewers in Improved System

Line No.	Line Length (km)	Pipe Diameter (mm)
Zone II (Total 38.3 km)		
TR-1	14.9	150 to 1400
TR-2	7.7	150 to 600
TR-3	8.7	150 to 1000
TR-4	4.8	150 to 600
TR-5	2.1	150 to 250
Zones III and IV (Total 22.6 km)		
TR-1	15.5	350 to 1100
TR-2	4.0	150 to 400
TR-3	3.1	150 to 400

Source: JICA Study Team

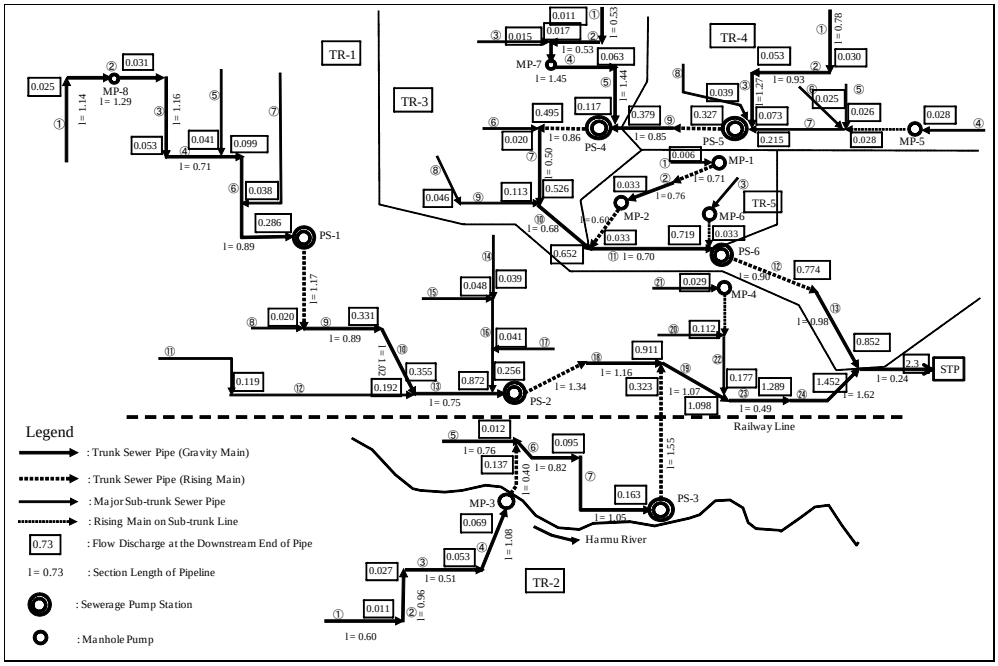
2) Lateral, Collector, and Sub-trunk Sewers

The JICA Study Team proposed the lateral, collector, and sub-trunk sewers in the same way as proposed in DPR. Minor modifications and adjustments of these sewers in accordance with the realignment of trunk sewer routes will be indispensable during the detailed design stage.

3.3.3 Flow Calculation

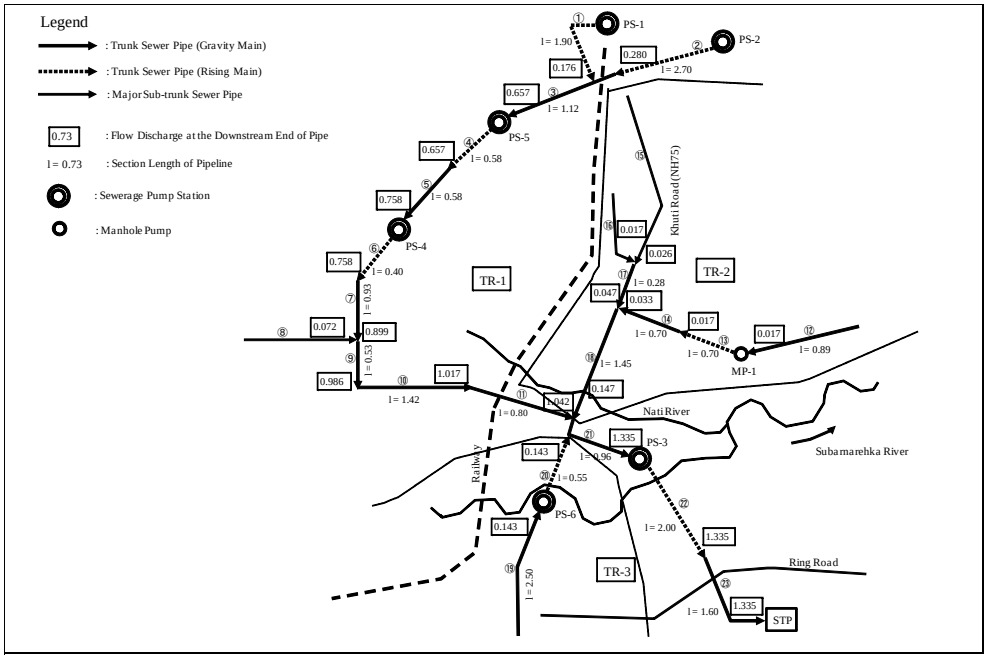
(1) Flow Rate

The sewage flow rates of the trunk sewers for Zone II and Zones III and IV were calculated based on the flow diagram shown in Figures 3.3.5 and 3.3.6, respectively.



Source: JICA Study Team

Figure3.3.5 Flow Diagram of Proposed Sewerage System for Zone II



Source: JICA Study Team

Figure 3.3.6 Flow Diagram of Proposed Sewerage System for Zones III and IV

(2) Equation of Design Flow for Pipes

The design flow is determined as follows:

Design flow for pipe and pumping facilities = $Q_{h.max}$

$Q_{h.max} = Fc * Q_{d.\ mean}$

Where,

$Q_{h.max}$: Hourly maximum sewage flow (m^3/s)

$Q_{d.\ mean}$: Daily mean sewage flow (m^3/s)

Fc: Conversion factor; hourly max./daily mean
(Fc = 2 is applied according to CPHEEO Manual)

The sewage flow rate of each pipe is calculated with the service area of each sewage pipe, population density, and daily water consumption (135 L/c/d). Based on the CPHEEO Manual, sewage flow rate was calculated with the target year of 2046. The pump facilities and rising mains were calculated with the target year of 2031. The flow tables for the sewage facilities for 2031 and 2046 are shown in Appendices B1.2 to B1.5.

3.3.4 Design of Sewer Facilities

(1) Types of Pipe (Laterals, Collectors, Sub-trunk Mains, and Trunk Mains)

1) Hydraulic Calculation

Manning's formula was applied in the design calculation for gravity sewers. As per the CPHEEO Manual, all the gravity sewers are to be designed by applying d/D=0.8 (d=flow

depth, D=pipe diameter). The sewer was designed to attain a velocity greater than 0.6 m/s and less than 3.0 m/s at the maximum to avoid abrasion of pipes. For the rising mains, the pipe diameter is obtained so as to meet the required flow discharge under the required pumping head with the flow velocity of 1.5~1.8 m/s considering abrasion of pipes and avoidance of high surge pressure. The minimum diameter of 150 mm was adopted considering the transmission of sewage flow.

2) Pipe Material

The type of gravity sewer varies depending on the diameter, i.e., double-walled corrugated (DWC) pipe was applied for pipes with diameter equal to or less than 1,000 mm and RCC pipe was applied for those with diameter larger than 1,000 mm. For the rising mains, ductile cast iron (DCI) pipe was applied to resist the internal pressure and durability. The roughness coefficient applied for DWC, RCC, and DCI are 0.011, 0.013, and 0.011 respectively, according to the CPHEEO Manual.

3) Pipeline Profile

For the trunk sewers, the pipeline profile was established based on the design flow, pipe gradient, topographical conditions, possible underground utilities, and obstacles for installation of pipes, such as rivers and railway crossings. The plans and profiles are provided in Drawing Nos. A-01 to A-35. The sewage pipe length by each diameter and material for the trunk sewers is shown in Table 3.3.3.

Table 3.3.3 Sewage Pipe Length by Diameter for Trunk Sewers

	DWC/RCC Pipe				DCI Pipe	
Zone II	Dia.(mm)	Length (m)	Dia.(mm)	Length (m)	Dia.(mm)	Length (m)
	150	3,510	1,000	3,663	150	1,310
	200	3,030	1,100	200	200	400
	250	3,835	1,200	1,988	350	1,545
	300	3,525	1,400	253	450	2,120
	400	3,590			600	860
	600	3,860	-	-	750	900
	800	2,930	-	-	800	1,330
	DWC/RCC Pipe				DCI Pipe	
Zones III and IV	Dia.(mm)	Length (m)	Dia.(mm)	Length (m)	Dia.(mm)	Length (m)
	150	800	800	1,700	150	700
	200	690	900	3,280	300	550
	250	1,180	1,100	2,560	350	1,900
	300	600			450	2,700
	350	600			650	580
	400	1,950			700	400
	700	400			900	2,000

Source: JICA Study Team

(2) Manhole Pumps

Eight manhole pumps are proposed in Zone II. Three out of these eight pumps are located on the sub-trunk sewers. In Zones III and IV, one manhole pump was proposed on the trunk sewer. A pump was proposed to be installed in a manhole on the pipeline as "manhole pump" in case the pipe earth covering exceeds 7 m and the design flow is less than 100 L/s. As installation of an emergency generator is not considered for a manhole pump, a manhole for emergency diversion of sewage flow to the adjacent river was proposed at just the upstream of the manhole pump site as shown in Drawing No. C-05. This manhole is designed so as to have a function of garbage screening during normal time. The further details are described in Section 3.6.

The locations of manhole pumps are shown in the aforementioned Figures 3.3.3 and 3.3.4 and the principal features are given in Table 3.3.4 below.

Table 3.3.4 Manhole Pump

Trunk Route	Pump No.	Location	Design Flow (L/s)	Total Head (m)	Rising Main		
					Length (m)	Diameter (mm)	Type of Material
Zone II							
TR-1	MP-8	Trunk	25	7	5	150	DCI Pipe
	MP-4	Sub-trunk	25	25	650	150	DCI Pipe
TR-2	MP-3	Trunk	58	19	400	200	DCI Pipe
TR-3	MP-7	Trunk	23	7	5	150	DCI Pipe
TR-4	MP-5	Sub-trunk	23	30	630	150	DCI Pipe
TR-5	MP-1	Trunk	5	20	710	150	DCI Pipe
	MP-2	Trunk	28	34	600	150	DCI Pipe
	MP-6	Sub-trunk	27	23	350	150	DCI Pipe
Zones III and IV							
TR-2	MP-1	Trunk	14	14	700	150	DCI Pipe

Source: JICA Study Team

(3) Manhole

Based on the CPHEEO Manual, the JICA Study Team proposed to provide a manhole at about 50 m interval. Irrespective of the above criteria, manholes were provided at every change of gradient, diameter, and confluence of sewers. The typical manhole structure introduced in the CPHEEO Manual is provided in Drawing No. A-36.

(4) Pipe Foundation and Cover Soil Depth

1) Pipe Foundation

According to the geotechnical investigation report in DPR and the boring survey results executed during this preparatory survey, it was generally observed that the soil layers showed a maximum N-value of around 20 up to the depth of GL-10 m in the city area.

Any special consideration for the foundation may not be required for the above type of soil. Based on CPHEEO's recommendation, the JICA Study Team proposed a sand bed foundation with a thickness of 200 mm, and an additional 200 mm above the pipe crown to protect pipes from damage except in the case of river and railway crossings as explained in detail in later subsection. The typical structure of the pipe foundation is shown in Drawing No. A-37.

2) Earth Covering

According to CPHEEO's recommendation, the sewers are designed such that a minimum earth covering of 1 m is ensured. A minimum clearance of 30 cm is generally maintained when a sewer has to cross other utilities.

(5) Pipe Installation Method

Open cut or trench method was generally applied when the excavation depth was less than 7 m or so in the sewage pipe installation works. In applying the open cut method, a temporary retaining wall comprising either wooden or sheet pile was generally proposed. Needless to say, the necessity of temporary work itself and selection of material should be dependent upon the soil conditions at the construction site. The pipe installation method applying steel sheet pile is illustrated as an example in Drawing No. A-37.

(6) River Crossing Method

The trunk sewers meet with river crossings at several locations on the way to the downstream area. The present site conditions of the river crossing sections are shown in the Inventory of Existing River Crossing Structures in Appendix A3.4.

Considering the topographic conditions that the depth from the bridge or levee crown of the embankment to the riverbed is from five to eight meters and that the river bank is generally steep, and the geotechnical conditions that the riverbed is mostly exposed with hard rocks, the JICA Study Team proposed a pipe bridge made of DCI supported by prestressed concrete beam and piers.

The locations of the river crossing are shown in the aforementioned Figures 3.3.3 and 3.3.4. The detailed specifications are shown in Table 3.3.5 and the typical river crossing structures are shown in Drawing No. A-37.

Table 3.3.5 Details of River Crossing and Structure

Location No.	Trunk No.	River Name/Location	River Width (m)	Depth (m)	Dia. of DCI Pipe
Zone II					
1	TR-1	Harum River (north branch), PS1 site	30	3	450 mm
2	TR-1	Harum River (north branch), PS2 site	25	7	800 mm
3	TR-2	Harum River, MP-3 site	30	3	200 mm
4	TR-3	No name, on Tata Road	10	5	1000 mm
5	TR-4	No name, before junction with TR-3	25	5	600 mm
6	TR-4	No name, PS5 site	65	7	400 mm
7	TR-5	No name, MP2 site	30	5	150 mm
Zones III and IV					
1	TR-1	Subarnarehka River, PS3 site	120	8	900 mm
2	TR-2	Nati River/Khuti Road (NH75)	20	7	400 mm
3	TR-3	Subarnarehka River/Khuti Road (NH75), PS6 site	70	8	300 mm

Source: JICA Study Team

3.3.5 Operation and Maintenance of the Pipe Network

(1) Establishment of GIS-based Ledger of Facilities

In order to realize the effective operation and maintenance (O&M) of the sewer network, the JICA Study Team proposed to establish a ledger for relevant facilities using geographical information system (GIS). The GIS should be established including the following information:

- Location of sewage pipes, manholes, pump stations, manhole pumps, STP and their capacities;
- Information of house connections;
- Location and features of underground utilities, such as water pipes, telephone and electric cables; and
- Record of construction, repair and replacement date, and work contents for sewage facilities.

It is important to update the above information according to the situation of house connections, and expansion of the pipe network and pumps.

(2) Monitoring and Recording System of Pump Facility

For monitoring and recording of the pump facilities, the Supervisory Control and Data Acquisition System (SCADA) system is generally applied to control the operation of the facilities. However, in this preparatory survey, the JICA Study Team did not recommend the SCADA system as a centralized control system because the system is rather complicated with high technology equipment and heavy financial burden for the maintenance by RMC.

Instead of the application of SCADA, the JICA Study Team recommended providing the necessary electric and mechanical equipment at each pumping station, and allocating technical staff to control and monitor these facilities.

3.3.6 Conduct of Trenchless Method

Microtunneling method or so-called horizontal jacking method is a construction method of

laying pipe in the ground by pressing the pipe by jacks from the "starting shaft". This method is to preserve the neighboring environment and maintain pleasant conditions on the ground surface.

The advantages of microtunneling method compared with the conventional open cut method are as follows:

1) Shortening of construction period;
2) Prevention of influence to the underground utilities;
3) Reduction of road occupation and avoidance of traffic congestion; and
4) Minimizing of the occurrence of construction pollution.

In this sewerage project, it is proposed to apply microtunneling method for the pipe laying at the railway crossing in the southern part of the Zone II area as indicated in Figure 3.3.7.

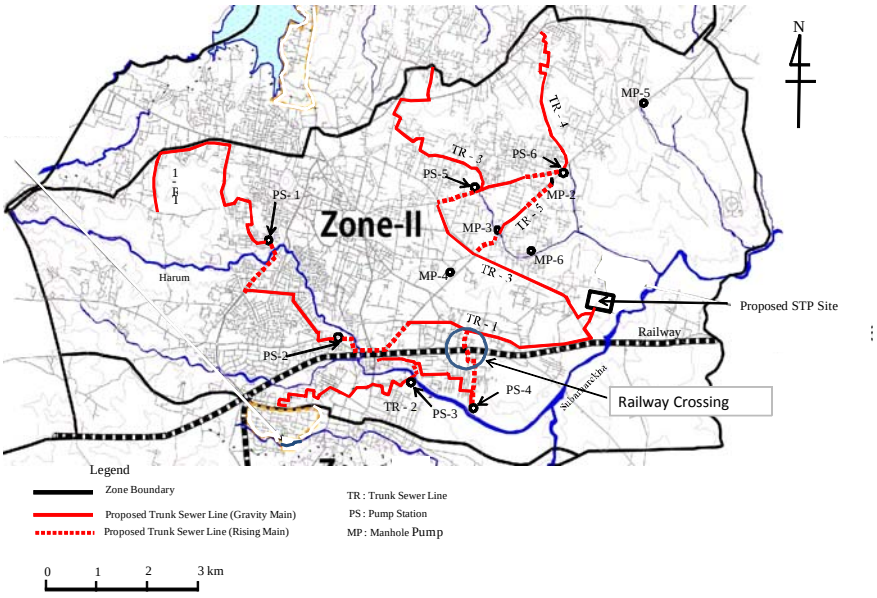


Figure 3.3.7 Location of Railway Crossing

(1) Classification of Microtunneling Method

The microtunneling method is generally classified into the types shown in Table 3.3.6, depending on the internal diameter and shape of tunnels, i.e., internal tunnel diameter equal to or more than 800 mm or less than 800 mm, or tunnel with circular or rectangular cross sectional shape.

The microtunneling method is a method used for constructing tunnels by inserting pipes with a drilling machine at the head. The length of the microtunneling method is from several tens of meters to a couple hundred meters at most depending on the tunnel diameter, type of drilling machine, and the location of jack setting. If the jacks are installed immediately behind the head of the machine and preceded by them, but not in the starting shaft, it is called shield tunneling

method, which will enable a tunnel length of several kilometers at one time. If the jacks are installed in the starting shaft, it is generally called horizontal jacking method.

Table 3.3.6 Classification of Microtunneling Method

(1) Large and medium diameter	1) Open type	i) Blade mouth type
	2) Closed type	i) Slurry type
		ii) Earth pressure balance type
		iii) High density slurry type
(2) Small diameter propulsion (or small diameter jacking method)	1) High load-carrying	i) Press fitting type
		ii) Slurry type
		iii) High density slurry type
	2) Low load-carrying	i) Press fitting type
		ii) Slurry type
		iii) High density slurry type
	3) Sheath pipe method	i) Auger type
(3) Special type jacking method	1) Box type jacking method	
	2) Deslip curtain method	
(4) Shield tunneling method	Both open and closed types are applicable	

Source: JICA Study Team

(2) Microtunneling Method and Drilling Machine

1) Type of Pipes, Depth, and Diameter

The proposed site of the pipe installation is on the road crossed by the railway where the sewage rising main pipe made of ductile iron with diameter of 350 mm is planned. The distance of pipe installation is 30 m. The earth covering of the sewage pipe is planned at 5 m in order to avoid the loosen soil effect to the railway running immediately above the sewage pipe.

2) Soil Condition

The soil condition at the microtunneling site consists of weathered and reclaimed soil from the ground surface to GL-4 m with N value of 7 on the average. Thereafter, clayey silt with sand and gravels appears until GL-7 m with N value of 20 on the average and very dense silty sand with N value of more than 30 appears below GL-7 m. The groundwater level is identified at GL-9.3 m.

3) Optimum Type of Machine

In accordance with the firm soil conditions with low groundwater table and comparatively short distance of tunneling, an auger type, small diameter tunneling machine was selected in this project. Typical configuration of the operation of auger type is shown in Figure 3.3.8.

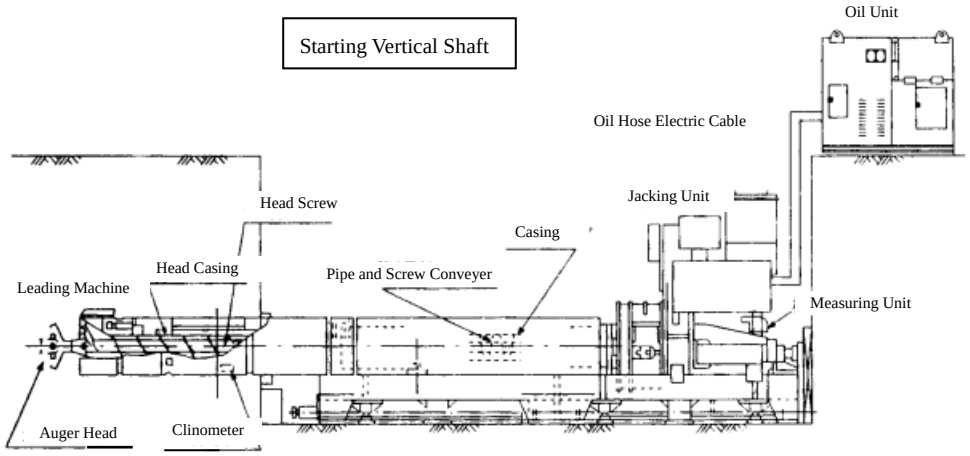


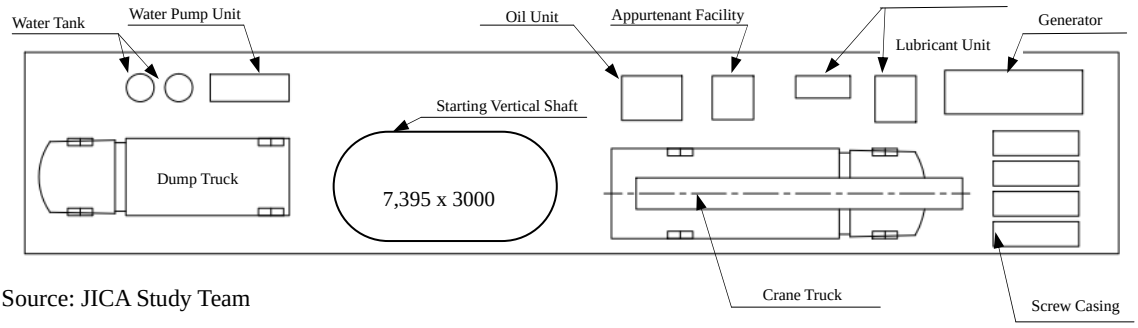
Figure 3.3.8 Typical Configuration of Operation of Auger Type

4) Starting and Arrival Vertical Shaft

Based on the soil conditions of comparatively dense clayey sand with N value of more than 20, groundwater level at GL-9.3 m, and auger type of tunneling machine, the vertical shaft for microtunneling operation was planned with a liner plate shaft. The sizes of the starting and arrival vertical shafts are planned at 7,395 x 3,000 mm and ϕ 3,000 mm, respectively. The detailed size of the vertical shaft by the liner plate will depend on the type of the drilling machine of each manufacturer, so that it should be adjusted during the detailed design stage.

5) Working Area for Operation and Plant Yard

Microtunneling method generally requires an operation area of approximately 150 to 200 m^2. The configuration of a typical operation area is shown in Figure 3.3.9. The area consists of the necessary area for vertical shaft, oil and lubricant units, generator, dump truck and crane truck unloading space, screw and casing for drilling, and stockyard for reserved ductile iron pipes.



Source: JICA Study Team

Figure 3.3.9 General Layout of Plant Yard

3.4 Plan of Sewage Treatment Plant

3.4.1 Selection of the Sewage Treatment Process

(1) Water Quality Standards Relevant to STP

The Jharkhand State Pollution Control Board (JSPCB) is the organization that regulates and monitors the discharged water qualities from the facilities in the state. JSPCB adopts the water quality standards prescribed under the Environmental Protection Rules laid down by the Ministry of Environment and Forests (MOEF), although the state governments/municipalities can prescribe more stringent standards than those of the MOEF. The Environmental Protection Rules comprise the general standards which the effluents from any facilities including STPs shall not exceed and the specific standards for various types of industries.

a) General Standards for Discharge of Pollutants

The general standards in the Environmental Protection Rules were originally established in 1986 and several amendments were made up to 1996. It stipulates the general standards for discharge of environmental pollutants in the effluent water from all types of facilities with/without treatment plants as shown in Table 3.4.1. The table shows the maximum limits for four categories of the discharge points. The discharge of effluents into the "public sewers" should be applicable only if such sewer leads to a secondary treatment plant. The effluent quality from STPs in Ranchi City shall follow the standards stipulated for "inland surface water". In this regard, the maximum limits which are applied for the effluents from STPs are 30 mg/L for biological oxygen demand (BOD) and 100 mg/L for suspended solids (SS). Meanwhile, since the values in the column of public sewer were determined so that the permissible limits do not affect the performance of STPs, all industries shall follow the values (e.g., SS of 600 mg/L and BOD of 350 mg/L) when they connect to the new sewerage system in Ranchi City. Otherwise, they shall treat the pollutants up to the permissible levels before discharging to the public sewers.

The faecal coliform as a basic parameter for the design of STP is not stipulated in the general standards of MOEF but the standards are stipulated in the Manual on Sewerage and Sewage Treatment published by the Central Public Health and Environmental Engineering Organization (CPHEEO) under MOEF in May 2012. The JICA Study Team proposes to adopt the desirable limit for the faecal coliform (1,000 MPN/100 mL).

All the materials shown in Table 3.4.1 in the effluents from STPs shall be monitored through periodical water quality tests in the laboratories of STPs and external institution(s).

Table 3.4.1 General Standards for Discharge of Environmental Pollutants in Effluent Water from Facilities

S.No	Parameter	Standards (mg/l)			
		Inland surface water	Public sewers	Land for Irrigation	Marine coastal areas
1	Suspended Solids	**100**	600	200	100
2	Dissolved Solids(inorganic)	2100	2100	-	2100
3	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Temperature, °C	*	-	-	*
5	Oil and Grease	10	20	10	20
6	Total Residual Chlorine	1.0	-	-	1.0
7	Ammonical Nitrogen(as N)	50	50	-	50
8	Total Kjeldahl Nitrogen(as N)	100	-	-	100
9	Free Ammonia (as NH^3)	5.0	-	-	5.0
10	Biochemical Oxygen Demand (3 days at 27°C)	**30**	350	100	100
11	Chemical Oxygen Demand	250	-	-	250
12	Aresenic(as AS)	0.2	0.2	0.2	0.2
13	Mercury(as Hg)	0.01	0.01	-	0.01
14	Lead (as Pb)	0.1	1.0	-	2.0
15	Cadmium(as Cd)	2.0	1.0	-	2.0
16	Total Chromium(as Cr)	2.0	2.0	-	2.0
17	Copper(as Cu)	3.0	3.0	-	3.0
18	Zinc(as Zn)	5.0	15	-	15
19	Selenium(as Se)	0.05	0.05	-	0.05
20	Nickel(as Ni)	3.0	3.0	-	5.0
21	Cyanide(as CN)	0.2	2.0	0.2	0.2
22	Fluoride(as F)	2.0	15	-	15
23	Dissolved Phosphates (as P)	5.0	-	-	-
24	Sulphide (as S)	2.0	-	-	5.0
25	Phenolic Compounds(as C^6H^5OH)	1.0	5.0	-	5.0
26	Manganese (as Mn)	2.0	2.0	-	2.0
27	Iron (as Fe)	3.0	3.0	-	3.0
28	Vanadium (as V)	0.2	0.2	-	0.2
29	Nitrate Nitrogen	10	-	-	20
NRCD Guideline for Faecal Coliform					
		Discharge onto land		Discharge onto water	
		Desirable	Max permissible	Desirable	Max permissible
30	Faecal Coliform (MPN/100mL)	1,000	10,000	**1,000**	10,000

Source: MOEF The Environment (Protection) Rules, 1986 – Schedule VI (last amendment April 2, 1996) (http://cpcb.nic.in/GeneralStandards.pdf)
"Manual on Sewerage and Sewage Treatment: Part A Engineering" (p. 5-2), Central Public Health and Environmental Engineering Organization (CPHEEO), May 2012
Note: * Shall not exceed 5 °C above the receiving water temperature

b) Specific Standards for Industrial Effluents

The Environmental Protection Rules stipulates the discharge standards for more than 70 categories of industries and plants, which are based on the general standards shown in Table 3.4.1. Among all the categories, the effluent standards for the iron and steel industries are listed in Appendix B2.1 as a reference, since the plants of these industries exist in Ranchi City.

(2) Selection of Optimum Treatment Method

1) Nomination of Treatment Processes

Sequencing batch reactor (SBR) was proposed for the treatment process in the existing DPR. SBR employs a simple structure and is advantageous in terms of the removal of suspended solids as well as nitrogen and phosphorus. However, this method is not so easy to operate, particularly, in controlling the fluctuation of the inflow rate and inflow quality compared with other treatment processes.

In this regard, the JICA Study Team proposed alternative treatment processes for comparison, namely, conventional activated sludge (CAS) and upflow anaerobic sludge blanket with final polishing unit (UASB + FPU).

2) Comparison of Characteristics and Costs

The JICA Study Team compared the initial and O&M costs among the three options for the treatment capacities of 86 and 50 MLD in Zone II and Zones III and IV at the target year of 2031 (see Appendix B2.2 and Appendix B2.3).

In addition to the cost comparison, other significant factors have also been taken into consideration, including adaptability to a large-scale STP, treated water quality, number of past performances in India, and ease of O&M.

The overall comparison of the characteristics and costs are summarized in Table 3.4.2.

3) Determination of Treatment Process

As a conclusion, the JICA Study Team proposed that CAS is the most optimum and appropriate treatment method due to the following factors:

- UASB+FPU has the lowest cost as a whole compared with the others. However, the difference is not that much. Therefore, the cost is not a decisive factor among the three options.
- CAS has been widely adopted in India (see the past record of CAS and SBR in India in Appendix B2.4) and the STPs with this method are generally operated well except some old STPs in which the maintenance and repair works have not been done properly.
- SBR has the best treated water quality among the three options. However, the difference from CAS is not that significant as far as the actual effluent water qualities of large-scale STPs are concerned. The effluent water quality of UASB+FPU is not within an acceptable level.
- UASB+FPU requires massive land area which leads to the difficulty of land acquisition and resettlement issue.

(3) Determination of Sludge Treatment Process

Sludge treatment with i) gravity thickener, ii) anaerobic digestion, and iii) sludge drying bed

was proposed in the existing DPR. Meanwhile, the JICA Study Team proposed to omit items ii) and iii) due to the following reasons:

1) Anaerobic Sludge Digestion

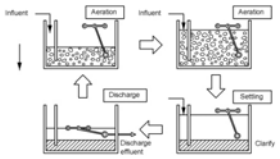
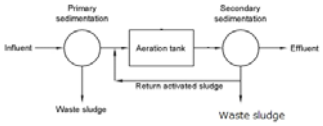
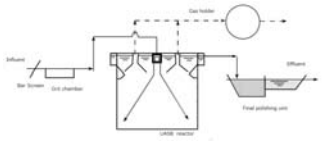
Although this process was proposed in DPR, anaerobic digestion has disadvantages, namely: 1) operational difficulties in O&M, 2) high initial costs including land cost, and 3) high O&M costs. For example, the fuel cost during operation was assumed to be much higher than in the case of other cities.

For reference, cost comparison was made between the "with digestion" and "without digestion" cases (see Appendix B2.6). In the comparison, land cost, construction cost, and sludge transportation cost were conventionally considered. As a result, the "without digestion" case was found to be more cost effective than the "with digestion" case.

2) Sludge Dewatering/Drying

The sludge drying bed was proposed in DPR for reducing the water content of sludge. However, sludge drying bed and composting have disadvantages such as: 1) massive land acquisition, 2) difficult handling of dried or composted sludge cake because Ranchi City experiences much rain during the rainy season, and 3) uncertain marketability of composted sludge. Considering these disadvantages and the existence of proposed sludge dumping site as mentioned in Subsection 3.4.4, sludge dewatering, which does not require much area for construction, was selected as a substitute to sludge drying.

Table 3.4.2 Comparison of Three Treatment Processes for Zone II and Zones III and IV

Process / Items	Sequencing batch reactor (SBR) - DPR Proposal		Conventional Activated Sludge (CAS)		Up-flow anaerobic sludge blanket + final polishing unit (UASB+FPU)	
Schematic diagram						
Outline	The sewage flows into a single reactor. Aeration, sedimentation, discharge of supernatant water, etc. are repeated sequentially and periodically.		The sewage flows into an aeration tank through a primary sedimentation tank. The oxygen is supplied to the aeration tank and the organic matter is dissolved by bacteria. Solid-liquid separation is performed in a final sedimentation tank, and supernatant water is discharged as treated water after disinfection.		The organic matter is dissolved into carbon dioxide and methane gas by up-flow in the preceding anaerobic sludge blanket. The remaining organic matters are dissolved further in the latter aerobic treatment (final polishing unit).	
Adaptability for large scale STP	- Inflow: 103 MLD (Zone-II), 53 MLD (Zone-III&IV) - This process is mainly for small scale STP (less than 10 MLD in general) - Some large scale STPs more than 50 MLD have been constructed recently but the performances are not certain yet.	3	- Inflow: 103 MLD (Zone-II), 53 MLD (Zone-III&IV) - Adaptable for large scale STP. - There are many examples of large scale STP of more than 100 MLD in India and they are operated well.	4	- Inflow: 103 MLD (Zone-II), 53 MLD (Zone-III&IV) - Adaptable for large scale STP. - There are many examples of large scale STPs of more than 100 MLD in India.	4
Treated water quality	- Discharge water quality standard: BOD 30mg/L, SS: 100mg/L - The standard above can be observed and the design effluent water quality is much less than above (such as BOD 5mg/L). However, to secure the level is difficult in case of large scale STPs and the difference is not so much from well operated CAS.	4	- Discharge water quality standard: BOD 30mg/L, SS: 100mg/L - The standard above can be observed with stable treated water discharge. - There are many examples of BOD around 10mg/L under proper operation in Japan and such STPs in India also can be observed.	4	- Discharge water quality standard: BOD 30mg/L, SS: 100mg/L - It is difficult to achieve the standard above observed from examples of existing UASB+FPU STPs in India, since the solid extraction ratio is not high. - The quality gets worse when the temperature is low. (Not suitable in Ranchi)	2
Required Area	- A primary and final sedimentation tanks becomes unnecessary but the total dimension of reactors gets more. It leads to less required area than the CAS. - With many numbers of reactors for large scale STP, the total required area is not so smaller than CAS.	4	- Medium required area - It can be layouted within the area proposed by RMC (around 6 ha) by replacing sludge drying to dewatering.	3	- Large required area for mainly FPU. - It can be assessed that this process requires the area more than 2 times of CAS.	2
Experience and ease of operation and maintenance	- The O&M is more difficult than CAS because of more automated switches and valves for sequential controller. - Since sewage cannot be flowed into sedimentation / discharge process, when a scale becomes large, operation adjustment between each reactor becomes complicated. - Compound liquid of activated sludge can be settled in the static condition. Therefore, solid-liquid separation is smooth. - Because of the short retention time, the volume of sludge becomes large.	3	- Operation can be manually adjusted in accordance with influent conditions - The O&M is more difficult than UASB+FPU because of the number of equipments. - Since there are many examples of CAS in India and Japan, it can be well operated after effective training.	4	- There are many such installations in India. -The O&M work is easier than SBR and CAS because of less number of equipments. - Since the organic matter is dissolved under long retention time, there are few amounts of sludge generation.	5
Cost (Construction and O&M)	- Capital cost excluding land cost is more than CAS. - Because of the shortest retention time, the volume of sludge becomes large. Therefore, power and chemical consumptions for sludge treatment is largest among three processes	3	- Number of equipments are more than UASB+FPU and it leads to higher construction cost. - Because of the short retention time, the volume of sludge becomes large. Therefore, power consumption for sludge treatment is more than UASB.	4	- Since Aeration is not carried out in a reaction tank, there is a little power consumption. - Since the organic matter is dissolved under long retention time, there are few amounts of sludge generation.	4
Environment	The odour is medium level.	3	The odour is medium level.	3	The odour is low level.	4
Total points for comparison	-	20	-	22	-	21
Evaluation	1. SBR is the most reasonable among three options when comparing the costs. However, the difference is not significant. 2. SBR is difficult to manage the storm water inflow successively in case adopting combined sewer system. It is not suitable for Ranchi where the number of trained STP technitians is quite few. 3. CAS is reliable since the primary settling, disinfection and discharge can be done in the primary sedimentation ponds in case of storm water inflow.					

Note: 5 – Excellent, 4 – Good, 3 – Acceptable, but problems exist, 2 – Problematic, and 1 – Extremely difficult or impossible to adopt.

Cost Comparison (STP Zone-II)

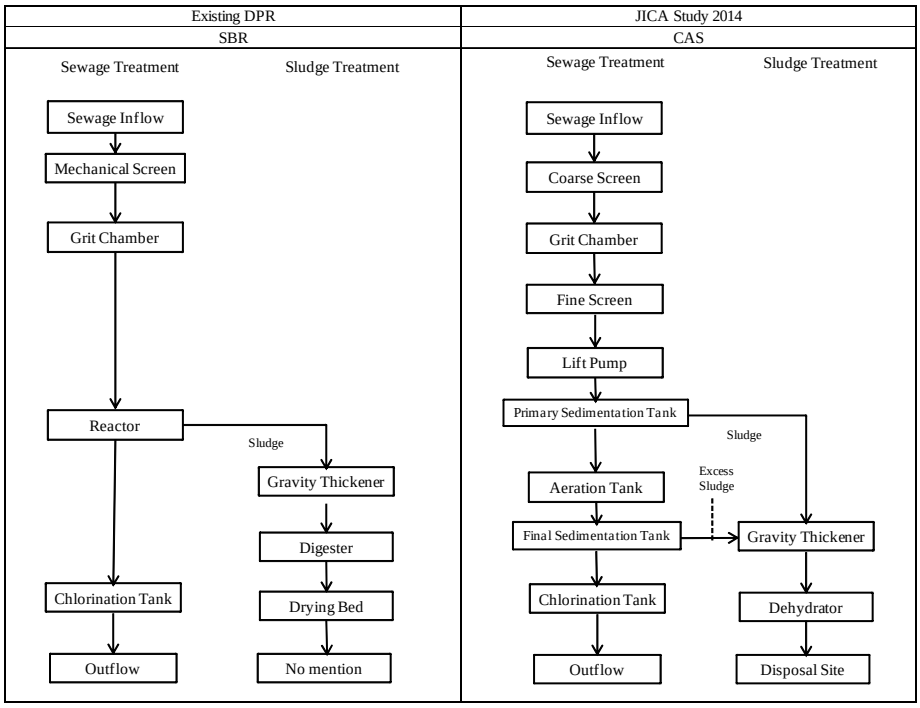
Flow at target year of 2031 (MLD)	86	86	86
Required area for 2031 (ha)	4.9	5.4	15.9
Unit Land Cost (Rs million/ha)	50	50	50
(1) Land Cost (Rs million)	247	270	796
(2) Capital Cost (Rs million)	1,367	1,135	946
(3) Annual O&M Cost (Rs million/year)	93	75	62
30 years cost performance (Rs million) (1+2+3x30)	4,410	3,650	3,590

Source: JICA Study Team

Note: 1. Technical informatoin was obtained from experiences in Japan and "Manual on Sewerage and Sewage Treatment - Part A: Engineering, Central Public Health and Environmental Engineering Organization (CPHEEO), 2012"
2. Unit capital & O&M costs were obtained from "Life cycle cost comparison of different STP processes" (NCRPB website) and adjusted with price escalation from 2010 for all and "Performance Evaluation of Sewage Treatment Plants under NRCD" (CPCB, 2013) for unit O&M cost of UASB+FPU
3: Unit land cost was obtained from average unit price for farm lands in Ranchi obtained from RMC

3) Determination of Sludge Treatment Process

As a result of the process-wise analysis above, the flowchart for sewage and sludge treatment, as shown in Figure 3.4.1, was selected.



Source: JICA Study Team

Figure 3.4.1 Comparison of Proposals between DPR and this Study

3.4.2 Design of Zone II STP

(1) Design Condition of Zone II STP

1) Location

The STP is situated in the eastern end of Zone II and faces the Subarnarekha River. To the south of the planned construction site lies an electrical substation of the Jharkhand State Electricity Board (JSEB). Farmland is located in the north of the substation.

2) Design Water Flows and Qualities

The design water flow is based on the daily average flow during a year (qs : m^3/d) and the peak flow is set at two times of the average flow (Q = 2 qs) in accordance with the CPHEEO Manual.

The influent water qualities in the existing DPR were reviewed based on the results of the water quality survey in this project which was conducted during the dry season in February 2014 (see Table 2.1.2 in this report).

The effluent water qualities in the general standards mentioned in Subsection 3.4.1 are high values which are not suitable for the design conditions. They were reviewed based on the general design criteria of CAS in India, which are the values in the “general objective of

sewage treatment in India" (CPHEEO Manual, 2012, p. 5-82).

The design conditions are shown in Table 3.4.3 as compared with those in the existing DPR. One of the salient items between the proposal of the JICA Study Team and DPR is found on the effluent water qualities. The effluent BOD and SS in DPR are so stringent that quality control seemed to be very difficult and not appropriate for the public sewerage system. In addition, faecal coliform did not meet the requirement of the governmental standards.

Table 3.4.3 Design Water Flows and Qualities for Zone II STP

Item		Proposed Design Parameters	Existing DPR (for Reference)
Influent in 2031	Average flow (m^3/d)	86,000	103,000
	Peak flow (m^3/d)	172,000	206,000
Influent Water Quality	BOD (mg/L)	200	200
	SS (mg/L)	200	400
Effluent Water Quality	BOD (mg/L)	20 (CAS)	5 (SBR)
	SS (mg/L)	30 (CAS)	10 (SBR)
	Faecal coliform (MPN/100 mL)	1,000	10,000

Source: JICA Study Team and Existing DPR

(2) Design of Zone II STP

1) Pre-treatment Facilities

The coarse screens are installed in order to remove large objects such as plastics which are trapped in the sewers. Subsequently, the grits in the sewage are settled in the grit chambers. The fine mechanical screens are installed before the lift pumps in order to remove the small objects and avoid damages to the pumps.

The designs of grit chambers and screens are listed in Table 3.4.4.

Table 3.4.4 Design of Pre-treatment Facilities for Zone II STP

Item	Average	Peak
Design flow	86,000 m^3/d (qs)	172,000 m^3/d (2 qs)
(A) Coarse Screen		
Type	Manual	
Dimension	W1.2 m x 4 nos.	
Clear opening	100 mm	
Operation	2 W + 2 SB	4 W
(B) Grit Chamber		
Dimension	W1.2 m x L15 m x D1.5 m x 4 nos.	
Operation	2 W + 2 SB	4 W
Surface overflow rate	2,389 $m^3/d/m^2$	2,389 $m^3/d/m^2$
Detention period	54.3 s	54.3 s
(C) Fine Screen		
Type	Mechanical	
Dimension	W1.2 m x 4 nos.	
Clear opening	20 mm	
Operation	2 W + 2 SB	4 W

Note: W: Working, SB: Standby

Source: JICA Study Team

The detention period should be less than 60 s for the average flow in India (CPHEEO Manual 2012). The period should be secured with proper flow control and number of units operated in balance with the flow.

2) Lift Pumps

The pump pits and lift pumps are designed with sewage capacities of 2 qs. Considering much garbage in the sewage in Ranchi City, the lift pump station is designed with the vertical mixed flow volute pump, which has advantages in terms of less clogging, low operation cost, and simple maintenance.

In order to cover the hourly maximum design flow as peak flow, the pump capacity and number of pumps for the lift pump are designed as shown in Table 3.4.5.

Table 3.4.5 Pump Capacity and Number of Pumps for the Lift Pump for Zone II STP

Item	Average	Peak
Design flow (m^3/d)	86,000 (qs)	172,000 (2 qs)
Design flow (m^3/min)	59.72 (qs)	119.44 (2 qs)
Pump capacity (m^3/min)	Small pump: 33 Large pump: 66	Small pump: 33 Large pump: 66
Number of pump in operation	Small pump: 0 W + 2 SB Large pump: 1 W + 1 SB	Small pump: 2 W + 0 SB Large pump: 1 W + 1 SB
Total capacity (m^3/min)	66 >59.72	132 >119.44

Note: W: Working, SB: Standby
Source: JICA Study Team

3) Primary Sedimentation Tank

Primary sedimentation tanks are located after the screens and grit chambers and they reduce the organics load on aeration tanks. Since 2 qs flow will be treated in the tanks, the surface overflow rate was designed to be small value for average and peak flows within the range of Indian design criteria (25 to 35 $m^3/d/m^2$ at average flow and 50 to 60 $m^3/d/m^2$ at peak flow) which leads to large dimensions in order to keep allowance for peak flow. The design of primary sedimentation tanks is shown in Table 3.4.6.

Table 3.4.6 Design of Primary Sedimentation Tanks for Zone II STP

Item	Average	Peak
Dimension	Dia. 23 m x D 3.5 m x 2 nos. x 4 units	
Design flow (m^3/d)	86,000	172,000
Surface overflow rate ($m^3/d/m^2$)	25.9	51.7
Detention period (h)	3.25	1.62

Source: JICA Study Team

4) Aeration Tank (Reactor)

The organic substances are treated by biological and chemical reactions in aeration tanks with activated sludge and blowers. The tanks were designed with large hydraulic retention time (HRT) in the range of Indian design criteria (4 to 6 hours) which leads to large dimensions in order to have allowance for peak flow. Basically, all the inflow can be treated with aeration tanks with allowance and proper flow control except in special cases such as massive infiltrating water during wet weather.

The design of aeration tanks and blowers is shown in Table 3.4.7.

Table 3.4.7 Design of Aeration Tanks and Blowers for Zone II STP

Design flow	86,000 m^3/d
Dimensions	W9 m x L50 m x D6 m x 2 nos. x 4 units
HRT	5.9 h
MLSS	1,700 mg/L
Air requirement	300 m^3/min
Blowers	160 m^3/min x 2 nos. (incl. 1 standby) 80 m^3/min x 2 nos.

Source: JICA Study Team

The pipes connecting from the aeration tanks to primary sedimentation tanks are necessary in order to realize the flexible handling of settling and withdrawing excess sludge generated in the aeration tanks in both primary and final sedimentation tanks depending on the sewage and climate conditions.

5) Final Sedimentation Tank

Final sedimentation tanks are located after the reactors and are used to separate the biologically treated water in reactors from activated sludge and other solids. The design of final sedimentation tanks is shown in Table 3.4.8.

Table 3.4.8 Design of Final Sedimentation Tanks for Zone II STP

Design flow	86,000 m^3/d
Dimension	Dia. 25 m x D3.5 m x 2 nos. x 4 units
Surface overflow rate	21.9 $m^3/d/m^2$
Detention period	3.84 h

Source: JICA Study Team

6) Chlorination Tank

The faecal coliform in the effluent water from the final sedimentation tanks is disinfected by chlorine in the chlorination tanks. The pure chlorine gas in cylinder and chlorine dosing pumps are used for the chlorination. The design of chlorination tanks and chlorinators is shown in Table 3.4.9.

Table 3.4.9 Design of Chlorination Tanks and Chlorinators for Zone II STP

Design flow (m^3/d)	86,000
Dimension	W2.0 m x L120 m x D2 m x 4 units
Detention period (min)	32.1
Amount of chlorine required (kg/d)	258
Type of chlorine	Pure chlorine gas in cylinder

Source: JICA Study Team

7) Sludge Thickener

The mixed sludge consisting of the sludge from primary sedimentation tanks and final sedimentation tanks are thickened in the gravity thickeners. In case the settling of sludge in the final sedimentation tanks shows bad condition such as due to high temperature, the excess sludge in the aeration tanks could be sent to the primary sedimentation tanks and the mixed sludge withdrawn from the tanks would be thickened. The design of sludge thickener is shown in Table 3.4.10.

Table 3.4.10 Design of Sludge Thickener for Zone II STP

Sludge volume	2,489 m^3/d
From primary sedimentation tank	1,160 m^3/d (99.0%)
From final sedimentation tank	1,329 m^3/d (99.4%)
Type of thickener	Gravity
Dimension	Dia. 12 m x D4 m x 4 nos.
Solids surface loading	43.3 $m^3/d/m^2$
Detention period	17.5 h

Note: Figures in parenthesis refer to the water content of sludge
Source: JICA Study Team

8) Sludge Dehydrator

The screw press, belt press, and centrifugal type dehydrators were preliminarily compared as shown in Appendix B2.6. Considering mainly the availability and experience in India, and the sludge cake volume, the centrifugal type is recommended. The design of the sludge dehydrator is shown in Table 3.4.11.

Table 3.4.11 Design of Sludge Dehydrator for Zone II STP

Thickened sludge volume	782.8 m^3/d (98.0%)
Type of dehydrator	Centrifugal
Capacity and Number	20 m^3/h x 3 nos. (+1 standby)

Note: Figure in parenthesis refer to the water content of sludge
Source: JICA Study Team

The aforementioned three types of dehydrators require organic coagulants in order to make the solid-liquid separation easy. The chemicals used in India are ferric and aluminum salts and lime. The more common is ferric chloride with or without lime according to the CPHEEO Manual 2012.

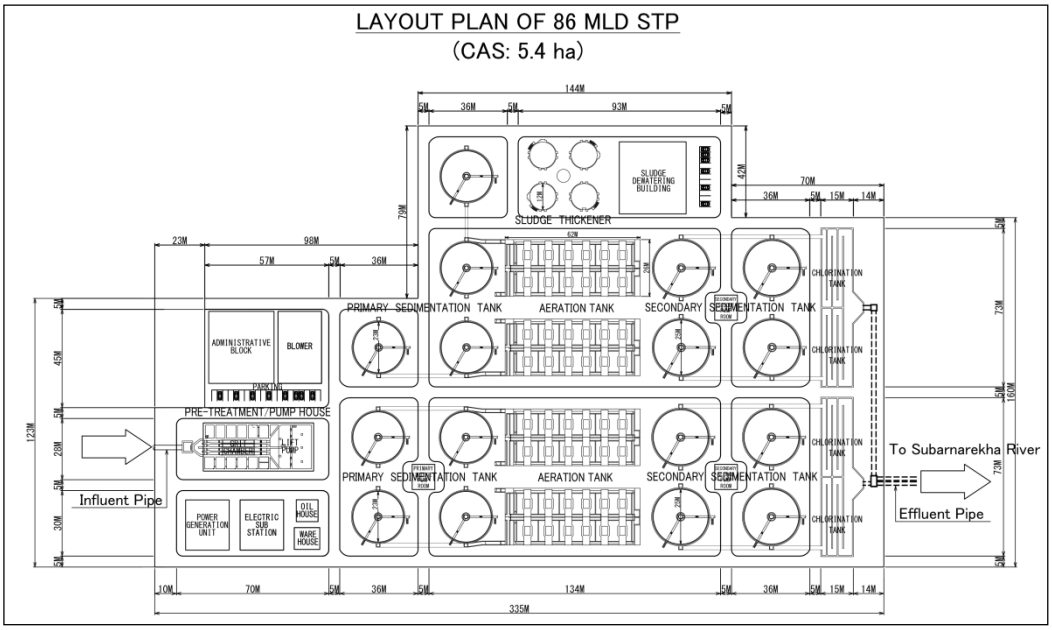
The dewatered sludge is loaded into the dump trucks by hopper and transported to the sludge dumping site as tentatively proposed in the STP in Zones III and IV.

9) List of Facilities and Major Equipment

The numbers and dimensions of all the facilities with the specifications of major equipment are shown in Appendix B2.7.

10) Layout and Section of STP

Based on the designs of the facilities mentioned above, the layout plan of Zone II STP was prepared as shown in Figure 3.4.2. (See Drawings B-01 and B-02 for more details.) The general cross section of STP was prepared based on the layout as shown in Drawing B-03.



Source: JICA Study Team

Figure 3.4.2 Layout Plan for Zone II STP with CAS (86 MLD)

11) Plans and Cross Sections of Each Facility

The plans and cross sections of 1) pre-treatment and lift pump house, 2) primary sedimentation tank, 3) reactor, 4) final sedimentation tank, 5) chlorination tank, and 6) outlet structure are shown in Drawings B-05 to B-14.

3.4.3 Design of STP in Zones III and IV

(1) Design Condition of STP in Zones III and IV

1) Location

The STP site in Zones III and IV was proposed by the JICA Study Team at the old STP site in HEC premises in Tonko in the southeastern outskirts of Zone IV.

2) Design Water Flows and Qualities

The STP in Zones III and IV was designed with the conditions shown in Table 3.4.12. The conditions for setting up the design parameters were the same as for Zone II STP.

Table 3.4.12 Design Water Flows and Qualities for STP in Zones III and IV

Item		Design Parameters	Existing DPR (Reference)
Influent in 2031	Average flow (m^3/d)	50,000	53,000
	Peak flow (m^3/d)	100,000	106,000
Influent Water Quality	BOD (mg/L)	200	200
	SS (mg/L)	200	400
Effluent Water Quality	BOD (mg/L)	20 (CAS)	5 (SBR)
	SS (mg/L)	30 (CAS)	10 (SBR)
	Faecal coliform (MPN/100 mL)	1,000	10,000

Source: JICA Study Team and Existing DPR

(2) Design of STP in Zones III and IV

1) Pre-treatment Facilities

The designs of grit chambers and screens are shown in Table 3.4.13.

Table 3.4.13 Design of Pre-treatment Facilities for STP in Zones III and IV

Item	Average	Peak
Design flow	50,000 m^3/d (qs)	100,000 m^3/d (2 qs)
(A) Coarse Screen		
Type	Manual	
Dimension	W1.0 m x 4 nos.	
Clear opening	100 mm	
Operation	2 W + 2 SB	4 W
(B) Grit Chamber		
Dimension	W1.0 m x L10 m x D1.5 m x 4 nos.	
Operation	2 W + 2 SB	4 W
Surface overflow rate	2,500 $m^3/d/m^2$	2,500 $m^3/d/m^2$
Detention period	51.8 s	51.8 s
(C) Fine Screen		
Type	Mechanical	
Dimension	W1.0 m x 4 nos.	
Clear opening	20 mm	
Operation	2 W + 2 SB	4 W

Note: W: Working, SB: Standby
Source: JICA Study Team

2) Lift Pumps

The capacity and number of lift pumps are designed as shown in Table 3.4.14.

Table 3.4.14 Pump Capacity and Number of Pumps for the Lift Pump for STP in Zones III and IV

Item	Average	Peak
Design flow (m^3/d)	50,000 (qs)	100,000 (2 qs)
Design flow (m^3/min)	34.72 (qs)	69.44 (2 qs)
Pump capacity (m^3/min)	Small pump: 15 Large pump: 33	Small pump: 15 Large pump: 33
Number of pump in operation	Small pump: 1 W + 1 SB Large pump: 1 W + 1 SB	Small pump: 1 W + 1 SB Large pump: 2 W + 0 SB
Total capacity (m^3/min)	48 >34.72	81 >69.44

Note: W: Working, SB: Standby
Source: JICA Study Team

3) Primary Sedimentation Tank

The design of primary sedimentation tanks is shown in Table 3.4.15.

Table 3.4.15 Design of Primary Sedimentation Tanks for STP in Zones III and IV

Item	Average	Peak
Dimension	Dia. 25 m x D3.5 m x 2 nos. x 2 units	
Design flow (m^3/d)	50,000	100,000
Surface overflow rate ($m^3/d/m^2$)	25.5	50.9
Detention period (h)	3.30	1.65

Source: JICA Study Team

4) Aeration Tank (Reactor)

The design of aeration tanks and blowers is shown in Table 3.4.16.

Table 3.4.16 Design of Aeration Tanks and Blowers for STP in Zones III and IV

Design flow	50,000 m^3/d
Dimension	W9 m x L50 m x D5 m x 4 nos.
HRT	5.9 hours
MLSS	1,700 mg/L
Air requirement	200 m^3/min
Blowers	160 m^3/min x 1 nos. 80 m^3/min x 2 nos. (incl. 1 standby)

Source: JICA Study Team

5) Final Sedimentation Tank

The design of the final sedimentation tanks is shown in Table 3.4.17.

Table 3.4.17 Design of Final Sedimentation Tanks for STP in Zones III and IV

Design flow	50,000 m^3/d
Dimensions	Dia. 27 m x D3.5 m x 4 nos.
Surface overflow rate	21.8 $m^3/d/m^2$
Detention period	3.85 h

Source: JICA Study Team

6) Chlorination Tank

The design of chlorination tanks and chlorinators is shown in Table 3.4.18.

Table 3.4.18 Design of Chlorination Tanks and Chlorinators for STP in Zones III and IV

Design flow (m^3/d)	50,000
Dimension	W2.0 m x L140 m x D2 m x 4 units
Detention period (min)	32.3
Amount of chlorine required (kg/d)	150
Type of chlorine	Pure chlorine gas in cylinder

Source: JICA Study Team

7) Sludge Thickener

The design of sludge thickener is shown in Table 3.4.19.

Table 3.4.19 Design of Sludge Thickener for STP in Zones III and IV

Sludge volume	1,447 m^3/d
From primary sedimentation tank	674 m^3/d (99.0%)
From final sedimentation tank	773 m^3/d (99.4%)
Type of thickener	Gravity
Dimension	Dia. 12 m x D4 m x 2 nos.
Solids surface loading	50.3 $m^3/d/m^2$
Detention period	15 h

Note: Figures in parenthesis refer to the water content of sludge
Source: JICA Study Team

8) Sludge Dehydrator

The design of sludge dehydrator by centrifugal type is shown in Table 3.4.16.

Table 3.4.16 Design of Sludge Dehydrator for STP in Zones III and IV

Thickened sludge volume	455.1 m^3/d (98.0%)
Type of dehydrator	Centrifugal
Capacity and Number	20 m^3/h x 2 nos. (+1 standby)

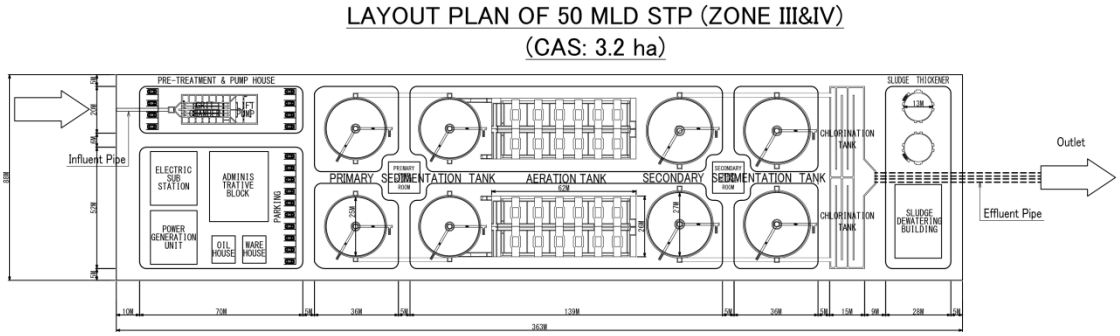
Note: Figure in parenthesis refer to the water content of sludge
Source: JICA Study Team

9) List of Facilities and Major Equipment

The numbers and dimensions of all the facilities with the specifications of the major equipment are shown in Appendix B2.8.

10) Layout of STP

Based on the designs of the facilities mentioned above, a preliminary layout for the STP in Zones III and IV with CAS was made as shown in Figure 3.4.3.



Source: JICA Study Team

Figure 3.4.3 Layout for STP in Zones III and IV with CAS (50 MLD)

3.4.4 Appurtenant Works Necessary for Sewage Treatment Process

(1) Access Road

The access roads to the STP sites shall be secured before commencing the construction to construct the STPs efficiently.

1) Access Road to Zone II STP in Lowadiah Basti

The access road to the proposed STP in Zone II should be constructed from Road 33 (Tata Road) because the new road is wide enough and has a capacity to let the massive construction materials to be transported through the road. The proposed alignment of the access road is shown in Appendix B2.9.

The road is proposed to have a length of 300 m and width of 6 m according to the typical cross section of municipal roads with two lanes provided by RMC, and with concrete pavement (semi dense bituminous concrete). For adding road side drains and buffer zones, 8 m width is proposed, which requires land acquisition of around 0.24 ha for this access road.

2) Access Road to Proposed Site for STP in Zones III and IV in Tonko

There is an existing access road to the proposed site for STP in Zones III and IV, which is undergoing improvement. The road is assumed to be a paved road in the future. Because the road is almost straight and flat, it can be used as an access road to the new STP in this project.

(2) Effluent Discharge Facilities

1) Design of Effluent Discharge Facilities for STP in Zone II

The design for the effluent pipes of STP for Zone II is listed in Table 3.4.17. The treated water is discharged with two pipes for maintenance and each pipe was designed with the average flow of STP (qs).

Table 3.4.17 Design of Effluent Pipe from the Zone II STP

Design flow	1.0 m^3/s (=86,000 m^3/d)
Diameter	1,200 mm
Number of lines	2 nos.
Type of pipe	RCC Hume pipe
Length	100 m
Gradient	1/667 (1.5%)
Velocity	1.43 m/s
Discharge point	Subarnarekha River

Source: JICA Study Team

The outlet structure to the river is shown in Drawings B-12 to B-14. In order to protect the STP from the backwater of the Subarnarekha River during high water events, the invert elevation of the effluent pipe was kept high with a step of 1 m at the exit of the pipe. The flow velocity of discharge is reduced by gabion mats to protect the riverbed against scouring.

2) Design of Effluent Discharge Facilities for STP in Zones III and IV

The preliminary design for the effluent pipes of STP for Zones III and IV is listed in Table 3.4.18.

Table 3.4.18 Design of Effluent Pipe from the STP in Zones III and IV

Design flow	0.6 m^3/s (=50,000 m^3/d)
Diameter	900 mm
Number of lines	2 nos.
Type of pipe	RCC Hume pipe
Length	100 m
Gradient	1/588 (1.7%)
Velocity	1.29 m/s
Discharge point	Stream near STP

Source: JICA Study Team

(3) Electrical Facilities for STP

Zone II STP receives a power supply of 33 kV. The 33 kV power is received at the power receiving unit located outside the plant and is step-downed to 6.6 kV by the transformer in the electric substation in the plant. The 6.6 kV power is distributed to the panels in the electric rooms of each facility. This voltage is further step-downed to 0.43 kV, which is then supplied to the equipment in the facility.

(4) Power Generators in STPs

Because there are frequent power failures in Ranchi City, diesel generators are necessary for the STPs. In order to keep the flowing functions in the STPs and the activated sludge in the aeration tanks, the generators for the STP in Zone II should have the capacity as described in Table 3.4.19.

Table 3.4.19 Capacity of Generators for the STP in Zone II

Equipment	Number	Power Requirement (kVA)
Lift pump	3	380
Blower	2	580
Return sludge pump	4 (one for each of the 4 units)	290
Lighting, etc.	1	120
Total	-	1,370 (Say, 1,400)

Source: JICA Study Team

The minimum generating capacity will be 1,400 kVA (700 kW x 2 nos.) for Zone II STP. The power generating system consists of a brushless generator with 6.6 kV x 50 Hz, four cycle diesel engine, and their auxiliary equipment (fuel system, cooling system, and lubricating system).

The operation time of generators is assumed to be six hours at the minimum in emergency cases such as failure of the equipment in the electric substation. An adequate volume of fuel for the generators should be stored within the vicinity of STPs.

3.4.5 Sludge Dumping Site for STPs

(1) Sludge Volume from Zone II STP

According to the estimation of sludge volume generated in Zone II STP, the required area for sludge disposal site is 3.21 ha for ten years when loaded up to 4 m height. The land acquisition and transportation costs amounted to Rs.191 million when the compression of sludge by the load at the site is not considered, as shown in Table 3.4.20.

Table 3.4.20 Required Area and Cost for Dumping of Sludge from Zone II STP

Items	Amount	Note
(1) Sludge generation (m3/year)	25,716	m3/day X 365 days
(2) Area for disposal site (ha for 10 years)	3.21	(1)/2avr X 10 years/4m
(3) Land cost (Rs)	161,000,000	Rs/ha 50,000,000
(4) Sludge transportation cost (Rs/year)	2,996,000	Rs.233 per m3 (About 400 yen/m3)
(5) 10 years cost performance with 0% inflation. (Rs)	191,000,000	

Source: JICA Study Team

(2) Proposal of Sludge Dumping Site Location

The capacity of the existing dumping site for night soils from septic tanks in Ranchi City,

which is located in the south of the power substation along the Zone II STP site, is not enough for receiving the dewatered sludge from the planned STPs.

The JICA Study Team estimated the total area for the facility of STP in Zones III and IV and the sludge dumping site for both STP in Zone II and STP in Zones III and IV. It was confirmed that the total area, which is 8.79 ha for ten years, is less than the available land area of the old STP site in the HEC premises in Tonko (10.9 ha) as shown in Table 3.4.21. The JICA Study Team proposed to RMC to discuss this matter with HEC.

Table 3.4.21 Design of Sludge Dumping Site for STPs in Zones II and III&IV

Item	Capacity	Sludge Volume		Area (ha)				Length (Square : m x m)		Note
				Sludge		With Ancilary Work				
	(m3/day)	(m3/day)	(m3/year)	5 years	10 years	5 years	10 years	5 years	10 years	
Sludge from STP Zone-II	86,000	70.5	25,716	1.61	3.21	1.77	3.54	130	190	10% for ancilary work (drains, pit for leachate)
Sludge from STP Zones-III&IV	50,000	41.0	14,965	0.93	1.87	1.03	2.06	100	140	
Sub-total for sludge dumping	-	111.5	40,681	2.54	5.09	2.80	5.59	170	240	
Required Area for STP Zones-III&IV (without sludge digester and drying bed)	-	-	-	-	-	3.2		(360x90)		
Total	-	-	-	-	-	6.00	8.79	240	300	
Existing available area in Tonko						10.9				(=27 acres)

Note: 1) The site will be used up to 4m height
2) The area might be smaller in case considering compression of sludge by load and discharge of leachate water
3) Sludge volume of STP Zones-III&IV can be smaller in case constructing sludge drying bed

Source: JICA Study Team

(3) Design of Sludge Dumping Site

The Notification on Municipal Solid Waste Management Handling Rules published on September 25, 1999 by MOEF stipulates that management of leachate water collection and treatment should be made in solid dumping sites. The treated leachate water should meet the general effluent standards for discharge of environmental pollutants (see Table 3.4.1 in Subsection 3.4.1). The JICA Study Team proposed the following design of sludge dumping site based on the discussion with the Jharkhand State Pollution Control Board (JSPCB) about this notification:

- The walls separating the sludge from STP and domestic solid waste should be constructed in a dumping site.
- The base of the dumping site for sludge from STP should be leachate-proof structure with concrete and plastic.
- The drains and a pit for leachate should be constructed so that the water is vacuumed and returned to STP periodically.
- The pit for leachate water should be a waterproof structure with cover in order to avoid stormwater inflow.

Since the proposed STP site for Zones III and IV would be adjacent to the proposed dumping site, the vacuuming and returning method above is desirable for leachate treatment.

3.4.6 Operation and Maintenance (O&M) for STPs

(1) Operation Time of STP

The STPs will be operated continuously for 24 hours a day and seven days a week. Among the equipment, the blowers will be operated for 24 hours a day and seven days a week and a standby machine will be installed. However, the sludge dehydrators will be operated 24 hours a day and six days a week in order to lessen the O&M cost. The control and monitoring of STP will be for 24 hours a day.

(2) Control and Monitoring System

The SCADA system is necessary for proper control and monitoring of STP operations. This system presents the data as a viewable and controllable system on the screen of a computer.

The major equipment are automatically operated and the operation status data is sent to a central supervisory room in the administrative building. The sent data is displayed on the Programmable Logic Controller/Remote Terminal Unit (PLC/RTU), which is a key device of the SCADA system, and the time-series data is recorded in the personal computers which can achieve the preparation of daily, monthly, and annual records on STP operation.

Basically, the equipment will be operated in automatic mode but these can be controlled through manual mode from the central supervisory room in emergency cases. The list of major equipment for the SCADA system is shown in Table 3.4.22.

Table 3.4.22 Major Equipment for SCADA System in STPs

Category	Device	Location	Nos.
Local control device	PLC/RTU	Lift pump house Blower house Aeration tank Chlorination tank Sludge dewatering building	5
Central supervisory control device	PLC/RTU	Administration building	1
	SCADA application server	Administration building	1
	Personal computer	Administration building	1
	(SCADA software)	Administration building	1
	Printer	Administration building	3
	Alarm equipment	Administration building	1 set
Telecommunication equipment	Modem Cable	Administration building Lift pump house Blower house Aeration tank Sludge dewatering building	1 set

Source: JICA Study Team

The sets of equipment which are automatically operated and should be connected to the SCADA system are shown in Table 3.4.23.

Table 3.4.23 Equipment that Should be Connected to the SCADA System

Location	Equipment	Control Item
Pre-treatment/lift pump house	Mechanical (coarse) screens	Status
	Lift pumps/pit	Status, water level
	pH/conductivity/DO/TOC sensors	Inlet water qualities
Blower house	Blowers	Air flow, pressure, temperature
Aeration tank	Aerators/diffusers	Status
	Return sludge pumps	Pressure
	DO/turbidity sensors	Water qualities
Chlorination tank	Chlorine dosing pumps	Pressure, water level
	DO/TOC/residual chlorine sensors	Outlet water qualities
Sludge dewatering building	Centrifugal dehydrators	Status
	Coagulant dosing pumps	Pressure, water level

Source: JICA Study Team

(3) Water Quality Monitoring in STPs

A laboratory for the monitoring of influent and effluent water qualities should be put up in the administrative building. Besides, some equipment for water quality measurement should also be installed in the treatment facilities for proper operation control. The parameters shown in Table 3.4.24 at least should be measured in the laboratory on a daily basis. The parameters measured in the STPs should be monitored on a daily basis and those outside the laboratory should be tested on a weekly or monthly basis.

Table 3.4.24 Proposed Parameters for Water Quality Monitoring in STPs (Reference)

Measurement Location	Objective	
	Effluent Quality Control	Operation Control
In STP (daily)	1) Water temperature 2) pH 3) Biological oxygen demand (BOD) 4) Suspended solid (SS) 5) Faecal coliform	1) Air temperature 2) Water temperature 3) Dissolved oxygen (DO) 4) Turbidity 5) Sludge volume (SV)
Outside laboratory (monthly)	1) Total nitrogen (TN) 2) Total phosphorus (TP) 3) Oil and grease	None

Source: JICA Study Team

(4) Maintenance

The civil structures and electromechanical equipment in the STPs shall be maintained and inspected daily and periodically for the sound and stable operation of the plants.

Examples of items requiring attention with regard to the maintenance of equipment in STPs are shown in Table 3.4.25.

Table 3.4.25 Examples of Items Requiring Attention for the Maintenance of Equipment

No.	Item	Works/Check Points
1	Plant Cleanliness	Wash down tank walls, weirs, and channels to reduce the collection of odor-causing materials periodically.
2	Aeration Equipment	
	i) Air blowers and air diffusion units ii) Mechanical aerators	noise, vibration, clogging
3	Air Lift Pumps	noise, vibration
4	Scum Skimmer	actuation, scum condition
5	Sludge Scrapers	noise, vibration
6	Froth Spray System	clogging of nozzles
7	Weirs, Gates, and Valves	volts, rusts, openings, water leakage
8	Raw Sewage Pumps	noise, vibration
9	Dehydrator (centrifugal)	oil level, cooling water, vibration

Source: CPHEEO Manual 2012

These items should be monitored and the results should be recorded every day. More detailed instructions for the above items and other items should be given to the operators by the contractor during the defects liability period. The repairs for small equipment parts affected by corrosion should be conducted at least once a year.

(5) Estimated Power, Chemicals, and Proposed Staff for O&M

1) Power Consumption

As shown in Table 3.4.26 below, the estimated annual power consumption is around 10.5 million kWh. The lift pumps, blowers/diffusers for aeration, return sludge pumps, and centrifugal dehydrators for the dewatering of sludge were considered as the major mechanical equipment with high power consumption. Meanwhile, the other equipment were categorized as “Others” in the table.

Table 3.4.26 Estimated Annual Power Consumption in STP in Zone II

Equipment	Power Consumption (kWh/year)	Ratio
Lift Pump	1,401,600	13%
Blower and Diffuser	3,153,600	30%
Return Sludge Pump	2,102,400	20%
Dehydrator (Centrifugal)	1,098,504	10%
Others	2,765,157	26%
Total	10,521,261	

Source: JICA Study Team

2) Chemical Consumption

The chlorine gas in cylinder would be used for the disinfection of treated water. The coagulants, which are dosed for the coagulation of thickened sludge during the sludge dewatering process, are assumed to be ferric chloride and alum as per the description in the subsection for sludge dewatering in the Manual on Sewerage and Sewage Treatment (CPHEEO 2012). The annual consumption of chemicals in Zone II STP was estimated as shown in Table 3.4.27 below.

Table 3.4.27 Estimated Annual Chemical Consumption in STP in Zone II

Chemical	Consumption (t/year)
Chlorine gas (in cylinder)	94
Ferric chloride and alum	286

Source: JICA Study Team

3) Manpower Requirement

The proposed staffing for the STPs in Zone II and Zones III and IV is shown in Table 3.4.28.

Table 3.4.28 Proposed Staffing for STP in Zone II and STP in Zones III and IV

SI No.	Position	Nos.	Remarks
STP in Zone II			
1.	Plant Manager / Assistant Engineer (STP)	1	Managing the day-to-day operation of STP
2.	Junior Engineers (STP)	3	Overseeing the O&M of the STP; 1 per 8-hour shift
3.	Water Quality Analyst (Chemist)	1	Monitoring of water qualities of influent/effluent water and facilities
4.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8-hour shift
5.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8-hour shift
	Total for STP in Zone II	14	
STP in Zones III and IV			
1.	Plant Manager / Assistant Engineer (STP)	1	Managing the day-to-day operation of STP
2.	Junior Engineers (STP)	3	Overseeing the O&M of the STP; 1 per 8-hour shift
3.	Water Quality Analyst (Chemist)	1	Monitoring of water qualities of influent/effluent water and facilities
4.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8-hour shift
5.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8-hour shift
	Total for STP in Zones III and IV	14	

Source: JICA Study Team

The electromechanical engineers from the proposed Mechanical Division in the Water Supply and Sewerage Wing (WSSW) of RMC will patrol the STPs along with one from the Water Treatment Plants (see Subsection 4.1.2 in this report for the details of the proposed overall organizational framework).

3.5 Plan of Sanitary Facilities and Operation

3.5.1 Plan of Public Toilets and Relevant Facilities

(1) Policy for Locations of New Public/Community Toilets

The number, locations, and status of all existing public/community toilets in Ranchi City were explained in Subsection 2.5.2. In order to propose the sites of new public/community toilets, the following items were considered:

i) Priority was given to community toilets in slum areas rather than public toilets for the improved living conditions of urban poor.

ii) Since there are many urban poor in Zone II, the priority was given to the wards in Zone II rather than those in Zones III and IV.

iii) Priority was given to wards without existing public and community toilets.

iv) Priority was given to remote and wide wards where the colonies are scattered. In such wards, at least one community toilet should be constructed even if the wards have some existing public/community toilets.

v) Areas where RMC has plans to construct public toilets in the near future was excluded.

(2) Proposed Locations of New Public/Community Toilets

The available space for community toilets in the slums in Zones II and Zones III and IV based on the abovementioned prioritization was confirmed by the JICA Study Team. The ownerships of public or private lands were inquired from the neighbors of said locations during the interview. According to the questionnaire results of the social survey, many residents signified their willingness to pay for community toilets and the results of the interviews at the sites for the new community toilet locations showed similar trends.

The proposed locations for new community toilets are listed in Table 3.5.1 and the location map is shown in Appendix B3.1. A total of 22 locations in Zone II and 11 locations in Zones III and IV with available spaces were identified by the JICA Study Team. Based on the number of existing public/community toilets and the proposed numbers in a similar project in India, a total of 40 public/community toilets should be newly installed in Zone II, which is the prioritized zone in this project, to enhance the sanitation improvement effect. Therefore, additional 18 locations for Zone II including public toilets for public places should be identified by RMC. Because the confirmation of land ownerships mentioned in the table was conducted based only on interviews, RMC should also confirm the exact availability of the nominated locations based on the land ownership maps.

Table 3.5.1 Proposed Locations of New Public/Community Toilets

SI No.	Ward No.	Category of Toilet	Proposed Toilet Location	Land Owner
Zone II				
1	7	Community	Hotwar	Public
2	11	Community	Lowadhi Basti	Private
3	12	Community	samlong	Private
4	13	Community	Gungu Toli	Private
5	16	Community	Karbala Tank	Public
6	20	Community	PNT Colony	Public
7	21	Community	Lower Karamtoli	Private
8	22	Community	RMC Road	Public
9	23	Community	Bakri Bazar	Private
10	24	Community	Bhumiyar Toli	Private
11	25	Community	OPP Ranchi Lake	Private
12	26	Community	Hindpidi	Private
13	27	Community	Madarsa	Private
14	28	Community	Dhela Toli	Private
15	29	Community	Ashok Nagar	Private
16	30	Community	Pahari Mandir	Public
17	31	Community	Kumar Toli	Private
18	36	Community	Hinoo	Private
19	37	Community	Nawa Toli	Private
20	38	Community	Mukti Dham	Private
21	48	Community	Anand pur,Namkum	Private
22	49	Community	Namkum	Private
23-40	-	Community /Public	To be found by RMC	-
Zones III&IV				
1	38	Community	Pundag Basti	Public
2	39	Community	Tiril Basti	Public
3	41	Community	Gwala Toli	Public
4	43	Community	Naya Toli	Private
5	44	Community	Dhurva Sector2	Private
6	45	Community	Shukla Colony	Private
7	50	Community	Bada Ghaghra Basti	Private
8	52	Community	Hinoo	Public
9	53	Community	Khuti road	Private
10	54	Community	Patel Nagar	Public
11	55	Community	Tupudana Basti	Private

Source: JICA Study Team

(3) Relevant Facilities for Public/Community Toilets

1) Water Supply Facilities

The overhead water tanks of public/community toilets are necessary to supply water. The JICA Study Team confirmed the current status of the water source in the areas where the proposed community toilets will be located. The results of the findings are shown in Appendix B3.2. Basically, the water should be supplied by piped water but the areas without public water supply system or those with low pressure can be supplied by pumping the groundwater. The water source should be determined during the detailed design stage in accordance with the progress of the water supply project being done by JNNURM.

2) Septic Tanks

The night soils flow to the septic tanks inside the public/community toilet sites and the supernatant water will be drained to the nearby stormwater drains. For the time being, the septic tanks can be utilized but this will depend on the progress of new sewer installations in this project. The night soils should be drained to nearby sewers once the sewers will be constructed.

(4) Cost Estimate for New Public/Community Toilets

The estimated cost for new public/community toilets is shown in Table 3.5.2. Based on the scale of slums for the proposed community toilets, it is assumed that ten seated toilets are sufficient. The unit cost for ten seated toilets was obtained from RMC's document for fiscal year 2011-12 and adjusted for price escalation.

There are some public/community toilets which require small renovations but the number is negligible to be considered in this project.

Table 3.5.2 Cost Estimates for Public/Community Toilets in Zone II

(Rs.1,000)

No.	Item	Unit Cost	Qty.		Total
1	Construction of New Community Toilets (ten seated toilets)	4,800	40	nos.	192,000
2	Renovation of Existing Public Toilets	1,000	-	nos.	-
	Total				**192,000**

Source: JICA Study Team

3.5.2 Operation and Maintenance Plan of Sanitary Facilities

The following are recommended for good O&M of sanitary facilities:

(1) Public/Community Toilets

1) O&M Contract with SISS

The current framework of O&M by SISS, which is in charge of construction and O&M works of public toilets, functions well in more than half of all public/community toilets according to the site visits and interviews in the existing toilets. The well operated and maintained toilets appear to be very clean. The current framework can be basically maintained. However, for better supervision of local public toilets, the contract should be made between SISS with RMC, which directly funds the construction of public toilets and supervises the O&M works, rather than between UD of the state government, which just subsidizes the funds, and SISS under the current framework.

2) Strengthening of Supervision by RMC

Only an assistant engineer in the Engineering Section of RMC is in charge of supervising the works related to the public/community toilets and there is no periodical reporting from SISS

to RMC. Besides, although RMC grasps the locations of existing public toilets, the required area for new public toilets and status of O&M works are not acknowledged. The organization in RMC for public toilets including the monitoring of works by SISS should be strengthened with more number of staff in RMC and submission of appropriate periodical reports from SISS.

3) Annual Budget of RMC for Rehabilitation Works

The excess budget for construction works leads to the situation where the rehabilitation works have not been conducted when they are required. RMC should ensure in their annual budget the rehabilitation cost for relatively huge improvement works which cannot be managed from the fees collected by SISS.

4) Training for O&M Staff

The toilets and hand washing units in the public/community toilets shall be cleaned and maintained regularly. It is recommended to clean them every day. The current status of cleanliness and deterioration of structures do not depend on the fee collections and number of staff in each public toilet. They appear to be dependent upon the quality and state of mind of the staff. An integrated training for the staff should be conducted to enhance the minds and levels of the staff.

(2) Septic Tanks

1) Strengthening of Management by RMC

There is no person in charge of O&M of septic tanks in the Health Section of RMC, which owns the vacuum trucks that collect the night soils in septic tanks. Moreover, there is no record of night soil collection or maintenance of the tanks. The Health Section should engage at least one staff who will be in charge of O&M of the septic tanks and management of vacuum truck drivers who are paid on a daily basis. Since the construction of septic tanks is handled by the Engineering Section of RMC, the number of constructed septic tanks and O&M status should be properly coordinated.

RMC should instruct the owners to monitor their own septic tanks and periodically inform RMC about the maintenance works.

2) Handling of Night Soils

RMC should extract night soils at certain intervals such as about once every two to three years. For the proper extraction, RMC should patrol households with septic tanks periodically by themselves, not upon the requests of owners, by employing the adequate number of staffs.

Every year, RMC should secure the budget for O&M works and ensure enough number of vacuum trucks for extraction and conveyance of night soils.

3.6 Plan of Mechanical and Electrical Facilities

3.6.1 Design of Pumping Facilities

(1) Pumping Facilities on Trunk and Sub-trunk Sewers

1) Zone II

The pumps including manhole pumps on trunk and sub-trunk sewers were designed where the earth covering exceeds 6 to 7 m depending on site and topographic conditions. In this study, the pumps with design flow of 100 L/s or more are installed at pumping stations and the pumps with design flow of less than 100 L/s are installed in the manholes as the "manhole pumps". Although, 100 L/s is comparatively a large flow for a manhole pump, this figure of demarcation has been tentatively applied in this project.

The characteristics of the pumps are summarized in Tables 3.6.1 and Table 3.6.2.

Table 3.6.1 Pump Facilities on Trunk Sewers

Trunk Route	Pump Facility Code	Design Flow (L/s)	Number of Pump Unit	Pump Unit Capacity (m^3/min)	Type of Pump Station	Total Head (m)
TR-1	PS-1	257	2W + 1S	7.71	PS	20
	PS-2	774	3W + 1S	15.48	PS	10
	MP-8	25	2W	0.75	MP	7
TR-2	MP-3	58	2W	1.74	MP	19
	PS-3	138	2W + 1S	4.14	PS	33
TR-3	PS-4	419	3W + 1S	8.38	PS	24
	PS-6	656	3W + 1S	13.12	PS	11
	MP-7	23	2W	0.69	MP	7
TR-4	PS-5	278	2W + 1S	8.34	PS	26
TR-5	MP-1	5	2W	0.15	MP	20
	MP-2	28	2W	0.84	MP	34

Source: JICA Study Team
Note: PS: Pumps installed in the ordinal pumping station
MP: Pumps installed in the manhole
W: Duty, S: Standby

Table 3.6.2 Pump Facilities on Sub-trunk Sewers

To be Connected from Sub-trunk	Pump Facility Code	Design Flow (L/s)	Number of Pump Unit	Pump Unit Capacity (m^3/min)	Type of Pump Station	Total Head (m)
TR-1	MP-4	25	2W	0.75	MP	25
TR-4	MP-5	23	2W	0.69	MP	30
TR-5	MP-6	27	2W	0.81	MP	23

Source: JICA Study Team
Note: W: On-duty, S: Stand-by

a) Facilities at Pump Stations

Mechanical and structural facilities necessary for the pump station are shown in the Drawing No. C. The sand traps control sand sedimentation in the channels and protect the mechanical

facilities against abrasion and damages. The sand trap is designed to remove sand particles with minimum size of 0.2 mm.

The screens are provided to remove floatables such as plastic bags, weeds, paper wastes, and clothes to protect the impeller. Coarse screen is designed to remove large-sized floatables manually and fine screen is designed to remove small-sized floatables mechanically. The spacing of coarse and fine screens are 100 mm and 15-25 mm, respectively. Removed matters after scraping will be transferred to the hopper through belt conveyors.

Submersible motor type pump is adopted for the pump station, which has advantages in terms of initial equipment costs and O&M costs. In order to avoid clogging the impeller, the maximum solid diameter passing through the impeller is designed to be more than 45 mm.

b) Facilities at Manhole Pump

Manhole pump unit itself does not have any screening devices. Because a lot of rubbish is expected to flow into the manhole, an extra manhole has been provided for each manhole pump, namely in front of the manhole pump unit. This extra manhole is provided with bar screen as well as a discharging pipe which is supposed to be utilized for emergency cases such as sudden power failure occurrence, since the power generating system is not necessarily considered.

As for equipment, vortex or screw type submersible motor pump is adopted to avoid clogging. To prevent damaging the pump by directly discharging into the manhole, a plate is installed at the inlet of the inflow pipe.

The typical drawing of the manhole pump unit and the spillway manhole is shown in the Drawing No. C as well.

2) Zones III and IV

The characteristics of the pump station for Zone III and IV are summarized in Table 3.6.3.

Table 3.6.3 Pump Facilities on Trunk Sewers

Trunk Route	Pump Facility Code	Design Flow (L/s)	Number of Pump Unit	Pump Unit Capacity (m^3/min)	Type of Pump Station	Total Head (m)
TR-1	PS-1	145	2W+1S	4.35	Pump Station	37
	PS-2	238	2W+1S	7.14	Pump Station	38
	PS-3	1,111	4W+2S	16.67	Pump Station	18
	PS-4	627	3W+1S	12.54	Pump Station	9
	PS-5	552	3W+1S	11.04	Pump Station	7
TR-2	MP-1	14	2W	0.42	Manhole Pump	14
TR-3	PS-6	115	2W+1S	3.45	Pump Station	18

Source: JICA Study Team

The same design concepts are applied to the pump facilities as in Zone II for Zones III and IV.

3.6.2 Design of Electrical Facilities

(1) Electrical Management Organization of Ranchi City

Ranchi City does not have its own power supply system. Therefore, all the power supply to Ranchi City is managed by the Jharkhand State Electricity Board (JSEB). JSEB has functions of generation, transmission, and distribution including collection of electricity bills.

The state of Jharkhand instructed JSEB to take up all activities for the electrification of the whole state in 2001. JSEB has own generation system located at the Patratu Thermal Power Station (PTPS) and Sikidri Hydro Power Station (SHPS), and also procures power from the state companies of Damodar Valley Corporation (DVC), Tenughat Vidyut Nigam Limited (TVML), National Thermal Power Corporation (NTPC), National Hydroelectric Power Corporation (NHPC), and Power Trading Corporation (PTC), which is a semi-government company established under the public-private partnership scheme. Table 3.6.4 shows the power companies that supply power to JSEB.

Table 3.6.4 Power Companies which Supply Power to JSEB

Item	DVC	TVNL	NTPC	NHPC	PTC
Name of Company	Damodar Valley Corporation	Tenughat Vidyut Nigam Limited	National Thermal Power Corporation	National Hydroelectric Power Corporation	PTC India Ltd.
Type	State company	State company	State company	State company	Public-Private Partnership
Committed	1948	1987	1975	1975	1999
Services	Electricity generation, transmission, distribution	Electricity generation	Electricity generation, distribution	Electricity generation	Power trading

Source: JICA Study Team

There are major transmission lines to Ranchi City from PTPS and SHPS, and the national power grid. Ranchi City is receiving power mainly from two main 132 kV/33 kV substations named Hatia and Namkum. From these two substations, the power is distributed to 33 kV/11 kV substations situated at 24 locations. Depending on the requested loads at the proposed pump stations and a sewerage treatment plant, the necessary amount of electricity will be supplied from the nearest substation or grid by JSEB.

Ranchi City is chronically experiencing power shortage. The demand of Ranchi City was 80 MW in 2000 and it has become more than 200 MW recently. From the power interruption report of 2013, at the 33 kV/11 kV Namkum Substation which may supply 33 kV to the STP in Zone II, the frequency of power failure was recorded to be more than 270 times and 110 hours in total per year.

In order to address this problem, the number of power plants should be increased in Jharkhand. The extension of Tenughat unit and sharing of power in NTPC has a plan to increase the total capacity to more than 2,300 MW.

(2) Plan and Facilities Necessary for Pipe Installation, Pump Station and STP

In order to transmit power to the pump station and STP, construction of poles, connection of cables, and installation of power meters are necessary. Upon receiving the application from RMC prior to the construction, JSEB will prepare a report including feasibility study, method of construction, and cost estimation.

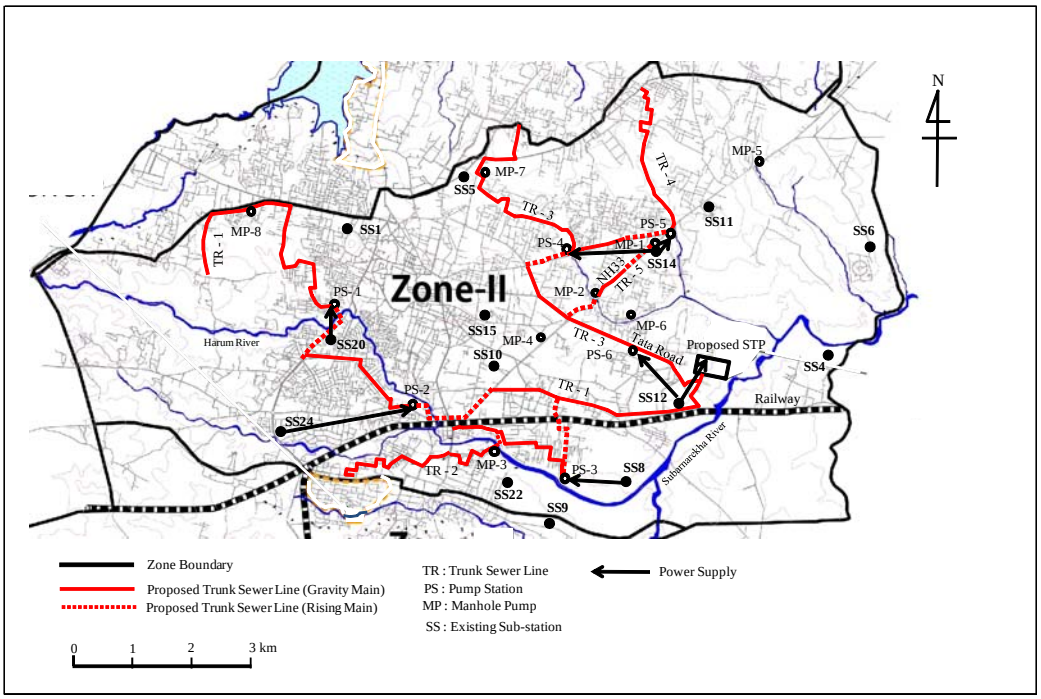
For power supply with the voltage of 11 kV or more, the new power supply systems from the existing substation up to the newly proposed pump stations or STP are required. The power supply system up to the power meter including poles and cable is the property of JSEB; therefore, maintenance of the power supply system is carried out by JSEB. For the low voltage pumps, power supply is available from the local transmission cables.

Table 3.6.5 shows the required loads and electricity supply at the pump station and STP. The locations of the existing substations are shown in Figures 3.6.1 and 3.6.2.

Table 3.6.5 Required Loads and Supply Voltage for the Pump Station and STP

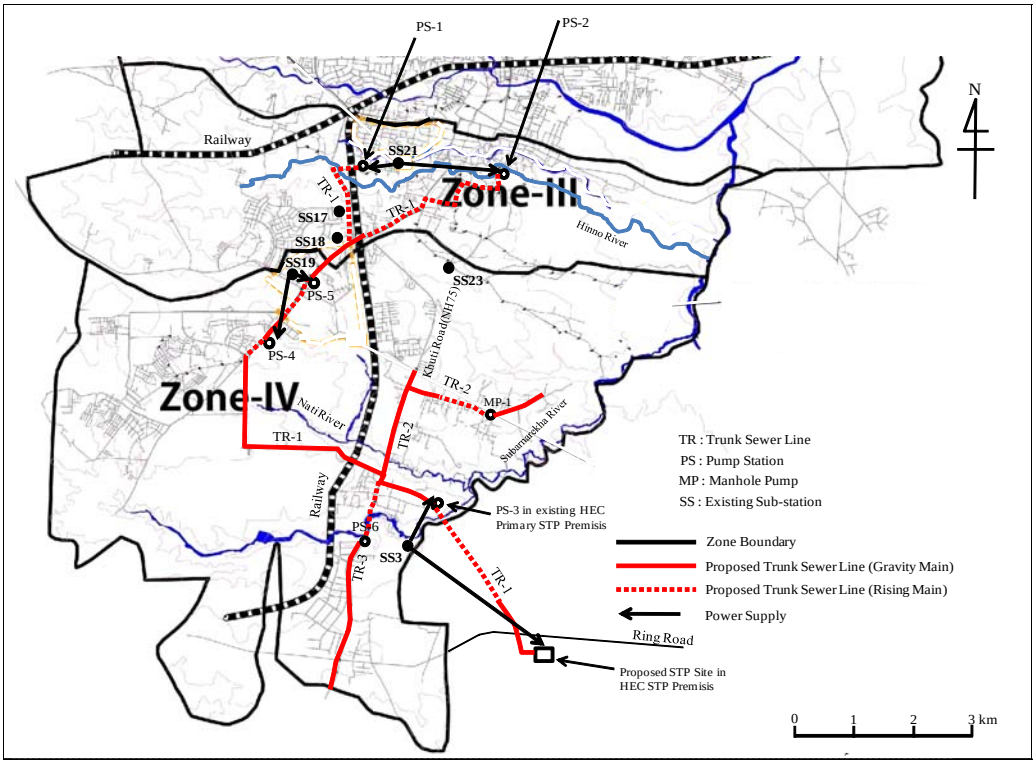
Trunk Route	Pump Facility Code	Required Loads (kVA)	Substation No.	Supply Voltage and 33/11 kV SS which will be connected
Zone II				
TR-1	PS-1	150	20	AC11 kV x 50 Hz, Harmu SS
	PS-2	220	24	AC11 kV x 50 Hz, Argora SS
	MP-4	30	-	AC0.43 kV x 50 Hz, Low voltage network
	MP-8	10	-	AC0.43 kV x 50 Hz, Low voltage network
TR-2	MP-3	40	-	AC0.43 kV x 50 Hz, Low voltage network
	PS-3	150	8	AC11 kV x 50 Hz, Vikash SS
TR-3	PS-4	270	14	AC11 kV x 50 Hz, Kokar Rural
	PS-6	190	12	AC 11 kV x 50 Hz, Namkum
	MP-7	10	-	AC0.43 kV x 50 Hz, Low voltage network
TR-4	MP-5	30	-	AC0.43 kV x 50 Hz, Low voltage network
	PS-5	200	14	AC11 kV x 50 Hz, Kokar Rural
TR-5	MP-1	10	-	AC0.43 kV x 50 Hz, Low voltage network
	MP-2	40	-	AC0.43 kV x 50 Hz, Low voltage network
	MP-6	30	-	AC0.43 kV x 50 Hz, Low voltage network
STP		2500	12	AC 33 kV x 50 Hz, Namkum
Zones III and IV				
TR-1	PS-1	180	21	AC11 kV x 50 Hz, Mecon
	PS-2	300	21	AC11 kV x 50 Hz, Mecon
	PS-3	590	3	AC11 kV x 50 Hz, Tupudana
	PS-4	150	19	AC11 kV x 50 Hz, Dhurwa
	PS-5	110	19	AC11 kV x 50 Hz, Dhurwa
TR-2	MP-1	10	-	AC0.43 kV x 50 Hz, Low voltage
TR-3	PS-6	70	-	AC0.43 kV x 50 Hz, Low voltage

Source: JSEB



Source: JICA Study Team

Figure 3.6.1 Location Map of Substations in Zone II



Source: JICA Study Team

Figure 3.6.2 Location Map of Substations in Zones III and IV

3.7 Project Cost Estimate

3.7.1 Review of Construction Cost in DPR

(1) History of DPR

In 2005, RMC entrusted the preparation of DPR to Meinhardt. The DPR was prepared from 2006 to 2007. Then, RMC submitted the DPR to CPHEEO for application to the JNNURM scheme in 2012. Subsequent to the observation by CPHEEO in February 2013, the DPR was revised by RMC and finally approved by CPHEEO in August 2013.

(2) Availability of DPR Document

The DPR prepared in 2007 was composed of the following volumes:

1) Sewerage

Volume-1:	Technical Report and Summary of Costs
Volume-2:	Hydraulic Design of Sewers
Volume-3:	Cost Estimates
Volume-5:	Layout Plan and Standard Drawings
Volume-6:	Longitudinal Section Drawings

2) Drainage

Volume-1:	Technical Report and Summary of Costs
Volume-2:	Hydraulic and Structural Design
Volume-3:	Cost Estimates
Volume-5:	Layout Plan and Standard Drawings
Volume-6:	Longitudinal Section Drawings

3) Common

Volume-4:	Topographic Survey Drawings
Volume-7:	7.01: Geotechnical Investigation Reports
	7.02: Environmental Impact Assessment Report
	7.03: Project Management Manual

However, in the revision work conducted in 2013, only Volume-1: Technical Report and Summary of Costs of each sewerage and drainage component were prepared. That is, the detailed breakdown of work quantity in the cost estimates is not available.

(3) Composition of Construction Cost

Review results of the cost estimates in the revised DPR are presented hereunder. The construction cost is composed of the following items:

1) Sewerage component consisting of gravity sewer, pump station and rising main, sewage treatment plant, and house connection; and

2) Drainage component consisting of drainage ditch and culvert.

(4) Basis of Cost Estimates in DPR

1) Gravity Sewer

The construction cost was estimated by multiplying the quantity for each work item and its unit cost. The unit costs presented in the Jharkhand Schedule of Rates (JSR) and Delhi Schedule of Rates (DSR) were adopted for earthworks, concrete works, and concrete pipe works. JSR and DSR is a list of unit cost of construction works prepared by the Government of Jharkhand and the Government of Delhi, respectively, based on the prevailing market rates of materials and minimum labor wages. For supply and installation of double wall corrugated polyethylene (DWC) pipe, the unit cost was set based on the quotation from suppliers.

2) Pumping Station and Rising Main

The cost of electrical and mechanical facilities was estimated based on the quotation of the suppliers. The cost of civil and building works for the pump house was estimated based on the concrete volume for civil works and floor area for building works. The lump sum unit cost per concrete volume and floor area were worked out based on the standard design of the pump house and unit construction costs listed in DSR.

The construction cost of the rising main was estimated in the same way as the gravity sewer.

3) Sewage Treatment Plant

The cost of the STP was estimated by multiplying the capacity of the STP by the lump sum unit cost of Rs.9,000/(m3/day) based on the quotations of the contractors. The type of treatment method of STP was the Sequential Batch Reactor (SBR) method.

4) Drainage Facility

The construction cost was estimated by multiplying the work quantity by the unit costs indicated in JSR or DSR. In addition, 10% of the cost was added for the removal of existing facilities.

(5) Observed Problems in Construction Cost Estimates

As a result of the review of the cost estimates in DPR, several problems were observed. Following are the major problems for each work item:

1) Gravity Sewer and Rising Main
   - Demolition cost of pavement was not included,
   - Work quantity of timbering was under estimated,
   - Unit cost for timbering was not appropriate,
     (The unit cost for a depth of 4.5 m was used for the works deeper than 4.5 m)
   - Cost for river crossing was not included.

2) Pump Station
   - Old unit cost in 2005 was used for electrical and mechanical works.
   - Cost of timbering for 8–10 m deep was not included.
3) Sewage Treatment Plant
   - The following cost were not included:
     - Site clearance works,
     - Outlet structure of treated water,
     - Boundary walls and access road, and
     - Administration buildings.
4) Drainage Facility
   - Cost for demolition and restoration of the pavement were not included.

It was found that a lot of cost items were missing in the cost estimates in DPR and the construction cost presented in DPR was considerably low.

(6) Improvement by the JICA Study Team

The JICA Study Team improved the construction cost in DPR by supplementation/correction as follows:

1) Gravity Sewer and Rising Main
   - Demolition cost of pavement was added.
   - Work quantity of timbering was re-calculated.
   - Unit cost of timbering with a depth of 4.5 m or more was newly set based on the unit price of machinery, materials, and labor.
   - Cost for concrete protection was added for river crossing.
2) Pump Station
   - Unit costs of electrical and mechanical works were revised to the 2013 price level.
   - Cost of timbering for 8–10 m deep was added.
3) Sewage Treatment Plant
   - 15% of the sewerage treatment plant cost was added for the cost of the following items:
     - Site development works,
     - Outlet structure of treated water,
     - Boundary walls and approach road, and
     - Administration buildings.

     The ratio: 15% was derived from the case of past similar projects.
4) Drainage Facility
   - The costs for demolition and restoration of the pavement were added. The work quantity was calculated by the work length and thickness of the pavement.

The corrected cost is shown in Appendix-B4.1 and summarized in Table 3.7.1.

Table 3.7.1 Correction of Cost Estimates in DPR

	Cost Estimate in DPR (2013 price level)		Corrected by JICA study team (2013 price level)	
	Million Rs.	Equivalent Million Yen	Million Rs.	Equivalent Million Yen
Zone-II				
A: Gravity Sewer	1,929	3,260	2,661	4,497
B: Pump Station and Rising Main	160	270	220	372
C: Sewerage Treatment Plant	927	1,567	1,066	1,802
D: House Connection	232	392	232	392
Sub-total	3,248	5,489	4,179	7,063
E: Drainage Facility	4,307	7,279	4,334	7,324
Total of Zone-II	**7,555**	**12,768**	**8,513**	**14,387**
Zone-III&IV				
A: Gravity Sewer	944	1,595	1,320	2,231
B: Pump Station and Rising Main	252	426	341	577
C: Sewerage Treatment Plant	477	806	549	927
D: House Connection	232	392	232	392
Sub-total	1,905	3,219	2,442	4,127
E: Drainage Facility	2,222	3,755	2,236	3,778
Total of Zone-III&IV	**4,127**	**6,975**	**4,677**	**7,905**
Total of Zone-II and Zone - III&IV	**11,682**	**19,743**	**13,190**	**22,292**

Source: JICA Study Team

3.7.2 Construction Cost of the Proposed Project

(1) Outline of the Proposed Facility

As described in the foregoing sections, the project facility plan was thoroughly reviewed and drastically revised, including the following major changes:

- Location of the sewage treatment plant,
- Alignment of trunk sewer,
- Addition of pump station and introduction of manhole pumps, and
- Treatment method of the sewage treatment plant.

Outline of proposed facilities in Zone II and Zones III&IV are shown in Table 3.7.2 and Table 3.7.3, respectively.

Table 3.7.2 Proposed Facility in Zone II

A: Gravity Sewer	
A-1: Trunk	Polyethylene Pipe (Corrugate pipe) D150 L = 3,510 m, D200 L = 3,030 m, D250 L = 3,835 m, D300 L = 3,525 m, D350 L = 510 m, D400 L = 2,880 m, D450 L = 1,080 m, D500 L = 200 m, D600 L = 2,430 m D700 L = 1,020 m, D800 L= 1,750 m, D1000 L= 3,663 m RC Pipe D1100 L = 200 m, D1200 L = 1,988 m, D1400 L= 243 m River Crossing: 4 nos.
A-2: Sub-trunk and Collector and Lateral	Polyethylene Pipe (Corrugate pipe) D150 L = 299,537 m, D200 L= 21,423 m, D250 L= 13,310 m, D300 L = 12,638 m, D400 L = 10,534 m, D600 L = 10,632 m, D800 L = 3,644 m
B: Pump Station and Rising Main	
Pump Station	Pump Station (Inlet gate, Sand trap, Screen, Pump well, Control room): 6 nos. 45 kW x 3 (2W +1S) Rising main DCI D450 L = 1,170 m River crossing: 1 no. 45 kW x 4 (3W +1S) Rising main DCI D800 L = 1,340 m 45 kW x 3 (2W +1S) Rising main DCI D350 L = 1,545 m Railway crossing: Pipe jacking tunnel (auger type) L = 30 m 55 kW x 4 (3W +1S) Rising main DCI D600 L = 860 m 60 kW x 3 (2W +1S) Rising main DCI D450 L = 950 m 37kW x 4 (3W +1S) Rising main DCI D750 L = 900 m
Manhole Pump	Manhole (Dia = 1.52 m, Average depth: 4.5): 8 nos. 1.5 kW x 2, Rising main DCI D150 L = 710 m 11 kW x 2, Rising main DCI D150 L = 600 m River Crossing: 1 no. 11 kW x 2, Rising main DCI D200 L = 400 m River Crossing: 1 no. 7.5 kW x 2, Rising main DCI D150 L = 650 m 7.5 kW x 2, Rising main DCI D150 L = 630 m 7.5 kW x 2, Rising main DCI D150 L = 350 m 2.2 kW x 2, Rising main DCI D150 L = 7 m 2.2 kW x 2, Rising main DCI D150 L = 7.5 m
C: Sewerage Treatment Plant	
Sewage Treatment Plant	Design Capacity: 86,000 m3/day Treatment Method: Conventional Activated Sludge Method Major Facility: Coarse Screen W = 1.2 m Grit Chamber W = 1.2 m , L = 15 m Fine Screen W = 2 m Lift Pump 250 kW x 2 (1W+1S) 120 kW x 2 (2W) Primary Sedimentation Tank D = 23 m, H = 3.5 m 8 nos. Primary Sludge Pump 3.7 kW x 6(4W+2S) Aeration Tank W = 8 m, L = 70 m, H = 1.5 m, 8 nos. Blower 160 m3/min x 220kW x 2 (1W+1S) 80 m3/min x 140kW x 2 (2W) Secondary Sedimentation Tank D = 25 m, H = 3.5 m 8 nos. Secondary Sludge Pump 15kW x 16 (12W+4S) Chlorination Tank W = 2.0 m, L = 140 m, H = 2 m, 4 nos. Discharge Pipe D1200 Sludge Thickener (Gravity) D = 12 m, H = 4.0 m 4 nos. Sludge Dewatering Facility 66 kW x 4 (3W+1S) Electric Substation 33 kV x 2,500 kVA x 2 (1W+1S) Power Generation Unit 6.6 kV x 1,875 kVA Control Room SCADA System
Land Development	land grading, drainage works, boundary wall, access road and internal road
Outlet Facilities	Outlet Pipe D1400 L = 100 m x 2 , Outfall Structure
D: House Connection	Inspection chamber and PVC pipe D160 L = 10 m 28,666 nos.
E: Drainage Facility	
RCC Precast Drain	W300 x H200, W350 x H400, W450 x H500, W500 x H700 W600 x H750 Total Length: 504.1 km
Box Culvert and Pipe Culvert	W300 x H200, W350 x H400, W450 x H500, W500 x H700 W600 x H750W Total Length: 7.8 km RC Pipe D 600 -1000 Total Length : 2.0 km
F: Social Development	Public Toilet: Ten-seater, 40 nos.
G: Decentralized Sewerage Facilities	Septic Taknk: 2,200 nos.

Source: JICA Study Team

Table 3.7.3 Proposed Facility in Zones III and IV

A: Gravity Sewer	
A-1: Trunk	Polyethylene Pipe (Corrugate pipe) D150 L = 800 m, D200 L = 690 m, D250 L = 1,180 m, D300 L = 600 m, D350 L = 600 m, D400 L = 1,950 m, D700 L = 400 m, D800 L = 1,700 m, D900 L = 3,280 m, RC Pipe D1100 L = 2,560m River Crossing: 1 no.
A-2: Sub-trunk and Collector	Polyethylene Pipe (Corrugate pipe) D150 L= 115,235 m, D200 L = 13,087 m, D250 L = 8,833 m, D300 L = 8,428 m D400 L = 4,244 m, D600 L = 2,349 m
B: Pump Station and Rising Main	
Pump Station	Pump Station (Inlet gate, Sand trap, Screen, Pump well, Control room): 6 nos. 55 kW x 3 (2W +1S) Rising main DCI D350 L = 1,900 m 90 kW x 3 (2W +1S) Rising main DCI D450 L = 2,700 m 90 kW x 6 (4W +2S) Rising main DCI D900 L = 2,000 m River crossing: 1 no 30 kW x 4 (3W +1S) Rising main DCI D700 L = 400 m 22 kW x 4 (3W +1S) Rising main DCI D650 L = 580 m 18.5 kW x 3 (2W+1S) Rising main DCI D300 L = 500 m River crossing: 1 no
Manhole Pump	Manhole (Dia = 1.52 m, Depth: 4.5): 1 no. 2.2 kW x 2, Rising main D150 L = 700 m
C: Sewerage Treatment Plant	
Sewage Treatment Plant	Design Capacity: 53,000 m3/day Treatment Method: Conventional Activated Sludge Method Major Facility: Coarse Screen — W = 1 m Grit Chamber — W = 1 m , L = 10 m, D = 1.5 m Fine Screen — W = 1 m Lift Pump — 120 kW x 2 (2W); 75 kW x 2 (1W+1S) Primary Sedimentation Tank — D = 25 m, H=3.5 m 4 nos. Primary Sludge Pump — 3.7 kW x 3(2W+1S) Aeration Tank — W = 9 m, L = 50 m, H = 1.5 m 4 nos. Blower — 160 m3/min x 220 kW x 1 (1W); 80 m3/min x 140 kW x 2 (1W+1S) Secondary Sedimentation Tank — D = 25 m, H = 3.5 m 4 nos. Secondary Sludge Pump — 15 kW x 6 (4W+2S) Chlorination Tank — W = 2 m, L = 140 m, H = 2 m, 2 nos. Discharge Pipe — D1000 Sludge Thickener (Gravity) — D = 12 m, H = 4.0 m 4 nos. Sludge Dewatering Facility — 66 kW x 3 (2W+1S) Electric Substation — 33 kV x 1,500 kVA x 2 (1W+1S) Power Generation Unit — 6.6 kV x 1,250 kVA Control Room — SCADA System
Land Development	land grading, drainage works, boundary wall, access road and internal road
Outlet Facilities	Outlet Pipe D1200 L= 100 m x 2 Outfall Structure
D: House Connection	Inspection chamber and PVC pipe D160 L = 10 m 28,666 nos.
E: Drainage Facility	
RCC Precast Drain	W300 x H200, W350 x H400, W450 x H500, W500 x H700 W600 x H750 Total Length: 239.8 km
Box Culvert	W300 x H200, W350 x H400, W450 x H500, W500 x H700 W600 x H750W Total Length: 2.5 km
Pipe Culvert	RC Pipe D 600 -1000 Total Length : 1.9 km
F: Social Development	Public Toilet: Ten-seater, 40 nos.
G: Decentralized Sewerage Facilities	Septic Taknk: 900 nos.

Source: JICA Study Team

(2) Basis of Cost Estimate

1) Gravity Sewer

The construction cost was estimated by multiplying the quantity for each work item and its unit cost. The unit cost presented in JSR and DSR were adopted for earthworks, temporary works, concrete works, and concrete pipe works. For supply and installation of the DWC pipe, the unit cost was set based on the quotation from suppliers.

2) Pumping Station and Rising Main

The cost of mechanical and electrical facilities for the pumping station was estimated based on the quotation of the suppliers. The cost of civil and building works for the pump house was estimated based on the concrete volume for civil works and floor area for building works. The lump sum unit cost per concrete volume and floor area were worked out based on the standard design of pump house and unit construction costs listed in DSR.

The construction cost of the rising main was estimated by multiplying the quantity for each work item and its unit cost, in the same way as the gravity sewer. Pipe jacking method is planned on the railway crossing section. The cost for pipe jacking (DCI D450 L = 30 m by the auger-type boring machine) was estimated based on the quotation from the Indian contractor. The cost for vertical shaft (Starting shaft: 395 x 3000 mm H = 6 m, and arrival shaft: D3000 mm H = 6 m) were estimated separately.

3) Sewage Treatment Plant

The cost of STP was estimated on a lump sum basis based on the quotation from the Indian EPC contractor. The quotation was requested on the following conditions:

a. The scope of work shall be:

i) Construction of civil structures of the treatment plant;
ii) Building works for the administration building, plant control rooms, aeration blower room, generator room, sludge dewatering room, and chlorination room;
iii) Supply, installation, erection, and commissioning of the mechanical equipment for the treatment plant;
iv) Supply, installation, erection, and commissioning of the electrical equipment for the treatment plant including emergency generator; and
v) Design, supply, installation, and commissioning of the supervisory control and data acquisition (SCADA) system.

b. Land development including cutting and grading works, access and internal road works, drainage works, and boundary fence shall be out of scope of the quotation.

c. Power receiving cost from outside to the HT substation to be constructed in the STP shall be out of scope of the quotation.

d. Outlet facilities consisting of outlet pipeline and outfall facility shall be out of scope of the quotation.

The quotation price for an STP with a capacity of 84,000 m^3/day is shown in Table 3.7.4.

Table 3.7.4 Quotation Price for STP with a capacity of 84,000 m^3/day

Category	Price (Rs.)
Civil Works	543,449,600
Building Works	35,280,000
Mechanical Works	240,068,400
Electrical Works	211,680,000
SCADA System	58,800,000
Total	1,089,278,000

Source: JICA Study Team

From the above quotation price, the unit cost of an STP per 1 m^3/day of capacity on a lump sum basis can be derived:

Rs.1,089,278,000/84,000 (m^3/day) = Rs.12,970/(m^3/day).

This figure is deemed to be appropriate referring to the data in the recent study report on the construction cost of the STP in India entitled "Assessment of Some Aspects of Provisioning Sewerage Systems in Urban Agglomerations of the Ganga River Basin GRBMP: Ganga River Basin Management Plan prepared by the Indian Institute of Technology (IIT), December 2013".

In addition to the cost of the treatment plant mentioned above, the costs for the following works were separately estimated by multiplying the quantity of each work item and its unit cost:

- Land development of the STP site: earth works, masonry retaining wall, drainage works, boundary wall, and road works (access and internal road);
- Outlet facilities: outlet pipeline and outfall structures; and
- Power receiving cost from outside of the STP site.

4) House Connection, Public Toilet, and Septic Tank

The house connection works consists of the inspection chamber and connection pipe from the inspection chamber to the sewer. The unit cost of house connection applied in DPR, which was set based on the market price, was followed in this cost estimates.

The unit cost of public toilet (ten-seater) and septic tank was set based on the information from RMC.

5) Drainage Facility

The cost was set based on the unit costs per 1 m length of RCC precast drain, box culvert, and pipe culvert and their planned length. The unit cost was set referring to the cost estimates in

DPR. In addition, the cost for demolition and restoration of the pavement was added.

(3) Construction Cost

The construction cost is shown in Appendix-B4.2 and summarized in Table 3.7.5.

Table 3.7.5 Construction Cost

	Rs. Million	Equivalent ¥ Million
Zone II		
A-1: Gravity Sewer - Trunk	584	986
A-2: Gravity Sewer – Sub-trunk, Collector, and Lateral	1,874	3,174
B: Pump Facility and Rising Main	359	607
C: Sewerage Treatment Plant	1,191	2,013
D: House Connection	255	431
E: Drainage Facility	4,767	8,057
F: Social Development	191	323
G: Decentralized Sewerage Facilities	28	47
H: Public Outreach Program	50	85
Total of Zone II	**9,303**	**15,722**
Zones III and IV		
A-1: Gravity Sewer - Trunk	405	684
A-2: Gravity Sewer - Sub-trunk, Collector, and Lateral	733	1,239
B: Pump Facility and Rising Main	374	632
C: Sewerage Treatment Plant	742	1,253
D: House Connection	255	431
E: Drainage Facility	2,459	4,156
F: Social Development	191	323
G: Decentralized Sewerage Facilities	11	19
H: Public Outreach Program	50	85
Total of Zones III and IV	**5,220**	**8,823**

Source: JICA Study Team

3.7.3 Project Cost

(1) General

Zone II was nominated as the priority project for the JICA loan project, considering the urgency of necessity and size of the cost. The project cost consists of the following:

1) Eligible Portion
   i) Construction and supporting activity
   ii) Consulting services
2) Non-eligible Portion
   i) Land acquisition
   ii) Administration cost
   iii) VAT
   iv) Import tax
3) Interest during Construction
4) Front End Fee

(2) Conditions of Cost Estimate

The following conditions were set for the cost estimates:

1) Exchange Rate
   Rs.1 = ¥1.69 (RBI reference rate as of June 30, 2014)
2) Base Year for Cost Estimates
   June 2014
3) Price Escalation
   FC: 2.0% per year LC: 4.2% per year
4) Physical Contingency
   Construction: 5.0 % Consultant: 5.0 %
5) Tax Rate
   VAT: 12.36 % Import tax: 3.0%
6) Rate of Interest during Construction
   Construction: 0.3% Consultant: 0.01%
7) Rate of Front End Fee (Charged at the time of L/A)
   0.2%

(3) Estimated Project Cost

The project cost was estimated based on the abovementioned conditions and implementation and procurement plan which are described in the following section. The estimation method of construction cost, consulting services cost, and land acquisition cost is described hereunder.

1) Construction Cost

The construction cost was estimated as described in Subsection 3.7.2. The estimated construction cost was divided into foreign currency (FC) and local currency (LC) portions by the ratios shown in Table 3.7.6, considering the following:

- Most part of the construction resources is available in India.
- The contractors for STP and pump station are planned to be procured through international competitive bidding (ICB). Thus, 40% of the construction cost of the said works was allocated to the FC portion.

Table 3.7.6 Demarcation Ratio between FC and LC

Work	FC	LC
A-1: Gravity Sewer - Trunk	10%	90%
A-2: Gravity Sewer – Sub-trunk, Collector, and Lateral	10%	90%
B: Pump Facility and Rising Main	40%	60%
C: Sewerage Treatment Plant	40%	60%
D: House Connection	10%	90%
E: Drainage Facility	10%	90%
F: Social Development	10%	90%
G: Decentralized Sewerage Facility	10%	90%
H: Public Outreach Program	10%	90%

Source: JICA Study Team

2) Consulting Services

Consulting services will be provided for:

- Engineering services: Detailed design, tender assistance, and construction supervision; and
- Capacity development: Assistance in capacity development of RMC.

The cost was estimated by man-month basis of the expert. The contents of the consulting services are described in Subsection 3.9.1. The draft TOR of the consulting services and proposed manning schedule are shown in Appendix-B6.1 and Appendix-B6.2. The breakdown of the consulting services cost is shown in Appendix-B4.3and Appendix-B4.4 and summarized in Table 3.7.7.

Table 3.7.7 Consulting Services Cost

Item	Q'ty	Foreign Portion (¥)		Local Portion (Rs.)		Total Equivalent
		Rate ('000)	Amount ('000)	Rate ('000)	Amount ('000)	¥ ('000)
Engineering Services Consultant						
A. Remuneration						
Professional (A)	158 MM	2,895	457,410	0	0	457,410
Professional (B)	311 MM	0	0	342	106,362	179,752
Support Staff	648 MM	0	0	100	64,800	109,512
Subtotal of (A)			457,410		171,162	746,674
B. Direct Cost			70,050		51,594	157,244
Total			527,460		222,756	903,918
Capacity Development Consultant						
A. Remuneration						
Professional (A)	83 MM	2,895	240,285	0	0	240,285
Professional (B)	246 MM	0	0	342	84,132	142,183
Support staff	161 MM	0	0	100	16,100	27,209
Subtotal of (A)			240,285		100,232	409,677
B. Direct Cost			51,597		43,889	125,769
Total			291,882		144,121	535,446

Source: JICA Study Team

3) Land Acquisition

The land acquisition cost was estimated based on the required land area and unit cost of the land. The unit cost of land (Rs.50 million/ha) was based on the information from RMC.

4) Administration Cost

The administration cost for the project implementation was estimated at 2.0 % of construction cost, consulting service cost, and land acquisition cost.

5) Total Project Cost

The estimated total project cost is shown in Appendix-B4.5 and summarized in Table 3.7.8.

Table 3.7.8 Project Cost (Zone-II)

Item		FC (¥ million)	LC (Rs. million)	Total (¥ million)
A. ELIGIBLE PORTION				
I)	Procurement / Construction	2,761	10,422	20,375
	Base cost	2,358	7,907	15,722
	Price escalation	272	2,018	3,683
	Physical contingency	131	496	970
II)	Consulting Services (Engineering Services)	599	280	1,072
	Base cost	527	223	904
	Price escalation	43	44	117
	Physical contingency	29	13	51
III)	Consulting Services (Capacity Development)	330	183	639
	Base cost	292	144	535
	Price escalation	23	30	73
	Physical contingency	16	9	30
Total (I+II+III)		3,691	10,884	22,086
B. NON ELIGIBLE PORTION				
a	Land acquisition	0	370	625
b	Administration cost	0	269	454
c	VAT	0	1,569	2,651
d	Import tax	0	49	83
Total (a+b+c+d)		0	2,256	3,813
TOTAL (A+B)		3,691	13,141	25,898
C. Interest during Construction		151	0	151
D. Front End Fee		44	0	44
GRAND TOTAL (A+B+C+D)		3,886	13,141	26,093
E. JICA Finance Portion (A)		3,691	10,884	22,086

Source: JICA Study Team

3.7.4 Comparison of Project Cost with DPR Cost

Table 3.7.9 shows the comparison of the proposed project cost with DPR cost. The cost "[2]: Corrected by Study Team (2013 price)" is the construction cost corrected by the study team as described in Subsection 3.7.1. The cost "[3]: Project Cost (2014 price)" is the cost estimated by this study as described in Subsection 3.7.2 and 3.7.3.

Table 3.7.9 Comparison of Project Cost with DPR cost

(Million Rs)

DPR			Project Cost proposed by JICA Study			
	[1] Original Cost (2013 price)	[2] Corrected by Study Team (2013 price)	[3] Project Cost (2014 price)	Major Change from DPR		
				Balance [2] to [3]	Reason for the Balance	
1. Construction and Supporting Activity						
A: Gravity Sewer	1,929	2,661	2,462	-199	266	Price Escalation (2013-2014)
					-465	Re-alighnment and re-design of sewer
B: Pump Station and Rising Main	160	220	359	139	22	Price Escalation (2013-2014)
					117	Additional PS&RM associated with re-alignhment of trunk sewer
C: Seweage Treatment Plant	927	1,066	1,191	125	107	Price Escalation (2013-2014)
					-176	Change of Capacity (103MLD=>86 MLD)
					195	Adoption of latest quotation
D: House Connection	232	232	255	23	23	Price Escalation (2013-2014)
E: Drainage Facility	4,307	4,334	4,767	433	433	Price Escalation (2013-2014)
F: Social development	-	-	191	191	191	Provision of Public Toilets
G: Decentralized Sewerage Facility	-	-	28	28	28	Provision of Septic Tanks
H: Public Outreach Program	-	-	50	50	50	Public Outreach Program
Total	7,555	8,513	9,303			

Note:
From [1] to [2]
Major Corretion of /Addition to DPR Cost by Study Team
- River crossing structure and protection for pipe installation
- Temporary earth retaining wall with appropriate cost estimation which is not stipulated in Jharkand Schedule of Rates and Delhi Schedule of Rates
- Correction of unit cost of mechanical & electrical works at pumping station (2006 price =>2013 price)
- Appurtenant works at STP including land grading, access and internal road, outlet facilities, Administration building, and Power receiving works
- Pavement demolishing and restoration

Physical Contingency & Price Escalation	2,753
Total of 1.	12,056
2.1 Engineering Consulting Service	634
2.2 Capacity Development	378
3. Land Acquisition	370
4. Administration Cost	269
5. VAT + Import Tax	1,618
6. IDC & Front End Fee	115
Total Project Cost	**15,440**
JICA Finance (1.+2.)	13,068
Government Finance (3.+4.+5.+6.)	2,372

Note:
Price Escalation (2013-2014) was set reffering to "Worlld Economic Outlook Database, April 2014" by IMF.

Condition of Project Cost Estimation:
Physical Contingency & Price Escalation
- Physical contingency: 5% ,
- Price Escalation: FC: 2.0%, LC: 4.2%

Consulting Serviice
- Detail design, Tender assistance, Construction supervision
- Assistance in capacity development

Land Acquisition
Unit cost of land is based on the information from RMC.

Administration Cost
2% of Construction, Consulting service, and Land acquisition cost

Interest during Construction (IDC)
- 0.3 % per year for constuction, 0.01 % per year for consulting service

Source: JICA study team

3.8 Implementation and Construction Plan

3.8.1 Project Implementation Procedure

This project is initiated with the signing of a loan agreement (L/A) between JICA and the Government of India. The executing agency of the project will be RMC. Although the organization for project implementation has not been determined at this moment, RMC is required to set up a system for the smooth implementation of the project.

After the L/A conclusion, the executing agency will employ an engineering services consultant who will provide engineering services, including review of DPR, detailed design, tender assistance, and construction supervision. In this project, the employment of a capacity development consultant is also proposed. The task of the capacity development consultant is described in Subsection 3.9.1.

Selection of the consultant will take nine months as described in Subsection 3.9.1. The engineering service will commence with the review of DPR (three months) followed by the detailed design (12 months). After the detailed design is completed, the selection of the contractor will commence. Selection of the contractor will take 12 months as described in Subsection 3.9.1. The construction period is assumed to be 48 months as described in Subsection 3.8.2.

The project implementation schedule is shown in Appendix-B5.1 and summarized in Figure 3.8.1, assuming that Zone II is taken as a JICA-funded project and L/A is concluded on March 2015.

Procedure	Period	Year									
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Conclusion of L/A		△									
Selection of Consultant	9 months	■									
Consulting Service (Engineering Service)	99 months		■	■	■	■	■	■	■	■	
Review of DPR	3 months		■								
Detail Design	15 months		■	■							
Tender Assistance	12 months			■	■						
Construction Supervision	72 months				■	■	■	■	■	■	
Selection of Contractor	12 months			■	■						
Land Acquisition	12 months	■	■								
Construction	48 months				■	■	■	■			
Defects Liability Period of STP	24 month								■	■	
Consulting Service (Capacity Development)	87 months		■	■	■	■	■	■	■		

Source: JICA Study Team

Figure 3.8.1 Procedure for Project Implementation

It is expected that construction work will commence from 2018. Land acquisition should be

completed by RMC by the time when the detailed design commences. The defects liability period will be two years after the facility is handed over.

3.8.2 Construction Plan and Schedule

(1) Construction Method

1) Gravity Sewer and Rising Main

The sewer pipe will be laid by open-cut method except for railway crossing. Before excavation works, the surface pavement must be demolished in the city area. In areas outside of the city area, it is necessary to cut the existing trees and to clear the site. The construction site in the city area is on the existing road. Thus, traffic control is necessary during construction. The road must be temporary closed in the area where the road width is narrow.

The excavated trench must be protected by temporary earth retaining wall. Backfilling must be carefully carried out with proper compaction. After backfilling, pavements will be restored.

For river crossing section, a pipe bridge will be constructed. The DCI pipe will be used for the pipe bridge. A concrete girder bridge will be built and the DCI pipe will be installed on the concrete girder.

For railway crossing, the pipeline will be constructed by microtunneling using the auger-type pipe jacking method. The railway crossing pipeline will be of D450 DCI pipe L= 30 m. Two vertical shafts for driving and receiving the boring machine will be constructed on both sides of the railway crossing. The size of the vertical shaft will be B=3 m x L=7.395 m x 6 m depth for the starting vertical shaft and D3000 x 6 m depth for the arriving vertical shaft. A steel liner plate will be used for the temporary earth retaining wall of the vertical shaft.

2) Pump Station

Construction works will be commenced with site clearance works. Excavation depth for the pump station will be from 5 m to 9 m. Thus, it requires timbering by sheet pile and strutting. A temporary dewatering facility will be installed during construction.

3) Sewage Treatment Plant

Prior to construction of the sewage treatment plant, the land grading works including cutting and embankment works will be conducted. After the civil and building works have been completed, the electrical and mechanical equipment will be installed.

In addition to the construction of the sewage plant, the appurtenant facilities consisting of effluent discharge facility, earth retaining wall and boundary fence, drainage works, internal/access roads, and power receiving facility will be constructed.

After the construction works have been completed, commissioning test will be conducted with the attendance of future operation staff. Technical training will be given to the future operation staff during the commissioning test.

4) Drainage Facility

The drainage facility will be located on both sides of the road. Existing drainage ditch, if any, will be demolished. The surface pavement must be demolished and restored.

(2) Construction Schedule

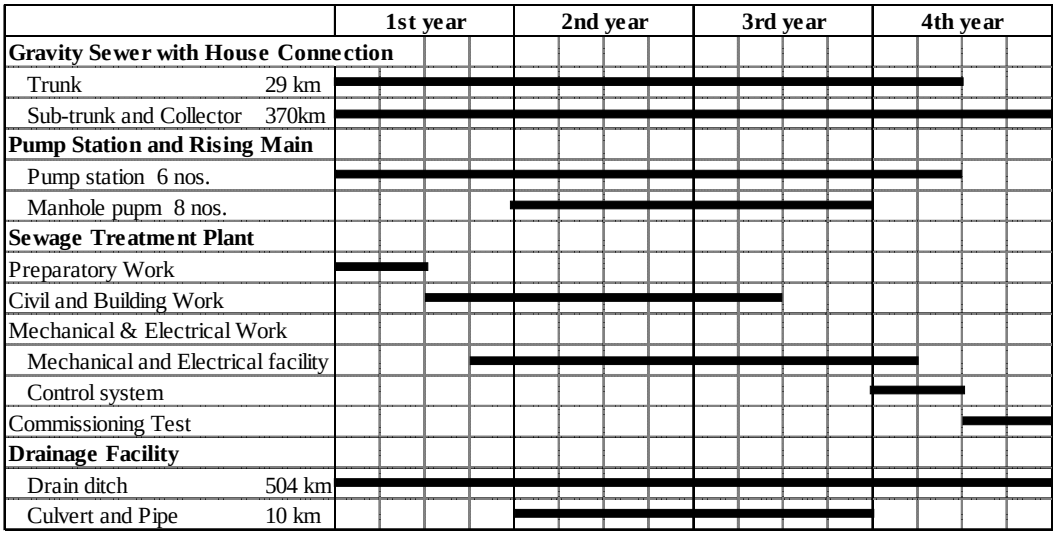
The annual rainfall in Ranchi City is approximately 1,500 mm, where 80% of rainfall occurs from June to September. In consideration of this and national holidays, the annual work day is set at 270 days. The construction period of each work of Zone II is assumed as shown in Table 3.8.1.

Table 3.8.1 Construction Period of Zone II

Work Item	Work Volume	Basis of Construction Period	Required Period
Gravity Sewer (Trunk)	Pipe line: L = 29 km	29 km /{15 m/day x 2 party x 270 day/yr} = 3.5 yr	3.5 years
Gravity Sewer (Sub-trunk, Collector and Lateral)	Pipe line: L= 370 km	370 km/{20 m/day x 17 party x 270 day/yr} = 4.0 yr	4 years
Pump Station and Rising Main	Pump station: 6 nos. Manhole pump: 8 nos.	7 months/ unit x 6 = 42 months 3 months/unit x 8 = 24 month	3.5 years
Sewage Treatment Plant	86,000 m^3/day Appurtenant facility	Preparatory works: 2 months Civil/Building works: 24 months Elec./Mech. Works: 30 months Commissioning test: 6 months	4 years
Drainage Facility	Drain ditch: L=504 km	504 km/{26 m/day x 18 party x 270 day/yr} = 3.99 yr	4 years

Source: JICA Study Team

The assumed construction period is four years as shown in Figure 3.8.2.



Source: JICA Study Team

Figure 3.8.2 Assumed Construction Schedule for Zone II

3.9 Procurement Plan

3.9.1 Procurement of Consultant

(1) Outline of Consulting Services

The consulting services consist of two categories: 1) Engineering services and 2) Capacity development.

1) Engineering Services

The engineering services comprise detailed design stage and construction supervision stage. The task of each stage is as follows:

a) Detailed Design Stage
- Review of DPR
- Supplemental topographic and geotechnical survey
- Preparation of detailed design
- Cost estimates
- Preparation of tender document
- Tender assistance

b) Construction Supervision Stage
- Setting out of the works
- Checking of construction drawings
- Quality and quantity control
- Monitoring and control of work progress
- Commissioning and preparation of O&M manual

The draft TOR of proposed expert and manning schedule is shown in Appendix-B6.1.

2) Capacity Development

The objective of capacity development is to assist RMC in the implementation of the "Organization Strengthening Action Plan" (Action Plan) proposed in Chapter IV. The Action Plan is composed of the following activities. The consultant shall assist and coordinate with RMC and the Government of Jharkhand in the implementation of these activities.

a) Setting of Policy, Rules, and Regulations
b) Establishment of WSSW
c) Establishment of the Administration System of WSSW
d) Development of a Business Plan
e) Improvement of the Financial Management System
f) Water and Sanitation Tariff Setting and Revenue Collection
g) Management Information System
h) Asset Management System
i) Customer Service

j) Outsourcing

For implementing the above activities, it is proposed that the following experts are assigned:

i) Institutional Development and Organizational Strengthening Specialist
ii) Human Resources Management and Training Specialist
iii) Municipal Water Tariff/Finance Specialist
iv) Management Information System Specialist
v) GIS Specialist
vi) Information, Education, and Communication Specialist

The Action Plan is proposed to be commenced in January 2015. However, the consulting services will be commenced in January 2016, because it will take nine months to select the consultant after L/A, which is assumed to be concluded in March 2015.

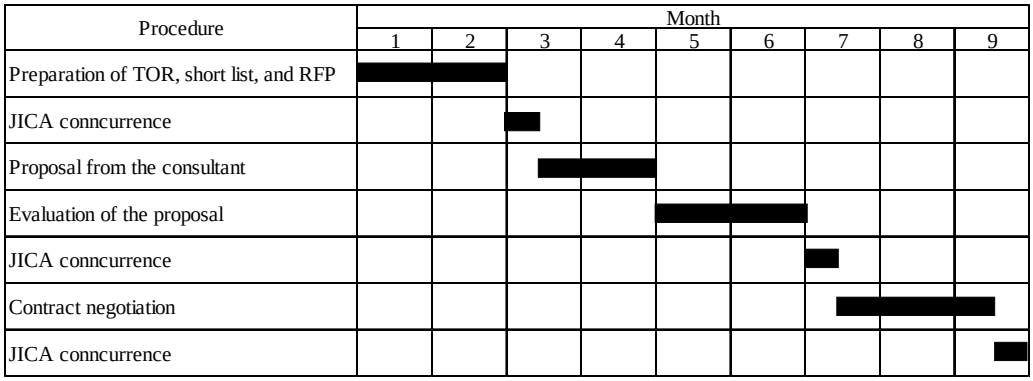
To assist RMC in implementing the Action Plan for the period before employment of the consultant, it is proposed that JICA dispatch the expert to assist RMC in the implementation of the initial stage of the Action Plan.

The proposed task matrix of the JICA expert and capacity development consultant is shown in Appendix-B6.3. The proposed manning schedule of the JICA expert and capacity development consultant is shown in Appendix-B6.4.

(2) Selection of the Consultant

The required expertise for the engineering services consultant and the capacity development consultant are different. Thus, the selection of consultants will be conducted separately so that the specialized consultant for each service can be selected.

The selection procedure will follow the "Guidelines for the Employment of Consultants under the Japanese ODA Loan" of JICA. The selection procedure and its normally required period are shown in Figure 3.9.1.



Source: JICA Study Team

Figure 3.9.1 Procedure for the Selection of Consultant

As shown in the above figure, it will take nine months for the selection of the consultant. The Request for Proposal (RFP) to be prepared by the executing agency will be composed of the

following documents:

1) Letter of Invitation
2) Selection Procedures
3) Technical Proposal - Standard Forms
4) Financial Proposal - Standard Forms
5) Terms of Reference
6) Standard Forms of Contract
7) Eligible Source Countries of the Japanese ODA Loans

The draft "Data Sheet" to be attached to 2) Selection Procedures is shown in Appendix-B6.5. The draft TOR to be attached to 5) Terms of Reference is shown in Appendix-B6.1 and Appendix-B6.2.

3.9.2 Procurement of Contractor

(1) Contract Packaging

In Ranchi City, a water supply project and road project funded by the Indian government (JNNURM) or ADB are being implemented. There are many big contractors all over India that can handle this kind of construction works. These big contractors have their head office in the major mega cities in India like Delhi, Bangalore, Mumbai, Chennai, Hyderabad, Ahmedabad, Kolkata, etc.

For the construction of STP and pump station, there are several contractors in India that can handle the works on EPC or turn-key basis. Some of these contractors are Indian-based companies and some are local subsidiary companies of the international EPC contractors.

Considering the above, it is proposed that the construction works be divided into six contract packages as shown in Table 3.9.1.

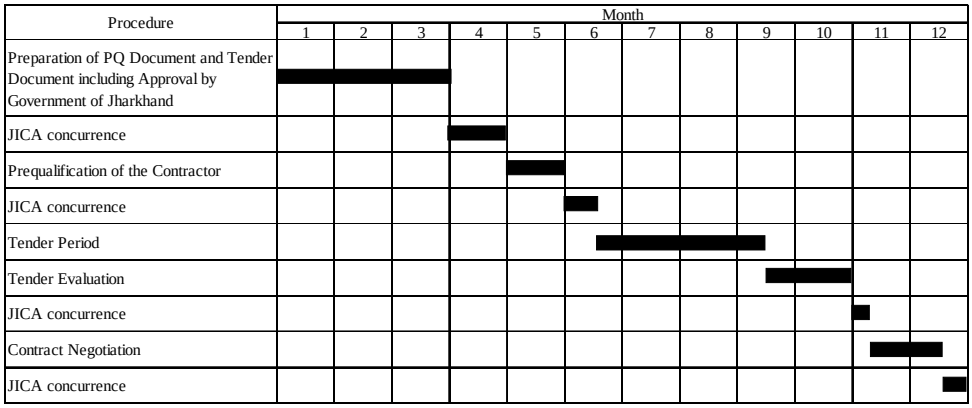
Table 3.9.1 Contract Packages

Contract Package	Work	Contract Value (Rs. billion)	Bidding Type	Applied Bidding Document
CP-1	Sewage Treatment Plant, Pumping Station, and Rising Main	1.6	ICB	Standard Bidding Documents under the Japanese ODA Loan
CP-2	Gravity Sewer, Drainage Facility and House Connection (South-West Area)	4.6	ICB	-do-
CP-3	Gravity Sewer, Drainage Facility and House Connection (North-East Area)	2.8	ICB	-do-
CP-4	Social Development	0.2	LCB	Standard Bidding Documents in Jharkhand
CP-5	Decentralized Sewerage Facilities	0.03	LCB	-do-
CP-6	Public Outreach Program	0.05	LCB	-do-

Source: JICA Study Team

(2) Selection of Contractor

The selection of contractor will be conducted following the "Guidelines for Procurement under the Japanese ODA Loan" of JICA. The standard selection procedure and its normally required period are shown in Figure 3.9.2. As shown in the figure, it will take 12 months for selection of the contractor.



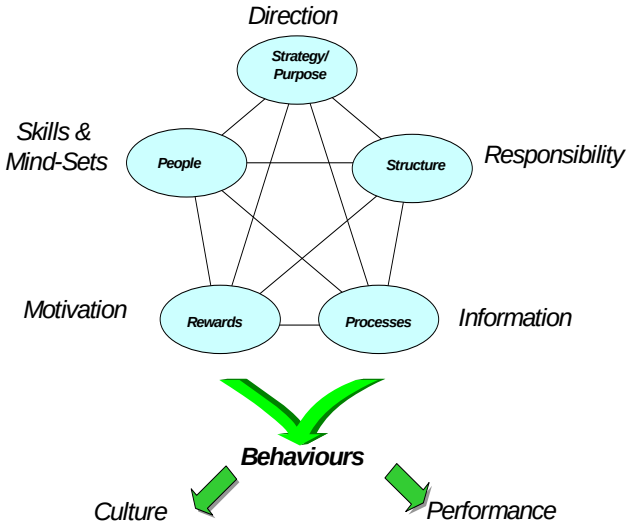
Source: JICA Study Team

Figure 3.9.2 Procedure for the Selection of Contractor

CHAPTER IV: ORGANIZATIONAL STRENGTHENING PLAN FOR RMC

4.1 Organizational Improvement Model

Improving the existing organization of Ranchi Municipal Corporation (RMC) as a whole is a prerequisite in executing and maintaining the water supply, sewerage and drainage system. The basic model that is to be followed in the organizational strengthening of RMC (and of the other organizations associated with the project) is an adaptation of J. R. Galbraith's "Star Framework" as presented in Figure 4.1.1.



Source: Adapted from Galbraith's Star Framework

Figure 4.1.1: Organizational Strengthening Model

The sequence of the organizational 're-design' shall include a relook at the five elements that are required when changed/new institutional roles are created within RMC.

4.1.1 Situational Analysis

To commence with any improvement and for creating a related plan, it is essential to understand the prevailing situation in RMC. During this preparatory survey, interactions with key officials and observations have resulted in a compilation of organizational challenges faced by RMC management and staff. These "areas for improvement/issues" are enumerated below:

(1) Strategic Issues

- Weak policies and institutions have led to weak service standards, especially for poor people - low coverage rates and poor service quality
- Quality deficiencies and loss of economic benefits due to lack of quality policy;
- Systematic review mechanism to monitor plans and regulations is missing;
- Multiple authorities (executive and legislative - two chains of instructions) and multiple responsibilities of staff have led to reduced productivity;

- Poor cadre management, missing of recruitment plan;
- Poor dissemination of policies and regulations (no IEC strategy);
- Lack of clarity on mandate (e.g., Engineering wing engaged in minor works rather than performing planned execution).

(2) Structural Issues

- Missing of functional units like planning and cost control, asset management, emerging technologies, HRM, HRD, and PPP;
- Lack of functional specialization, specialized 'project management' units required for water supply and sewerage sector;
- Need for contract management, financial analysis, and legal functions in RMC.

(3) Processes and System Issues

- Outdated, less relevant and inefficient procedures;
- Currently, 'expenditure incurred' is the 'success indicator' of work; quality of work is not considered as an indicator;
- Lack of delegation/decentralization of authority delays decision making;
- Quality assurance missing, inadequate quality monitoring;
- Poor access to data and information, improved documentation needed;
- Without 'in-house' knowhow (capacity/capability), outsourcing is failing;
- Asset management system is missing;
- Non-use of modern technologies such as GIS, remote sensing and computerized systems.

(4) People - HRM Issues

- Lack of effective human resource management & development policy (motivation, performance management, manpower planning, career path development, need based training, transfer policy not linked with workload, etc.);
- Serious shortage of full time operational staff in RMC that can be trained, retained and incentivized to perform well. This has affected the management of services, as well as works supervision.
- Lack of standard O&M procedures, occupational health & safety standards, or training programs to help the staff
- Work load analysis required to match geographical spread, manpower and other resources (vehicles) - rightsizing of all units for "adequate" and "appropriate" human resources;
- Feeling of 'ownership' missing among RMC staff – cause attributed to deputation practices and frequent transfers;
- Staff competencies to manage emerging factors like social (including community mobilization,

IEC, gender, R&R), environmental management, IT, PPP issues yet to develop;

- Missing of performance indicators/benchmarks and their measurement;
- New work dimensions relevant to new technologies and practices not incorporated (e.g., green technologies);
- Inadequate incentive to attract quality staff for contractual/specialist positions such as sewerage works;
- Training policy required; induction training, in-service training and exposure visits for updating technical skills as well as for learning new skills such as contract management, construction management, and overall project management.

(5) Cultural issues

- Reactive organizational culture, majority of time spent in crisis management;
- Lack of learning culture, objective oriented training is missing;
- Formal coordination mechanism with stakeholders needs to be evolved (feedback mechanism).

Challenges: Ranchi's urban water supply and sanitation infrastructure coverage is yet to improve; the quality of water and sanitation services is not commensurate either with the scale of public investments or the economic growth. The main challenge is that limited governance and administrative initiative is leading to weak service standards, especially for the poor, assets are poorly maintained and services are sub-standard and unsustainable. Policy targets are unclear, fiscal support delinked from performance. Reforms require appropriate institutional frameworks, avoiding fragmented piecemeal reforms.

To be able to achieve the critical success indicators, RMC needs to embrace internal reforms, adopt assessment and analysis tools, participatory approaches and communication strategies to implement and monitor. For both water and sanitation services, RMC has to develop mechanisms for monitoring of services, and ensuring customer feedback channels to improve service provision. The short and direct line of accountability between supplier (RMC) and consumer (People of Ranchi) serves to mitigate some of the challenges of revenue collection and governance.

Governance of Ranchi is through the Ward Councilors with the objective of decentralization; while it brings new opportunities it also presents significant challenges. Decentralization brings decision making closer to the people and can empower citizens to demand improved services from RMC. Decentralization can also present significant challenges due to the lack of technical capacity of RMC (technical capacity must be devolved as well as responsibility). As a result, there is a huge demand for technical assistance on service sustainability tied to sector governance and the overarching institutional and accountability frameworks. In this context, consultants need to work with sector stakeholders at multiple levels to assist in clarifying roles and addressing these capacity constraints.

In the current institutional structure the functions of policy making, oversight, and service

provision are not clearly delineated, and lead to conflicting objectives, political interference and lack of incentives and accountability. Consultants will have to work with both existing and new sector institutions to better clarify institutional arrangements, particularly with regards to functions such as planning, financing, regulation and oversight, etc.

The new policy initiative will have to be in conformity with the national policy which identifies "reaching the un-served and the poor" and "planned and managed community facilities" as priorities and key goals.

4.1.2 Improvement of Water Supply and Sewerage Functions of RMC

Having identified the organizational challenges faced by RMC, the following actions are proposed for improvement of water supply and sewerage management functions.

(1) Setting of Policy, Rules and Regulations:

There is growing recognition of the institutional weaknesses that underlie low coverage rates and poor service quality, and that more finance and infrastructure alone will not lead to improved services. The fundamental challenge is not one of fixing the pipes, but rather one of ‘fixing the institutions that fix the pipes’.

There are gaps that need to be fixed, most of these concern local policies, organizational, management, human resource, infrastructure and financing issues. There is fragmentation of service delivery; duplicity of responsibility for water supply between RMC & DWSD is a clear example. In water supply the main concern is the separation of service delivery, revenue management, and production. Sewerage and drainage is even worse off since O&M of STPs and pumping stations, slums sanitation, Municipal Solid Waste (which chokes sewerage networks), and industrial wastewater are all yet to be addressed. There is a lack of clarity in institutional mandates, structures, roles and capacities to provide improved WSS services.

WSS policies for regulation, funds allocation and accountability mechanisms need to be evolved. RMC has to take the initiative of revising the government policies, defining/clarifying institutional roles, allocating budgets, adopting cost-effective approaches. Designing a strategic planning process for promotion and advocacy of the policy and legislative reforms that incorporate a shared vision linked to project objectives and support the development of the ‘long/ medium- terms and annual strategic operational plan’.

- RMC needs to set up a target year for sound management (for example, 30 years as a guideline) and preparation of action plan to materialize the long-term plan.
- Medium-term Plan: formulation of a five-year plan conforming to the milestones of the long-term plan.
- Annual Plan: formulation of annual operational plan based on the five-year plan annual report, review/feedback.
- Medium term “performance improvement plans” and long term “capital improvement plans”

RMC has to shape the sector's engagement with communities by developing institutional policies and strategies that address the following throughout the project cycles of planning, design, budgeting, implementation, monitoring and evaluation:

a. Ranchi water supply plus wastewater master plan and sanitation plan.

b. RMC's Action on organizational/human constraints.

c. Implementation of new cost-recovery policy.

d. Modernize asset management.

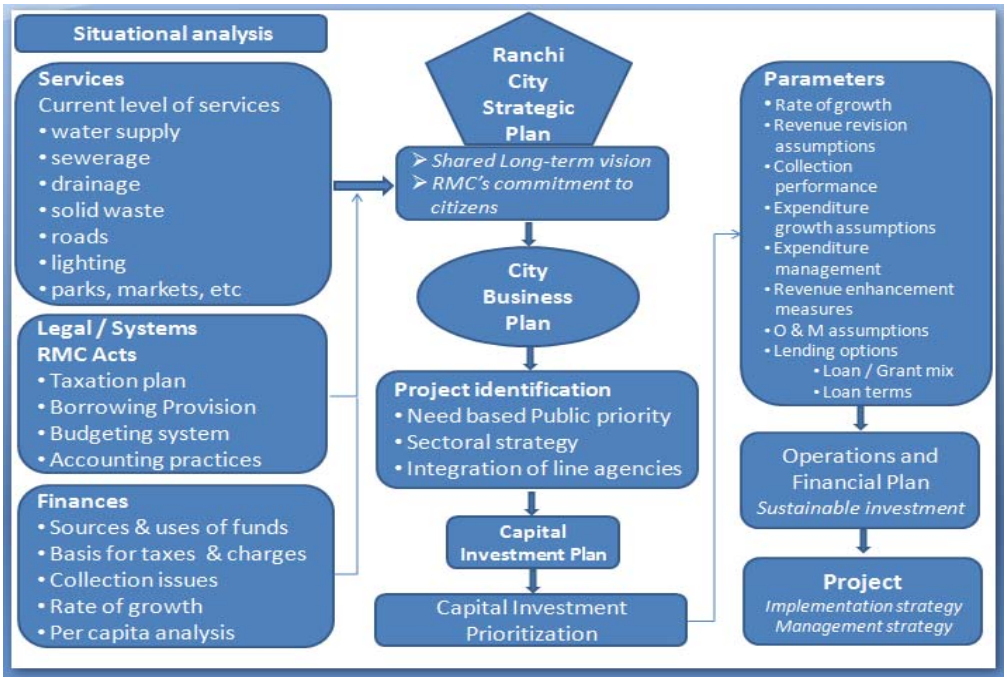
e. Prepare and implement an information, education and communications (IEC) campaign.

f. Proactive and innovative action to address river pollution.

(2) RMC's Business Plan for Water Supply and Sewerage:

RMC's Business Plan will reflect the aspirations during the next fifteen years i.e. upto 2030 to support scaling up of improved water supply and sewerage services for the city of Ranchi. The 'Business Plan' answers the questions, "Where is RMC now?", "Where does RMC want to be?" and "How is RMC going to get there?"

The plan sets out baseline for the performance of RMC, its priorities and aims for the future. The Business Plan will be a guide to implementation of projects and reforms to be undertaken by RMC. In addition, the Business Plan would provide a basis for additional resource mobilization to enhance the credit worthiness of RMC. Such an approach to RMC's business plan is portrayed in the Figure 4.1.2.



Source: JICA Study Team

Figure 4.1.2: Approach to RMC Business plan

Where is RMC now?: RMC is responsible for the administration and operation of Ranchi City's

water production, treatment, distribution, and wastewater collection and treatment including regulatory compliances. The current situation can be best exemplified by the values of the key financial indicators as tabulated in Appendix C1.1.

Where does RMC want to be?: RMC's approach is to address both the vertical chains of reform in policy, accountability, technical capacity and resource allocation as well as the horizontal framework of coordination, learning and cooperation so that people of Ranchi receive timely and adequate resources and capacity development support to implement programs that are aligned with priorities to ensure access to safe water and sanitation. This approach is complemented by a focus on citizen engagement for social accountability to enhance transparency, equity and accountability.

RMC's VISION - is to achieve improved service levels and better quality of life for the citizens to make Ranchi a 'Class A' city.

RMC's MISSION STATEMENT - RMC takes pride in maintaining a tradition of producing ample superior quality water, vigilantly maintaining water and wastewater infrastructure, and providing responsive and efficient customer-oriented service in a cost-effective and innovative manner emphasizing responsible environmental stewardship and compliance with all regulatory requirements.

RMC's Goal - RMC has set itself the goal of providing 24x7 self-sustainable, safe drinking water supply and wastewater collection and treatment, and pollution free nallahs and rivers by the year 2021

Current level of achievement service outcome targets for key performance indicators have been framed in The targets for years 2021 (medium term) and 2030 (long term) have been indicated in Table 4.1.1 so as to meet or exceed the Govt. of India standard for the respective parameter.

Table 4.1.1 Goals and Service Outcomes

S. No.	Indicators	GoI * Standard	Current 2013-14*	Target 2021	Target 2030
Water Supply					
a)	Network cover for general households - %	100	55	75	100
b)	Network cover for slum households - %	100	35	50	100
c)	Network cover for commercial establishments- %	100	50	75	100
d)	Network cover for Industrial establishments- %	100	100	100	100
e)	Per capita supply - lpcd	135	120	135	150
f)	Extent of metered water connections - %	100	40	75	100
g)	Supply duration - hours	24	5	7	24
h)	Quality of water supplied - %	100	58	100	100
i)	Un-accounted water - %	20	40	25	20
j)	O & M cost recovery - %	100	25	60	100

S. No.	Indicators	GoI * Standard	Current 2013-14*	Target 2021	Target 2030
k)	Collection efficiency - %	90	45	75	100
l)	Customer complaint redressal efficiency	80	40	80	100
m)	Customer satisfaction – Fair/ Good / Very Good	-	-	Good	Very good
Sewerage					
a)	Coverage of toilets - %	100	54	80	100
b)	Coverage of sewerage network - %	100	3	80	100
c)	Collection efficiency of sewerage network - %	100	7	80	100
d)	Treatment and disposal - %	100	7	80	100
e)	Quality of treated sewerage - %	100	15	100	100
f)	Recycling and reuse - %	20	-	20	40
g)	Customer complaint redressal efficiency	80	40	80	100
h)	Collection efficiency - %	90	20	75	100
i)	Cost recovery of O&M - %	100	20	50	100
j)	Customer satisfaction – Fair/ Good / Very Good	-	-	Good	Very good
Storm Water Drain and Water Bodies					
a)	Flood alleviation and macro drainage - %	100	55	80	100
b)	Micro drainage with-in Ranchi city - %	100	55	80	100
c)	Incidents of water logging	0	10	5	0
Solid Waste Management					
a)	Collection with-in Ranchi city %	100	83	100	100
b)	Door-to-door collection %	100	20	100	100
c)	Source segregation-%	100	30	100	100
d)	Scientific disposal - %	100	0	100	100
e)	Waste to energy generation - %	-	-	-	50
f)	Tariff collection-%	100	-	100	100
g)	Cost recovery of O&M - %	100	78	60	100
h)	Private sector participation - %	100	35	75	100
i)	Customer complaint redressal efficiency	80	49	80	100
j)	Customer satisfaction – Fair/ Good / Very Good	-	Fair	Good	Very good

Source: UDD Memo No: 3228350 dtd 17-8-2013 and JICA Study team

RMC's priorities are:

a. To achieve better results (service improvements) from investments made to date under JNNURM.
b. To introduce and scale up 24x7 continuous water supply, and ensure equitable and safe water supply throughout the city.
c. To create the infrastructure for collection and transportation of wastewater.
d. To identify the costs associated with improved service delivery and institutionalize cost recovery.
e. To put in place organizational/human and capacity building arrangements needed to scale up and sustain improved services.
f. To provide a strategy for sanitation in slums and low-income groups.
g. To address river pollution, especially from slums and local industries.

How is RMC going to get there?: In water supply, the goal is to provide self-sustaining, safe drinking water services for 24 hours on all days to the entire population of Ranchi by 2030. This will require that RMC augments its raw water transmission and water treatment works, together with expansion of feeder mains, service reservoirs and distribution. However, the capital investment required and associated operating expenses can be substantially reduced if network efficiency improvements are made to reduce non-revenue water/ physical losses in the existing distribution system and in the new network to be installed.

In detail, the Business Plan identifies the following potential projects for water supply, sewerage and drainage in RMC: a) 24x7 water supply project (network strengthening, household connections, customer meters, SCADA, project management); b) Implementation and strengthening of wastewater services in all areas of Ranchi (network and pumping stations, regularize connections, new sewerage treatment plants); c) Action on issues causing solid waste blockages of sewerage services (impacts, maintenance procedures, IEC behavior change programs, with City Sanitation Plan); d) Sanitation in slums and public facilities (new infrastructure and rehabilitation of existing infrastructure) and e) Treatment of polluting industrial and commercial wastewater from businesses in RMC areas (treat polluting waste from industries in Ranchi area).

Tariff Policy/Structure: To ensure the efficient and sustainable delivery of water and sewerage services, water pricing should be based not only on the financial costs involved in producing and delivering services but also on economic, environmental and pro-poor principles. Further narration on the subject of tariff for water supply and sewerage is detailed in section (7) Tariff Setting and Control and in Chapter V – Economic and Financial Evaluation.

Implementing the Business Plan: As part of the Business Plan, it is thought best that the processes will be carried out at the earliest, to include the following actions:

1 Ring fence finances by establishing cost centres for all department revenues and expenses, and bring all water and sewerage revenue collection under RMC’s control.

2 Prepare a written down Citizen's Charter for water supply, sewerage-cum-drainage and SWM.

3 Water supply, sewerage-cum-drainage and SWM:

   a. Establish single point responsibility for providing water services and revenue management.

   b. Meter readers and collection counter staff will report to person with specified responsibility.

   c. A centralized billing section will manage bill processing and printing, and delivery of bills (can be either by the meter readers or through an outsourced spot billing agency)

   d. Engineers responsible will be recruited vis-à-vis the workload for providing all the services (project management, network strengthening, pumping stations, household connections, customer meters, SCADA, regularize connections, new sewerage treatment plants, electrical, instrumentation environmental).

   e. Special attention to be given to ensure mechanisms for coordination over related services for storm drainage, Municipal Solid Waste, and toilets in public places and slums.

Discussions with stakeholders clearly brings out the need for a communication strategy focusing on service level targets, 24x7, tariffs vs. costs, issues in service provision in areas where illegal construction is predominant, water conservation, importance of proper internal plumbing and solid waste management practices (waste segregation and proper disposal) at household level. The communication strategy envisages the involvement of stakeholders and defines their roles and responsibilities. Involvement of local NGO/partner organization with a strong grassroots base in community mobilization, participation, information sharing and awareness generation will be key to a successful switch to individual connections by households and metering of public stand-posts. NGO/partner organization participation in the program shall be important for safeguarding the interests of the poor and giving them a voice. Key messages to be conveyed to citizens and other stakeholders through the campaign have to be drafted as part of the strategy. The communication strategy will involve engagement with media, awareness drives, dialogue with stakeholders, grievance redress and feedback mechanisms.

As part of the Business Plan it is has to be supported by a detailed financial plan and the phased action plan with specific milestones to be achieved which shall be evolved through consultation between RMC and the consultancy organization to be engaged by RMC to complement internal capability. The terms of reference of the consultancy organization will include, but not limited to, the following:

- Performance targets along with key monitoring indicators and phase-wise service improvement plan
- New organizational structure with clearly defined roles and responsibilities of each functional

group and position.

- Development of institutional re-organization plan and phase wise road map for its implementation
- Define roles and responsibility for each position
- Specific recommendations for improving the financial management system
- Capital investment plan for improving service delivery.
- Revenue improvement plan including strategies for improvement of coverage and collective efficiencies and reclassification of service categories and tariff structure.
- IT plan with details of functions that may be computerized and phase-wise implementation plan for the same.
- Strategies for improving customer orientation
- Cost reduction strategies.
- Strategies for improving environmental and energy efficiency in day to day operations.
- Analysis of constraints in current management of water supply operations
- Action Plan for achieving service level targets projected in business plan
- Identification of new skills, new training needs, equipment, software, contracting requirements etc. for implementation of service level action plan.

The consultant will be expected to provide handholding support for implementation of plans and strategies developed above for a period of twenty-four months. This implementation and handholding period may also include procurement, installation and implementation of IT reforms.

(3) Independent Operations

Though the responsibility of water supply, sewerage and drainage solely lies with RMC, the multiplicity in management of water supply and drainage services in Ranchi is illustrated in the matrix at Appendix C1.2. For example, for Water Supply, while RMC is responsible for providing household connections as well as billing and revenue collection, the remaining elements of Water Supply function are under the purview of other departments namely UDD, DW&SD and Water Resources Deptt. Similarly elements of Drainage and Sewerage functions are also executed by multiple departments, which often results in operational inefficiency.

RMC has to have a strong political leadership and administration, which demonstrates the will to be able to develop plans for the independent operation of water supply, sewerage and drainage; the new structure's focus will have to be on the following key areas:

- RMC's dual role as a partner and as a prime mover with respect to the multi-stakeholder scenario;
- Creation of Water Supply and Sewerage Wing (WSSW) of RMC
- Transfer of authority, functions and from 'Drinking Water Supply & Sewerage Department'

Transfer of authority, functions, human cum financial resources and all assets from DWSD to WSSW of RMC for water supply and sewerage functions for the city of Ranchi;

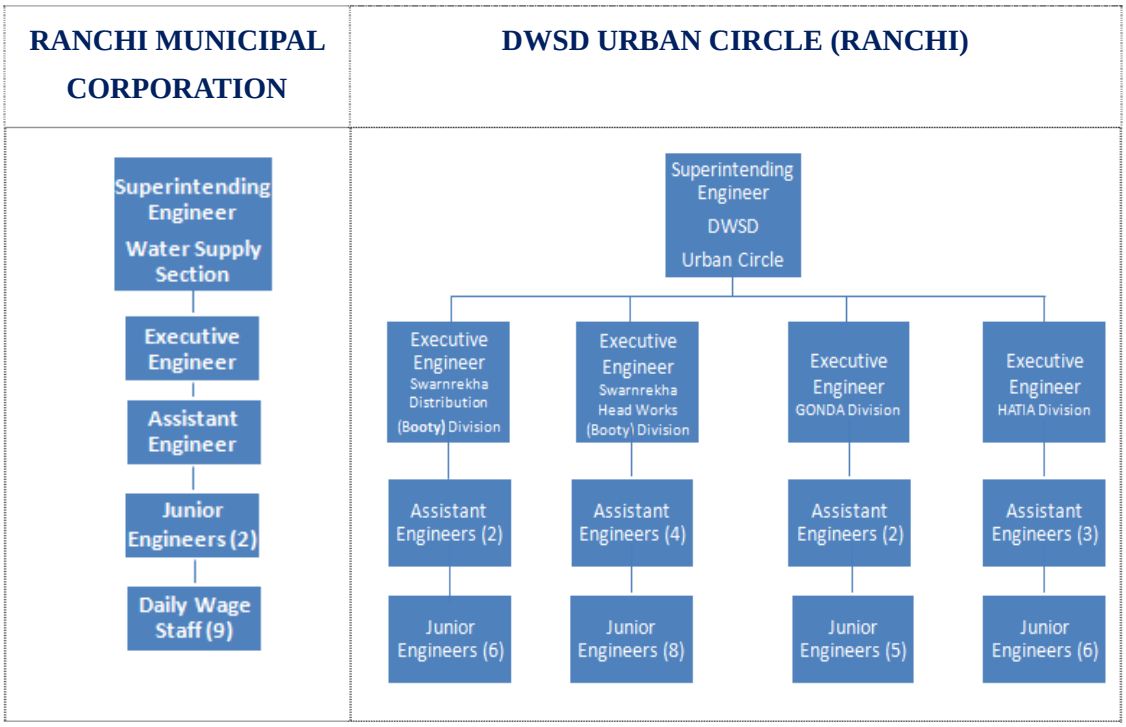
- Skill types and staff numbers needed for establishment of organizational systems for drinking water supply and sewerage works (strengthening of management and technical capability);
- Financial resource needs in the future and establishment of financial base on drinking water supply and sewerage works (increase in income and decrease in subsidy);
- Delegation of responsibilities and tasks to RMC officers; and
- Decentralization of regulatory tasks.

RMC has to explore the feasibility of integrating water supply sewerage-cum-drainage and SWM services. Creating an SPV organization for this purpose is a possible option that has to be explored.

Alternatively, establishment of a water (and wastewater) company under the Indian Companies Act (1956) as an optimum model in the longer term so that services are delivered by an autonomous public utility which has responsibility over all related service areas like O&M (including the NRW), Customer Services, Personnel (HR), Financial, and Capital Works. (Nagpur is an example in India where such a water company has been established, and operations outsourced under a management contract).

(4) Human Resources Planning & Management

The manpower engaged in performing only the water supply function for the city of Ranchi is shown in Figure 4.1.3.



Source: JICA Study Team

Figure 4.1.3 Manpower for Ranchi Water Supply

Presently, these 55 strong teams are managing the water supply services to 65 % of Ranchi city only. The above demonstrated the imbalance among the two organizations. There is an urgent need for a policy decision at the Govt. of Jharkhand level, regarding the role of RMC and then re-examining the workload with respect to water supply, sewerage and drainage; accordingly human resources have to be allocated commensurate with the functions to be performed.

In the present context of implementing the water supply, sewerage and drainage projects, RMC has to carry out human resource planning for 1) the project implementation phase and 2) for the O & M phase. The plans once in place will cater to the management and implementation needs of all Zones (i.e. Zone 1, 2 3 & 4)

1) HRM - Project implementation phase:

To manage the project efficiently, a well defined management structure has to be in place well before the first activity can begin. This management structure will comprise of a) Steering Committee (SC) and b) Project Implementation Unit (PIU).

a) Project Steering Committee (SC): This committee will be formed to monitor and guide the performance of PIU. The objective served by this committee will be to:

- review project performance
- decide on major issues, such as funding, manpower resource
- remove implementation bottlenecks,
- resolve land disputes,
- award permission for special procurement,

- carry out policy reforms, where needed, etc.

The committee will comprise of the following members:

- Principal Secretary, UDD
- Principal Secretary, DW&SD.
- Deputy Commissioner of Ranchi
- Mayor
- Commissioner, Ranchi Municipal Corporation
- Leader of opposition, Ranchi Municipal Corporation
- Project Director, as member secretary

The committee members will meet every three (3) months for the total duration of the project.

b) Project Implementation Unit (PIU): RMC has to ensure that the PIU is in place with immediate effect or least of all to coinciding with the start of the project for Zone 2, 3 & 4. The key aims and objectives of the PIU will be to:

- Ensure that 699 km of sewer pipe, 970 km of drainage channel, 16 sewerage pumping stations and 3 Sewerage Treatment plants needed for Ranchi city are constructed as per design parameters.
- Manage the loans, and coordinate with funding agencies and government departments.
- Engage Design and Supervision consultant for the purpose of planning, and execution of the projects.
- Facilitate arrangements with the agencies for execution of the project on BOO (Build , Own, Operate) , BOT (Build , Own, Transfer) or BOOT (Build, Own, Operate. Transfer) type, as may be the case.
- Monitor progress of projects under execution, receive implementation reports and issue such directions as may be necessary for securing satisfactory implementation and execution of the projects.
- Engage the services of experts, as and when needed, for advice on specific issues that may arise during the execution of the projects.

The PIU team will comprise of the following members as shown in Table 4.1.2

Table 4.1.2 Project Implementation Unit Team

S.No	Position	Numbers (approx.)	Remarks
1	Project Director (PD)	1	equivalent to CE, experience 25 yrs min
2	Project Manager (PM)	1	equivalent to SE, experience 20 yrs min
3	Director Finance (DF)	1	equivalent to CAO, experience 20 yrs min
4	Deputy Project Manager (DyPM) (STP)	1	equivalent to EE, experience 15 yrs min
5	Deputy Project Manager (DyPM) (Gravity Sewers & Drainage)	1	equivalent to EE, experience 15 yrs min
6	Deputy Project Manager (DyPM) (Pumping Stations & Rising Mains)	1	equivalent to EE-Mech/Elec, exp-15 yrs min
7	Deputy Project Manager (DyPM) - (Public Participation & Awareness Program, Training coordination, Monitoring and Evaluation)	1	equivalent to EE, experience 15 yrs min
8	Field Engineers (FE) (STP)	3	equivalent to AE, experience 8 yrs min
9	Field Engineers (FE) (Gravity Sewers & Drainage)	5	equivalent to AE, experience 8 yrs min
10	Field Engineers (FE) (Pumping Stations & Rising Mains)	5	equivalent to AE, experience 8 yrs min

Support Team

11	Environmental Engineer (Env. Er)	1	experience 15 yrs min
12	Community Development Officers (CDO)	1	experience 10 yrs min
13	Procurement Officer (PO)	1	experience 15 yrs min
14	Legal Officer (LO)	1	experience 12 yrs min
15	Management Information System Officer (MISO)	1	experience 12 yrs min
16	Accounts Officers (AO)	2	experience 15 yrs min
17	Assistant Accounts Officers (AAO)	2	experience 8 yrs min
18	Computer Operators (Com Op)	5	Graduate in Computer sciences, exp-10 yrs
19	Office Assistants (OA)	5	Graduate, experience 5 yrs min

The number of staff shown is an optimum number; however these can vary depending on the situation during the life of the project. It is suggested that the above staff should be hired on contractual basis and their services should be co-terminus with the project.

The general tasks of the team will include, but not limited to, the following:

a. Day-to-day implementation of contracts and project activities;
b. Coordinate planning, control, and management of the work of a multidisciplinary team;
c. Provide long-term input to the development of project methodologies;
d. Participate in carrying out detail investigation and engineering surveys (geotechnical, topographical, etc), wherever necessary;
e. Participate in and understand designing and undertaking construction supervision of sewerage and sewage treatment;
f. Ensure 'Third Party design review'
g. Presenting of the designs to all stakeholders (including local government and communities), addressing the concerns where necessary;
h. Participate in developing bidding documents, including bill of quantities and specifications following JICA / JNNURM guidelines and assist in evaluation of bids;
i. Update costs and economic and financial information (including rates of return), when needed;
j. Prepare and update implementation schedule and resource requirements (preferably in Microsoft Project Management software);
k. Define quality control mechanisms and parameters for all components;
l. Develop a coordinating mechanism with the government and the contractor/NGO and prepare public communication products
m. Develop O&M manuals for future maintenance;
n. Establish a contract tracking systems, including implementation schedules and milestones achievable;
o. Issuing contracts, completion certificates, settlement of contractor's claims;
p. Facilitate preparation of training programmes for effective implementation and O&M including training module, training plans and organize and conduct same through consultant's staff and other service delivery institutions.

Though the above list includes most of the tasks to be performed by the team, it is suggested that each team member should be provided with his individual job description. Specific tasks for each team member have to be linked with specific targets derived out of the 'Project activity' bar chart. These targets should then feed into the Microsoft Project Management software for regular monitoring.

Timely completion of each milestone should result in the team being rewarded with a monetary incentive and a citation; the incentive amount per milestone should be decided by the Project Steering Committee.

c) Project Implementation Unit Cost: Table 4.1.3 shows the estimated cost of staffing the PIU.

Table 4.1.3 Project Implementation Unit Team Cost

S. No.	Position	Numbers (approx.)	Monthly Remuneration (Rs.)	Annual (Year 1) (Rs.)
1	Project Director	1	120000	1440000
2	Project Manager	1	95000	1140000
3	Director Finance	1	95000	1140000
4	Deputy Project Manager	4	70000	840000
5	Civil Engineers	13	45000	585000
6	Environmental Engineer	1	70000	840000
7	Community Development Officers	1	60000	720000
8	Procurement Officer	1	70000	840000
9	Legal Officer	1	70000	840000
10	Management Information System Officer	1	70000	840000
11	Accounts Officers	2	70000	840000
12	Assistant Accounts Officers	2	45000	540000
13	Computer operators	5	20000	240000
14	Office Assistants	5	10000	120000
	Total	39	910000	10965000

Considering experiential increment and inflation the annual increase in remuneration for each subsequent year would be 10% per year amounting to Rs. 6,69,42,422 after five years.

d) Capacity Building of PIU staff: Capacity building efforts would be needed to update the skills of the team selected to manage the projects. These training initiatives should be extended to the staff currently engaged by UDD, RMC and DWSD Urban Circle and not be limited to the PIU team. The list of training programmes in Table 4.1.4 is an indicative list and other courses/ training titles can be added as per the training needs of the team. Also indicated is the estimated number of participants from respective organizations who should be trained in each of the topics from the different organizations.

Table 4.1.4 Capacity Building of Project Implementation Unit Team

S.No	Course Title	Estimated number of participants				
		PIU	UDD	RMC	DWSD	Total
1.	Understanding leadership and management	5	4	5	1	15
2.	Understanding project management concepts	7	4	9	5	25
3.	How to use Primavera / MS Project software for project management	17	2	4	2	25
4.	Construction of sewerage system - planning, norms, and institutional issues	20	4	6	5	35
5.	Understanding contract management process	8	2	5	2	17
6.	Contract administration and procurement procedures – FIDIC conditions	6	4	4	1	15
7.	Understanding JICA procurement procedures	6	4	4	1	15
8.	Quality Assurance Systems and TQM for sewerage projects	20	4	6	5	35
9.	Quality control tests in field and laboratories	13	2	5	4	24
10.	Land acquisition, resettlement and rehabilitation policies	5	2	6	2	15
11.	Understanding requirements of construction supervision (Project implementation)	20	4	6	5	35
12.	How to monitor and report physical & financial progress of work	17	2	4	2	25
13.	How to carry out topographical surveys, using total station equipment	13	2	5	4	24
14.	How to use GIS and GPS	13	2	5	4	24
15.	How to prepare a traffic management plan	5	2	5	4	16
16.	Financial accounting and management in Projects	6	4	5	-	15
17.	Understanding commercial banking operations and statutory requirements under IT Act (TDS) and Service Tax for contract management	6	4	5	-	15
18.	Concepts of asset management	4	2	4	2	12
19.	How to enter asset data, generate reports and manage asset e-register	4	2	4	2	12

S.No	Course Title	Estimated number of participants				
		PIU	**UDD**	**RMC**	**DWSD**	**Total**
20.	How to operate MS Office including MS Word and MS Excel, internet explorer, send e-mails and carry out electronic data transfer	5	4	4	2	15

Other customized training topics to be developed for RMC by the consultants are

21.	Understanding elements and developing RMC Quality Policy	2	4	10	-	16
22.	Tariff setting and revenue collection practices for RMC	2	2	10	-	14
23.	How to prepare an asset maintenance plan for RMC	5	2	10	-	17
24.	Customized MIS operations for RMC	2	2	10	-	14
25.	Complaint handling system and public relations for RMC	3	2	15	-	20

The identified list of training topics tabulated above are translated into 'Training profile sheets' which serve as 'Terms of Reference' for those who are to deliver the training. For each topic a further description has been made using a standard training profile format. Each of these 'Training Profile Sheets' is a plan in itself for the respective training delivery. These 'Training Profile Sheets' are appended in Appendix C1.3.

At this early training planning stage, one needs to be open minded and flexible on items like duration, methods etc. However, clear titles, precise training objectives and a short description of the key concept in key words, or indicative course contents, has been provided to avoid confusion when the modules are to be produced by training providers. Wherever '**Case Studies**' have been suggested, it is expected that the training providers will assimilate '**best practices**' globally and use them as a method of demonstration to the participants. The cost (indicative approximation) mentioned in each profile sheet is based on calculations presented in Appendix C1.4. The overall cost estimate of the capacity building initiative amounts to Rs. 6306800. The details are presented in Appendix C1.5.

2) HRM - Operation and Maintenance Phase:

Once the defect liability period is complete, Water Supply and Sewerage Wing (WSSW) of RMC has to take over all the facilities and the operation and maintenance will commerce. By such time self sufficiency has to set in within the WSSW team. To manage the water supply and sewerage operation and maintenance services in the city of Ranchi will require a dedicated team in WSSW as per Table 4.1.5:

Table 4.1.5 Water Supply and Sewerage Wing (WSSW) Staff of RMC

S. No	Position	Numbers	Remarks
Management			
1.	Chief Engineer	1	With overall responsibility for O&M of all the water supply and sewerage-cum-drainage facilities, those constructed under the project and the existing ones.
2.	Superintending Engineer (Water Supply)	1	Responsibility for O&M of all the water supply facilities and functions
3.	Superintending Engineer (Sewerage-cum-Drainage)	1	Responsibility for O&M of all sewerage-cum-drainage facilities and functions

The workload distribution for field staff involved with execution has been presented in Appendix C1.6 and the attempt has been to provide as much equity to staff based on the population they serve in the group of wards.

Sewerage-cum-Drainage - Zone 1 (Nine wards)			
4.	Executive Engineer	1	For O & M of STP, 1 pumping station, 191 km long Main and sub-main sewer and 212 km long drainage
5.	Assistant Engineer (S&D net)	1	Overseeing the O & M of network in 9 wards and 1 pumping station
6.	Junior Engineers (S&D net)	3	Overseeing the O & M of network in 9 wards and 1 pumping station.
7.	Pump Operators	3	O&M of pumps and other appurtenant equipment of 12 pumping station; 1 per 8 hour shift
Zone 1 STP			
8.	Assistant Engineer (STP)	1	Managing the day-to-day running of STP
9.	Junior Engineers (STP)	3	Overseeing the O & M of the STP; 1 per 8 hour shift
10.	Water Quality Analyst	1	Monitoring of treated water quality
11.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
12.	Watchman-cum-Plant Help	6	To carry out security function combined with menial labour functions; 2 per 8 hour shift
Sewerage-cum-Drainage - Zone 2 (Thirty wards)			
13.	Executive Engineer	1	For O & M of STP, 12 pumping station, 275 km long Main and sub-main sewer and 514 km long drainage
14.	Assistant Engineer (S&D net)	4	Overseeing the O & M of network in 30 wards and 12 pumping station (5 wards / AE)
15.	Junior Engineers (S&D net)	7	Overseeing the O & M of network in 30 wards;
16.	Junior Engineers (S&D SPS)	1	Overseeing the O & M of 12 pumping station.
17.	Pump Operators	3	O&M of pumps and other appurtenant equipment of 12 pumping station; 1 per 8 hour shift
Zone 2 STP			
18.	Assistant Engineer (STP)	1	Managing the day-to-day running of STP
19.	Junior Engineers (STP)	3	Overseeing the O & M of the STP; 1 per 8 hour shift
20.	Water Quality Analyst	1	Monitoring of treated water quality
21.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
22.	Watchman-cum-plant help	6	To carry out security function combined with menial

			labour functions; 2 per 8 hour shift

Sewerage-cum-Drainage - Zone 3 & 4 (Sixteen wards)

23.	Executive Engineer	1	For O & M of STP, 3 pumping station, 152 km long Main and sub-main sewer and 244 km long drainage
24.	Assistant Engineer (S&D net)	2	Overseeing the O & M of network in 16 wards and 1 pumping station
25.	Junior Engineers (S&D net)	5	Overseeing the O & M of network in 16 wards;
26.	Junior Engineers (S&D SPS)	1	Overseeing the O & M of 3 pumping station.
27.	Pump Operators	3	O&M of pumps and other appurtenant equipment of 3 pumping station; 1 per 8 hour shift

Zone 3 STP

28.	Assistant Engineer (STP)	1	Managing the day-to-day running of STP
29.	Junior Engineers (STP)	3	Overseeing the O & M of the STP; 1 per 8 hour shift
30.	Water Quality Analyst	1	Monitoring of treated water quality
31.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
32.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8 hour shift

For the water supply function, the existing DWSD Urban Circle strength can be adopted as a guide.

Water supply structure would include:

BOOTY Division - Swarnrekha Distribution

33.	Executive Engineer	1	Overseeing the O & M of network
34.	Assistant Engineers	2	Overseeing the O & M of network
35.	Junior Engineers	6	Overseeing the O & M of network

BOOTY Division - Swarnrekha Head Works

36.	Executive Engineer	1	Overseeing the O & M of network and WTP
37.	Assistant Engineers	4	Overseeing the O & M of network and WTP
38.	Junior Engineers	8	Overseeing the O & M of network and WTP
39.	Water Quality Analyst	1	Monitoring of raw and treated water quality
40.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
41.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8 hour shift

GONDA Division

42.	Executive Engineer	1	Overseeing the O & M of network and WTP
43.	Assistant Engineers	2	Overseeing the O & M of network and WTP
44.	Junior Engineers	5	Overseeing the O & M of network and WTP
45.	Water Quality Analyst	1	Monitoring of raw and treated water quality
46.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
47.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8 hour shift

HATIA Division

48.	Executive Engineer	1	Overseeing the O & M of network and WTP
49.	Assistant Engineers	3	Overseeing the O & M of network and WTP
50.	Junior Engineers	6	Overseeing the O & M of network and WTP
51.	Water Quality Analyst	1	Monitoring of raw and treated water quality
52.	Plant Operators	3	Responsible for plant operation and monitoring performance of equipment; 1 per 8 hour shift
53.	Watchman-cum-plant help	6	To carry out security function combined with menial labour functions; 2 per 8 hour shift

Mechanical Division:

54.	Executive Engineer	1	To support both the water supply and sewerage-cum-draining
55.	Assistant Engineers	3	To support both the water supply and sewerage-cum-draining
56.	Junior Engineers	6	To support both the water supply and sewerage-cum-draining

Suggested job descriptions for the various positions in the hierarchy are presented in Appendix C1.7. The lists includes most of the tasks to be performed by the individual, however it is suggested that each team member should be provided with his individual job description. Specific tasks for each team member have to be linked with specific targets.

Summarizing the above, the total WSSW water supply and sewerage operation and maintenance services staff is assimilated in Table 4.1.6 below. The existing Water Supply Section at RMC will be merged to form part of the above.

Table 4.1.6 Water Supply and Sewerage Wing (WSSW) Staff Cost

S. No	Position	Numbers	Present Monthly Unit Cost (Rs.)	Monthly Unit Cost in 2023 (Rs.)	Total Monthly Manpower cost in 2023 (Rs.)
1.	Chief Engineer	1	120000	186000	186000
2.	Superintending Engineer	2	85000	131750	263500
3.	Executive Engineer	6	70000	108500	651000
4.	Assistant Engineers	24	55000	85250	2046000
5.	Junior Engineers	57	30000	46500	2650500
6.	Pump Operators	9	20000	31000	279000
7.	Water Quality Analyst	6	50000	77500	465000
8.	Plant Operators	18	25000	38750	697500
9.	Watchman-cum-plant help	36	8000	12400	464400
	Support functionaries				
10.	Chief Accounts Officers	1	70000	108500	108500
11.	Accounts Officers	2	50000	77500	155000

S. No	Position	Numbers	Present Monthly Unit Cost (Rs.)	Monthly Unit Cost in 2023 (Rs.)	Total Monthly Manpower cost in 2023 (Rs.)
12.	Assistant Accounts Officers	4	30000	46500	186000
13.	Computer operators	9	18000	27900	251100
14.	Office Assistants	9	15000	23250	209250
	Total	184			86,12,750

Based on the present day unit cost, the O & M manpower cost as in 2023, (with minimum 5% increase in wages per year for nine years) tabulated above can be estimated to be **Rs.** 86,12,750/- per month as per table above.

It is assumed that by the year 2023, two years after the defect liability period, when the entire infrastructure is in place, functions such as billing and revenue collection would have been outsourced. However, managing the finances/accounts of WSSW will require independent manpower, other than those existing in RMC presently. Also, the menial labour needed for the routine cleaning of the U-drains have not been included. Those performing the solid waste management function can also be entrusted with the cleaning of the U –drains.

As part of a continuing effort to train staff of the WSSW on water and sewerage treatment topics, the vendors have to independently and in co-operation with other organizations, develop and conduct specialized training. Course locations, topics and frequency of presentation have to be determined based on the identified need and necessary resources. The following list of training programmes in Table 4.1.7 is an indicative list and other courses/ training titles can be added as per the training needs of the future team.

Table 4.1.7 Water Supply and Sewerage Wing (WSSW) Staff Training

S. No.	Training topics	Indicative duration (days)
1	Urban water and sewerage management	2
2	Sewerage Process Control - Activated Sludge Process: - concepts, process observations, - basic process control testing, including settled sludge volume (settleability) testing, - microscopic examination, dissolved oxygen and alkalinity - observation of an activated sludge system, collection and analysis of process control samples	5
3	Aeration Plant Operation - data analysis process control strategies, process control calculations, data interpretation and process troubleshooting	5

S. No.	Training topics	Indicative duration (days)
4	Wastewater Sampling & Testing - pH & Residual Chlorine, D.O. & BOD, TKN and Ammonia Nitrogen, Solids, Chemical Oxygen Demand	5
5	Recordkeeping, data interpretation and Reporting	3
6	Operation and maintenance of water supply network	5
7	Water treatment process controls	5
8	Preventive maintenance of water and sewerage network	3
9	Methods of minimizing unaccounted for water (UFW)	2
10	Leak detection and loss management in the water supply network	2
11	Energy management audit	4

The cost of conducting the above training has to be built-in in the vendors' cost of supply of plant and equipment.

(5) O&M Management

1) Management Information System for Billing and Collection

Ranchi City with a population of 1,073,440 (census 2011) has 1,50,000 households (approx.) and of these only 90,000 are assessed for property tax. Against this, the number of legal connections as of 2014, as per RMC records, is reported at more than 39,260 and further house connections are reported to have increased in recent days. In addition, government institutions (56 connections), apartments with single point connections (228), commercial (222 connections), and institutional (162 connections) are also reported by RMC as of March 13, 2014.

Presently, only about 7000 water supply connections are metered. Instead, both water and sewage taxes are separately charged as a percentage of the holding tax, which, in turn, is fixed on the basis of a unit-area method. Thus the result is that water and sewage demands are not very real and are mostly undervalued.

Meanwhile, it is reported that there are many illegal house connections and this is said to be one of the reasons for the high NRW ratio. Thus, illegal connections, water leakage and non meter provision are assumed to be the major causes of high NRW ratio in Ranchi City. Apart from direct connections, RMC also provides water supply through an array of other sources including 3,284 hand pumps, 315 stand posts and water tankers as of 2014. The water delivered by tankers is free of charge.

Billing for water and sewer connections is in the process of being computerized, but is not completely web-based. On the other hand, the collection is manual and is through cash or cheque methods only. Arrangement for payments through banks is underway. Online payment and payments through debit and credit cards are yet to be introduced, although the traditional payment system of issuing hand-written receipts is still in vogue and seems to be quite acceptable with the public. The

system of automatic recording of all revenues received is not efficiently ensured. Therefore, it is crucial at this point to maximize the billing system by developing the collection system and integrating both systems for efficiency of billing and collection.

RMC is planning to outsource the collection work of taxes and charges to a private company to increase the collection rate and enhance efficiency. The tendering process has been completed and a three-year contract is supposed to start. The outsourced work includes 1) Renew the household collection database, 2) update the software system, 3) collect tax and charge, 4) setup the on-line help desk, 5) arrange the SMS system for payment activities, 6) meter reading of water user charge and 7) collection of Holding tax, trade license fee, water user charge. Payment to the contracted agency will be made based on the amount of collected revenue, and hence, a significant improvement in collection rate and amount is expected. This will also pave the way for systematized billing and collection when the program of full metering is achieved.

The Management Information System (MIS) in a water and wastewater utility is typically a computer-based system that provides the ULB managers with the tools for organizing, evaluating and running their utilities effectively and efficiently and giving information that they need to make timely decisions. It has several components like the hardware, the software, the database or data resources or information, the procedures or data support systems and the people, and is distinct from other information systems in that it basically aims at decision making that include physical, financial and human resource management, resource planning, project management, performance management, customer relationship management, procurement etc. apart from data retrieval. Most water and wastewater utilities across the world have an MIS department alongside departments of accounting, finance, management or marketing.

Integrating MIS with Geographic Information System (GIS) helps analysis spatially and decision making easier. GIS stores both attributes and images of various components of the water and wastewater subsector like pipes, valves, reservoirs, manholes, WTPs, STPs and other related/ appurtenant facilities as objects with location coordinates and works as a true model of the system. Water and wastewater GIS is useful in: (i) asset management or storing, managing and maintaining accurate asset records; (ii) planning and analysis or transforming data into actionable intelligence; (iii)) field mobility or getting information into and out of the field; (iv) operational awareness or disseminating knowledge where and when needed; and (v) stakeholder engagement or sharing information with stakeholders. A web-based GIS further integrates the rich knowledge resources of the GIS between the professionals, the workgroups and the stakeholder organizations.

Computerized information and data storage and retrieval has been in place in the JKV in a piece meal and sporadic manner. There is no organized MIS that can provide the managers the data resources or information and at the same time the tools for making decisions. Neither is there in place a GIS linking any database spatially.

RMC has to develop a GIS-based Management Information System (MIS) for its water and

wastewater utilities fully computerizing as much of data as possible – physical, financial, human resources, operation and maintenance, customer connections, customer relations and customer care, complaints and redressal. The MIS should be integrated to a Geographic Information System (GIS), preferably web-based, to facilitate better decision-making and efficient management. While the MIS should be capable of handling the financial and human resources management, the GIS should be capable of handling the physical resources and issues like asset mapping and management, customer connections, customer relations/ customer care and complaint redressal. The implementation of MIS-GIS can also be executed by phase, in tandem with and in support of related reforms and strengthening initiatives.

The overall scope will include the provision of Geographic Information Systems (GIS) support services to create detailed database for RMC using high resolution (0.50 Meters or better resolution) satellite imagery, and overlay all infrastructure data like road, drain, water supply lines, sewer supply lines, over the base maps, in various layers. These databases are to be created using door-to-door household surveys and onsite physical surveying of assets. The master database thus created will be linked to GIS Compatible Web based Management Information System (MIS) to facilitate the process of revenue generation and proper management of assets. It shall also include the following:

- Develop performance indicator for management of core services provided by RMC.
- Preparation of up-to-date large-scale base map of Ranchi using high-resolution satellite imagery and ground based engineering survey techniques. (Existing database (say from UDD and RDA) needs to be integrated as unified Geo-spatial Data with all infrastructure details).
- Interpretation of high-resolution satellite imagery for capturing of building footprints, plot boundary, roads, major landmarks and other visible features.
- Incorporate information of utilities like water supply network and sewerage network (household level), as provided by RMC.
- Property mapping for assessment as per format to be approved by the CEO of RMC, creating updated database of all the properties within RMC jurisdiction.
- Detailed surveys for Water, Drainage pipelines (and sewerage, where it exists) through the conduct of on-site physical surveys as per format to be approved by RMC officials to create the updated database of all assets that includes connection to each household.
- Study, design, develop, configure and implementation of web-GIS based MIS with various modules accessible by RMC staff.
- Maintain data and system up to the completion of the project period and handholding period of six months after completion of the project.
- User training for both technical and end-user training.
- Preparation of Technical/ User Manual documentation.

2). Asset Management Systems

Asset management has the objective of defining and describing the key elements that are essential in

an asset management program for movable and immovable infrastructure; more specifically road networks, sidewalks, water supply, sewerage and drainage networks, pumping, storage, and treatment facilities. While the need for Asset Management is clearly felt, it is equally important to have appropriate management information on asset condition, infrastructure costs and performance, and the consolidated requirements for repairs and maintenance, as well as appropriate maintenance standards.

While the benefits of asset management range across many aspects, some examples of outcomes that can be realized:

- Prolonging asset life and aiding in rehabilitation, repair and replacement decisions through efficient and focused operations and maintenance
- Meeting consumer demands with a focus on system sustainability
- Setting rates based on sound operational and financial planning
- Budgeting focused on activities critical to sustained performance
- Meeting service expectations and regulatory requirements
- Improving responses to emergencies
- Improving the security and safety of assets
- Reducing overall costs for both operations and capital expenditures

Asset management is centered on a framework of five core questions, which provide the foundation for asset management best practices:

1. What is the current state of assets?
2. What is my required "sustainable" level of service?
3. Which assets are critical to sustained performance?
4. What are my minimum life-cycle costs?
5. What is my best long-term funding strategy?

The first stage of implementation of an asset management program for municipal infrastructure relies on the essential element of inventory. The location of all the available assets has to be mapped. For each element in each category of infrastructure it is fundamental to know all about as mentioned bellow:

(i) Available assets

(ii) Location of asset

(iii) Age of asset

(iv) Quantity/value of asset

(v) Physical characteristics of asset

Infrastructure assets include all movable and immovable equipment, properties including but not restricted to sectors like water supply, drainage, sewerage, solid waste management, roads, street

lighting etc. Unlike other assets of the municipal corporation, these assets undergo constant use, wear and tear, addition, repair etc. This correspondingly changes their values and hence a constant value updating is necessary.

The water supply assets basically comprise of all the assets from the headwork's, treatment plant, sump, transmission mains, pumping mains, feeder mains, distribution mains and sub mains, including all valves, connections, meters and all related facilities for the efficient delivery service of water. There are also different types of fixtures related to the intake from groundwater, viz. bore wells, public taps open wells hand pumps, OH tanks.

Ranchi does not have any sewerage system at the moment and the sanitation is through septic tanks and low cost sanitation units. RMC owns public conveniences and Pay & Use toilets in the city. More examples of assets include land and buildings which are of both types - remunerative assets and non-remunerative assets. Lands owned by RMC are of different types such as parks and play fields for recreation, burial and cremation grounds etc.

A long-term solution to Ranchi's perennial and expensive problem of maintaining the physical components of the water supply and drainage system – such as pipes, valves, tanks, pumps, wells, hydrants, treatment facilities, transmission mains and distribution lines – is putting in place an Asset Management Plan.

The maintenance of drainage system is a big problem compared to the maintenance of water supply mains and networks. Adding to this is the admission that RMC has limited information as to the sizes, types, material and year of installation. As-built drawings are also scarce, as many of the lines are old, or have been laid out at different periods of time, under different projects and schemes. Considering that assets lose value over time as the system ages and deteriorates, O&M costs increase affecting customer service quality and without asset management, RMC may be faced with excessive costs that it can no longer afford.

Asset management is a core utility standard that underlies everything a water or wastewater system does. The goal of RMC's asset management plan has to be in meeting a required level of service in the most cost-effective way through the creation, acquisition, operation, maintenance, rehabilitation, and disposal of assets. RMC should care about managing its assets in a cost effective manner because (i) the assets represent a major public investment; (ii) well managed infrastructure is important to economic development, public health and safety of the City; (iii) the utility assets are expected to provide an essential customer service; (iv) it guides the managers to make better decisions on when it is most appropriate to repair, replace, or rehabilitate particular assets by developing a long-term funding strategy; and (v) it ensures the long-term sustainability of the water or wastewater utility.

The knowledge of RMC's assets and user connection will avoid the costly pitfalls of emergency repairs and breakdown maintenance. It will ensure preventive, corrective and reliability-centered maintenance, prioritize timely rehabilitation and replacement of old and unusable assets, achieve maximum return on assets in terms of value and cost, and maximize service to the customers. Digital

asset maps of the water, sewerage and drainage system that are integrated to the Geographic Information System (GIS) further add value to the system by enabling spatial analysis.

3) Customer Care Services

The objective here is to ensure that the customer and their complaints are handled more professionally and effectively, to meet and exceed customer expectations leading to higher customer satisfaction.

The foremost task is to prepare water supply and sewerage specific 'Citizens' charter' which represents the commitment of RMC towards standard, quality and time frame of service delivery, grievance redress mechanism, transparency and accountability. This has to be done by letting people of Ranchi know the mandate of RMC, how one can get in touch with the concerned officials, what to expect by way of services and how to seek a remedy if something goes wrong.

Simultaneous action is needed in devising a system to resolve customer complaints. This will require study and evaluation of the existing public relations and complaint handling system and to understand the 'Present', 'Desired Future' and the 'Gaps'. This will include understanding the variety of complaints that are likely to happen and the flow to resolve them. Accordingly, devise systems to handle customer complaints effectively. Next step shall be to design a format that captures all relevant details. Lastly, a simple software shall have to be worked out that helps in logging complaints, is visible to each concerned department at the right stage when attention is sought, records progress at each stage and is also capable of retrieving past records. The system has to be linked to the MIS so that periodic reports get generated automatically for providing important information to management. Also, a link for logging complaints has also to be provided in the system and linked to RMC's website. Devising this system is a consultancy project and its usage monitored for a few months till it requires updation.

For the system to work and deliver the desired results, the staff had to be provided the requisite skills to be able to have customer orientation with desired spirit and enthusiasm and additionally have the skills to operate the system. The staff has to undergo soft skills training that will include:

- team building exercises to work as 'energizers' and to be sensitized that it is 'team work' that leads to results.
- customer expectations/anxieties and the issues that must be addressed patiently to satisfy him/her.
- verbal and non-verbal communication, so that the response elicits higher customer satisfaction

The staff-customer interface will comprise a) understanding customer expectations, b) One-on-one customer interaction, c) communicating effectively, and d) telephone etiquettes.

The staff have to be provided technical training skills so as to-

- develop enough skills in computer usage as per the requirements to handle complaints.
- log in complaints

- communicate while noting complaints
- provide information to public after retrieving from database
- respond when information asked is not available
- conclude leading to higher customer satisfaction
- carry out inter and intra departmental coordination
- generate MIS reports

Further, handling customer queries through the use of this system should result in a) frequently asked questions, b) log of customer concerns, c) manner of handling irate customers and d) details of fire-fighting situations.

(6) Financial Management System (Double Entry Accounting System)

Financial information of RMC is generally incomplete, inconsistent, un-confirmed and un-reconciled.Till recently RMC has been following cash-based single entry accounting system for maintaining the municipal accounts. Accounts were maintained manually. All the limitations of the single entry accounting system were prevailing in the current scenario. Revenue and capital items were not distinguished. Receivables, payables, non-cash items of expenditure were never considered. Budgeting was done on an incremental basis and there was no scientific methodology of forecasting both revenue and expenditure. There was no proper system of budget encumbrances for works done at the sanction stage. Hence there has been a regular problem of overshooting the budget cap and requests for re-appropriation of the funds were normal. There are no consolidated asset records in place. Information in regard to various assets is scattered. The accounts department is working merely as the final bill approval authority and cheque issuing authority. No finance functions per se are handled by the department. The pay-roll accounting and the stores/inventory are outside the accounts department. The Accounts section did not have information about the demand by Holding Tax section, Market section, License section and Engineering sections.

To carry out a rapid assessment of the financial situation of RMC, identify areas of intervention, and support RMC in implementation of identified intervention; Additionally, municipal reforms are mandatory under the JNNURM. These reforms comprise of:

- Adoption of a modern, accrual-based, double entry system of accounting;
- Introduction of a system of e-governance using IT applications, GIS and MIS for various urban services;
- Reforms of property tax with GIS, and arrangements for its effective implementation so as to raise collection efficiency to 85 percent;
- Levy of reasonable user charges, with the objective that full cost of operation and maintenance is collected within seven years;
- Internal earmarking of budgets for basic services to the urban poor; and
- Provision of basic services to the urban poor, including security of tenure at affordable prices.

Goals of the financial reform is to develop a municipal city accounting manual for Ranchi; improve resource mobilization and creditworthiness in RMC; and introduce and implement double entry accrual based system and improved financial management in RMC. The components of such reforms included improving organization structures, financial management systems and working out ways for revenue enhancement from own resources. Also, it is required to train the staff of RMC to continue to work independently on their own on the customised software after the exit of the consultants.

Strategy used to achieve the desired goals will include:

- Review of functions and structure of revenue and accounts department of RMC;
- Rapid municipal financial appraisal by review of existing financial management system including analysis of financial records and statements to know about past revenue and expenditure trends of RMC;
- Identification of areas of intervention through consultative process with administrative and elected officials of RMC, and other stakeholders including community to decide on the process/short term action plan, to identify menu of potential short-term interventions required to strengthen revenue base and expenditure management of RMC ; and
- Support to RMC for implementation of the action plan by providing handholding support to RMC for a period as shown in Figure 4.1.4 (organization strengthening action plan), and also providing training to staff on the developed software.

A team of a national consultant and local consultant have to be appointed to carry out the following activities:

- Review and assessment of the financial situation with respect to introduction of double entry accounting;
- Review of the current situation with respect to financial management and new areas of improvement with regard to expenditure management, cash management, receivables management, budgeting, costing of services, internal controls, maintenance of asset registers, auditing, and other operational aspects of financial management identified;
- Modern accrual-based, double entry system of accounting (DEAS) which is mandatory requirement under the Municipal reforms under JNNURM to be introduced and implemented at RMC.
- Training to officials of RMC. They are to be given thorough training on accrual based system of accounting and Tally 9.0, etc. As a part of capacity building organize a five-day study tour for key employees of Ranchi Municipal Corporation to Ahmadabad or Surat Municipal Corporations. A new DEAS cell to be formed in RMC and dedicated staff members designated to that cell to independently do the accounting entries for the year 2014-15.

The factors of success will depend on continuous monitoring and good support and active participation of officers and staffs of various departments like finance & accounts, cash, audit,

engineering, property tax, vehicle, market, license of RMC along with CEO and Dy. CEO; Also, appointment of good national and local consultants will contribute to the strengthening of RMC.

(7) Tariff Setting and Control

1) Water and Sanitation Tariff Setting

Tariff Structure Development: To ensure the efficient and sustainable delivery of water and wastewater services, water pricing should be based not only on the financial costs involved in producing and delivering services but also on economic, environmental and pro-poor principles. Without the balance of these factors, tariff is not going to be reflective of all costs, leading to rates set below the level of cost recovery and without consideration of a rate of return on capital. This often leads to a serious lack of preventive maintenance and requires significant subsidies for both investment and operation.

Historically both water and sewage tax against each house connection in RMC is charged separately as a percentage of the property tax against the house. The property tax, in turn, is fixed on the basis of unit-area method. While the water tax is levied at 0%, 7.5% and 12.5% (12.5 % for those with connection, 7.5 % for those households with no connection and nil from those drawing water from hand pump/post) of the assessed annual rental value of property tax, the sewage tax is levied at 7.5% of the same assessed annual value. These rates are flat and not based on volumetric consumption or other required parameters of economic principles of tariff setting.

A parallel exercise has been initiated under the Ranchi Municipal Corporation Water supply regulation No. 183 dated 01.06.2013 for those registering their property with RMC. Per kiloliter unit rates have been set for individual households, Institutional establishments, commercial establishments and industrial establishments. However, the basis for setting water supply and sewer tax rates or values in RMC remains unclear. But what is clear, however, is that the minimum expenditure requirements to cover for operation and maintenance of water supply and sewer services are not being met.

It is worth noting that metered water connection is not mandatory and only voluntary for the residents of Ranchi.

Existing pricing reforms on water and sewerage in India and few other similar utilities in Asia should be examined to have a better basis of setting tax rates or values for water and sewerage for RMC. The former will include reviewing the institutional, legal and regulatory frameworks under the national and state levels and ensure its alignment with the local level.

Consideration in the development of the tariff structure should be appropriate pricing and alternative tariff structures, such as, but not limited to any of the following models -single part variable or fixed tariff structures, linear uniform volumetric tariff structures, two-component volumetric tariff structures, volumetric increasing block tariff structures. Further narration on the subject is detailed in chapter V – economic and financial evaluation.

The tariff structure will have to be implemented in phases as RMC moves forward in meeting its cost recovery targets also in a phased manner while making service quality improvements felt on the level of each customer. In addition, the tariff structure will have to include the implementation plan for 100% metering now in the works under JNNURM. The development of the tariff structure shall also have built-in participative and consultative processes to ensure that principles of acceptability and affordability are balanced with economic efficiency in the use of resources, and financial sustainability to maintain and replace system in the long term and full cost recovery to operate and maintain in the short term.

The necessity exists for a "higher" body with the inherent function of: (i) regulating the sustainable and judicious management, allocation and utilization of state and/ or municipal-level water resources; (ii) establishing water and sewerage tariff systems and guidelines that take into consideration appropriate cost recovery schemes applicable to the utility.

Current and proposed tariff of water and sewerage services are presented in the Table 4.1.8 and Table 4.1.9 respectively.

Table: 4.1.8 Current and Proposed Tariff Structure for Water Supply

(Unit: Rs./kl.)

Category	Current	Proposed		
	Rs. Per kl.	2014-2016	2017-2019	2020 onwards
General households	6.00	6.00	9.00	12.00
Institutional / Government	10.00	10.00	15.00	20.00
Commercial establishments	15.00	15.00	22.50	30.00
Industrial – S.S.I. Units	15.00	15.00	22.50	30.00
Industrial – All others	20.00	20.00	30.00	40.00

Source: JICA Study Team

Table: 4.1.9 Current and Proposed Tariff Structure for Sewerage Services

(Unit: RS./kl.)

Category	Current	Proposed	
	Rs. Per k.l.	2014-2019	2022 onwards
General households	-	-	7.20
Institutional / Government	-	-	12.00
Commercial establishments	-	-	18.00
Industrial – S.S.I. Units	-	-	18.00
Industrial – All others	-	-	24.00

Source: JICA Study Team

Further narration on the subject of tariff for water supply and sewerage is detailed in Chapter V – Economic and Financial Evaluation.

2) Revenue Collection

Tariff reforms by RMC are of crucial importance, not only to bring in a commercial orientation, but also as a prerequisite for greater private sector participation in the long term. The general consensus in India is that tariff setting must focus on economic and financial viability, without losing sight of social affordability. The approach paper to the Ninth Five-Year Plan states that "Efforts will be made to enhance the financial viability of the water supply and sanitation sector through policies based on full cost recovery to permit resource mobilization… Subsidies, if required for the poorer sections of the urban society, should be selectively well targeted and transparent…"

Hence, RMC has to ponder and, using the assistance of consultants, find the answer to the following:

- How to establish a transparent structured mechanism for fixing the (cost-based) tariff
- How to increase the number of water connections
- What resources are needed to carry out systematic revenue collection
- How to get public consent to: a) get connections, b) pay tariff regularly

The key elements for planning and implementing a robust tariff plan are:

a) Institutionalization of a rational tariff system per user category which is based on metered water supply and sewerage charge proportioned accordingly. The rational tariff system is to include:

- Connection fee
- Non-payment penalty
- Water meter calibration rules – who does it/when is it to be done/how much will it cost
- Water meter tampering penalty
- Groundwater charges
- Tanker delivered water charges

b) Endorsement of the prevailing regulation with regards to the water user charges through people's acceptance of mandatory house connection (such as public notification and campaign), based on:

- Willingness-to-pay survey,
- Affordability-to-pay analysis.

c) Promotion of individual/commercial regulated water connection.

- Increase of water meter network;
- Listing every type of user – including parks, public toilets, fire stations, government offices, military offices;
- Management of the central/divisional metering system;
- Computerized management system.

d) Ensuring installation of customer meters, reviewing the existing meter reading system and improving its efficiency.

- Manpower requirement

e) Establishment and operation of invoicing and collection system

f) Preparation and execution of medium-/long-term charge adjustments targeting establishment of financial base (increase in income and progressive decrease in subsidy)

- Possibility of private participation in WTP & PS
- Introduction of revolving fund

g) Defined O&M function

- Management of divisional/zonal O&M teams
- Cost of O&M

h) Possibility of bulk supply (from Kanke, Hatia, and Rukka) being monitored by SCADA (flow rate, pressure, pumping)

(8) Outsourcing:

Though it may be too early to be implementing the outsourcing plan but it is the right time to be creating such a plan. As part of its evolution, RMC when preparing its business plan, has also got to put thought on the subject of outsourcing. There is a need to study and evaluate possibilities of outsourcing specific functions. Outsourcing 'function specific PPP' is an option for RMC to bring in better management of services and reducing the financial burden.

A few possibilities are: commercial management (metering, billing and collections), network efficiency (NRW/leak detection and repair), data centre management, network management, Human resource development, customer care, and IEC campaigns.

4.1.3 Organizational Strengthening Action Plan and Schedules

As described in Subsection 4.1.2, it is proposed that an organizational strengthening action plan consisting of the following tasks be implemented:

1) Setting of Policy, Rules and Regulations
2) Establishment of WSSW
3) Establish administration system of WSSW
4) Development of a Business Plan
5) Improvement of Financial Management System
6) Water and Sanitation Tariff Setting and Revenue Collection
7) Management Information System
8) Asset Management System
9) Customer Services
10) Outsourcing

The contents of the above tasks are presented in Table 4.1.10. The proposed schedule of the action plan is presented in Figure 4.1.4.

Table 4.1.10 Proposed Organization Strengthening Action Plan (1/3)

1. Setting of Policy, Rules and Regulations		
	1.1	Establish Regulation and Fund allocation
		- Development of institutional re-organization plan and phase-wise road map for its implementation
		- Costing (costs and cost-saving implications) of institutional development plan
		- Projection of funds to be mobilized on rolling plan basis
		- Identify structure, powers and resources needed to create sustainable and effective fund.
	1.2	Establish accountability mechanisms
		- Establish a sound accounting practice and systems to manage available resources
2. Establishment of WSSW		
	2.1	Institutional and organizational set up WSSW
		- Review of institutional options for creating functional autonomy in city-level RMC's WSSW operations.
		- Assist RMC in Independent operations - Creation of Water Supply and Sewerage Wing (WSSW)
	2.2	Transfer of authority, functions and assets from DWSD
		- Development of phase-wise road map for its implementation
3. Establish administration system of WSSW		
	3.1	Establish Project Steering Committee and PIU
		- Help in establishing
		・Project Steering Committee
		・Project Implementation Unit (PIU)
		- Assist in preparation of bidding documents compliant with latest standard bidding documents
		- Design qualification criteria which is compliant with donor guidelines.
		- Assist PIU staff in developing contract packaging and procurement time schedules for each contract package
	3.2	Formulate Administration system incl. decision making
		- Analysis of administrative and structural constraints to functional autonomy such as existing rules and regulations and staffing structure
		- Mapping of staff resources, skills and expertise
		- Define roles and responsibilities for each position
		- Suggest methods / programmes for organizational development
		- Design an incentive system for staff
		- Prepare HRM and HRD plan taking into account futuristic trends and likely technological developments
		- Identify weaknesses in official documentation, procedures and ways to modernize, upgrade and improve it
		- Review and prepare official procedures with emphasis on essential and critical documentation work of department at various levels
	3.3	Develop 'job description' for every position of WSSW
		- Study existing structure and its design for specifically defined various staff responsibilities
		- Assessment of current professional competence of staff at various levels
		- Identification of an integrated core techno-management skills and required knowledge spectrum at various structural layers of organization
	3.4	Establish Performance Management System for WSSW staff
		- Develop monitoring and evaluation indicator and criteria to assess performance at various levels
		- Establish Performance Management System for WSSW staff
	3.5	Implement recruitment at various positions
	3.6	Develop and conduct Training Plan for WSSW staff
		- Carry out Training Needs Assessment (TNA)
		- Prepare course / training curriculum and syllabus
		- Develop, facilitate, execute and implementation of rolling staff training programme covering all categories of staff
		- Identification of skill and operational requirement of field staff with priorities for phased training programmes and challenges linked
		- Identification of training needs and preparation of training plan, including technical, accounting and management training
		- Identification of training requirements for usage of IT applications and infrastructure implemented
		- Evaluation and mid-course assessment of imparted training to apply corrections.
		- Arranging/ contracting of training institutes, trainers, training modules
		- Plan and organize regular training events, including workshops and seminars for sharing lessons learnt

Source: JICA study team

Table 4.1.10 Proposed Organization Strengthening Action Plan (2/3)

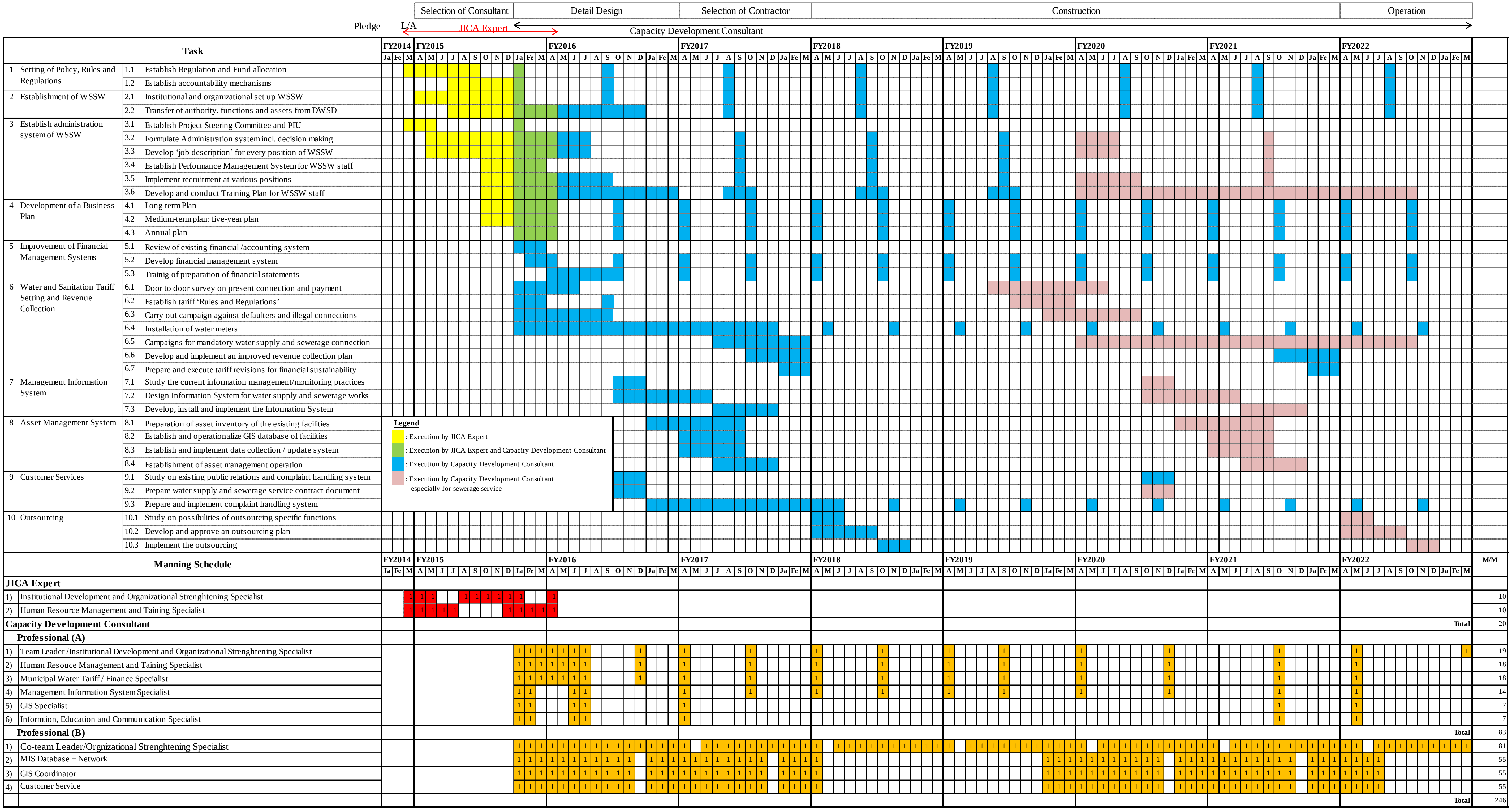
4. Development of a Business Plan		
	4.1	Long term Plan
		- Assist RMC in Development of a Business Plan
		・Assessment of present water supply operations
		・Planning Framework
		・Implementation and Handholding Support
		- Study and update water demand projection and wastewater discharge for various end-user groups
	4.2	Medium-term plan: five-year plan
		- Prepare financial projections for operations 10 years after project completion;
	4.3	Annual plan
		- Train staff in the preparation of annual budget estimates and disbursement plans;
5. Improvement of Financial Management Systems		
	5.1	Review of existing financial /accounting system
		- Study existing financial state / scenario w.r.to :-
		・Last five year spending.
		・Authority, delegation, financial powers and procurements.
		・Financial resources to meet present and futuristic targets.
		・Financial mechanisms, accountability system and regulatory controls.
		- Study budgeting allocation of previous years for its financial analysis linked with business planning.
		- Assess existing methodology and mechanism for financial reforms in accordance with State /Center rules and regulations.
		- Assessment of professional experience and skill of concerned staff in financial aspects.
	5.2	Develop financial management system
		- Develop financial management system (in relation to asset management system, establishment, operational costs, revenue collection etc.)
		- Assist in capacity building of staff for the improved financial management systems (Double Entry Accounting System)
		- Strengthening, restructuring and capacity building of RMC, for its assessment and integration with present and proposed financial outlook.
		- Develop budgetary control processes, design budget procedures and budget formats;
		- Develop mechanisms for the transfer of funds
		- Review the financial management system of agencies involved in the program and make recommendations for optimal integration.
		- Direct & advise on the establishment of an efficient billing & collection system.
	5.3	Trainig for preparation of financial statements
6. Water and Sanitation Tariff Setting and Revenue Collection		
	6.1	Door to door survey on present connection and payment
		- Facilitate and assist PIU in carrying out door-to-door survey to collect data and prepare report on –
		・Status of installed water meters
		・Illegal and unauthorized connections
		・Other water connections (non-revenue generating)
		・Present revenue system (meter reading, billing, revenue collection…etc.)
		- Train staff in data collection; oversee the collection of data for baseline & completion surveys and prepare reports accordingly.
		- Assist the PIU with the invitation and selection of NGOs to be involved in the surveys
	6.2	Establish tariff 'Rules and Regulations'
	6.3	Carry out campaign against defaulters and illegal connections
		- Prepare Awareness campaign on the need for and application of user charges for improved urban services,
		- Prepare Information, Education and Communication (IEC) materials and media campaigns, advertisement clippings, Web pages, etc
	6.4	Installation of water meters
		- Build stakeholders' awareness on the long-term benefits and short-term inconvenience in order to gain full support of the beneficiaries.
	6.5	Campaigns for mandatory water supply and sewerage connection
		- Provide continuous guidance on suitable mechanisms for participatory interaction with and training of local government and CBOs;
	6.6	Develop and implement an improved revenue collection plan
		- Prepare annual reports on performance and impact of community participation and development activities.
	6.7	Prepare and execute tariff revisions for financial sustainability
		- Assist RMC with water and sanitation tariff setting and revenue collection reforms
		- Support for preparation of rules and regulations for periodic review of tariff, as may be required
		- Preparation of water tariff determination manual with tariff norms and principles.
		- Review cost recovery policies and tariff levels including:
		・Cost-recovery mechanisms (including necessary institutional arrangements) through taxes, user charges and/or other techniques
		・Tariff structure taking into account affordability, willingness to pay, water conservation, cross-subsidization, and full cost-recovery requirements

Source: JICA study team

Table 4.1.10 Proposed Organization Strengthening Action Plan (3/3)

7. Management Information System		
	7.1	Study the current information management/monitoring practices
		- Assess the quality and completeness of data gathered and its use by all MIS implementers, communities and management;
		- Study existing Data Base management and Information system of RMC.
	7.2	Design Information System for water supply and sewerage works
		- Design MIS for water supply and sewerage works
		- Assess and propose MIS procedures, indicators, and reports;
		- Draft a conceptual design of the MIS program
		- Establish an Performance Monitoring System
		- Prepare a framework for continuous monitoring and feedback mechanism
	7.3	Develop, install and implement the Information System
		- Develop, install and pilot test the MIS operations
		- After MIS conceptual design is implemented, make periodic visits to all stakeholders to discuss MIS procedures
		- Mobilize local NGOs and community organizations in carrying out monitoring, quality control and reporting to bring transparency.
		- Prepare manual for MIS operations
8. Asset Management System		
	8.1	Preparation of asset inventory of the existing facilities
		- Implement data collection / monitoring system of water supply and sewerage network and at WTP/STP facilities
		- Preparation of the details of assets of the existing water supply and sewerage facilities and clarification of ownership and asset evaluation
	8.2	Establish and operationalize GIS database of facilities
		- Establish and operationalize GIS database of water supply and sewerage facilities
		- Develop & prepare comprehensive and efficient IT support system for infrastructure planning & management
		- Interpretation of available satellite imagery for use and establish coordination with Satellite and Imagery Department of DRDO / Private sector
		- Develop IT based mapping of network and associated Data Base
		- Assist RMC with GIS technology to identify and work out effective land use
		- Introduce methodologies and advise training of staff on technology and use of GIS and its applications
	8.3	Establish and implement data collection / update system
		- Study and assess available resources to collect/update information related with assets evaluation / management
		- Assess adequacy of funds for objectively determined 'Asset Management'
	8.4	Establishment of asset management operation
9. Customer Services		
	9.1	Study on existing public relations and complaint handling system
		- Study and evaluate the existing public relations and complaint handling system
		- Implement the improved public relations strategy and 'complaint handling system'
	9.2	Prepare water supply and sewerage service contract document
		- Develop and implement specific measures to ensure participation of vulnerable groups, including women and the poor.
		- Prepare water supply and sewerage service contract document
	9.3	Prepare and implement complaint handling system
		- Design a complaint handling system using MIS
		- Invite feedback from beneficiaries and advise RMC of how these might influence the future
		- Prepare complaint handling system manual
10. Outsourcing		
	10.1	Study on possibilities of outsourcing specific functions
	10.2	Develop and approve an outsourcing plan
	10.3	Implement the outsourcing

Source: JICA study team



Source: JICA Study Team

Figure 4.1.4 Proposed Schedule of Organization Strengthening Action Plan

CHAPTER V ECONOMIC AND FINANCIAL EVALUATIONS

5.1 Evaluation of Water and Sewerage Tariff System

In this sub chapter, overall environment for tariff setting is described. Firstly, the recommendation of responsible ministry is described regarding the water tariff. Secondly, the present tariff system of RMC and other Indian cities are compared to understand the general acceptance level of local users for water and sewerage tariff. Then, the willingness to pay and affordability to pay (ATP) of sewerage charge is estimated based on the conducted social survey result in this study to know the possibility of future tariff increase in Ranchi city.

5.1.1 Recommendations for Tariff Setting for Water Supply Service by the Responsible Ministry

The basic principle of water tariff setting is stipulated in the report issued by the Ministry of Urban Development in 2010, called the "review of current practices in determining user charges and incorporation of economic principles of pricing of urban water supply".

In the report, the following are stipulated as recommendations for future tariff setting:

- Minor tariff revision should be conducted every year (inflation, etc.) to cover deficit. Periodical revision should be done once in three years. (Page 74)
- In the short run, tariff should be based on full recovery of O&M cost and reasonable return on investment. In the long run, tariff should move towards recovery of full cross and gradual reduction of subsidies and cross subsidies. (Page 75)
- Non-domestic users should be charged by consumption. The Increasing Block Tariff (IBT) System can be adopted to promote economic efficiency. (Page 77)
- Domestic users should be charged through the IBT System (Page 77) (such as, "lifeline category" 5-10 m^3, "normal category" 11-25 m^3, "high consumption category" 26 m^3).

The proposed items are generally adopted for tariff setting in other countries, and the future tariff plan of the Ranchi Municipal Corporation (RMC) is conducted based on the above recommendations.

5.1.2 Present Water and Sewerage Tariff System in Other Indian Cities

(1) Outline of the Present Tariff System Water and Sewerage Services in Other Indian Cities

The tariff system and its coverage rate of O&M cost in Ranchi and the other six major Indian cities are summarized in Table 5.1.1.

Table 5.1.1 Present Tariff System of the Main Cities in India

City	Tariff System	Coverage Rate of O&M Cost	Charge for Domestic	Charge for Industry	Sewerage Charge
Ranchi (2014)	Linear uniform volumetric or fixed tariff	22% (2012)	Rs.6/m^3	Rs.10–15/m^3	None
Ahmedabad (2010)	Fixed Rate	60–65% of O&M cost (2008-09)	30% of Property Tax		None
Chennai (2010)	Increase Block Tariff (2 parts)	O&M cost full recovery	Rs.2.5–25/m^3	Rs.35–80/m^3	25% of water charge
Bangalore (2010)	Increase Block Tariff (2 parts)	O&M cost full recovery	Rs.6–36/m^3	Rs.51–60/m^3	Rs.15 (less than) or 15%–20% of water charge
Raipur (2010)	Ferrule Based Fixed Rate	34% of O&M cost	Rs.2/day	Rs.4.90–130.0/day depends on size of connection	None
Hyderabad (2011)	Increase Block Tariff (2 parts)	n.a.	Rs.7–40/m^3	Rs.20–100/m^3	35% of water charge
Delhi (2014)	Increase Block Tariff (2 parts)	34% of O&M cost (1996-97)	Base Rs.67–266/month + consumption Rs.2.7–33.3/m^3	Base Rs.532–1198 /month + consumption Rs.13.3–133.1/m^3	+ 60% of consumption charge

Source: (Data in 2010) Table 4.10 of the "Review of current practices in determining user charges and incorporation of economic principles of pricing of urban water supply", Ministry of Urban Development, 2010, (Data during 2011-2014 and sewerage charge) Homepage of each Water Service Provider

As can be observed, the tariff system of water and sewerage services varies in each city as there was no specific guideline, and the final decision is made by the mayors of each legislative city.

Out of the six cities, full recovery of O&M cost of water supply service was achieved in Chennai and Bangalore, the other four cities have earned only 30-60% of the O&M cost.

The consumption charge of the IBT system is mainly adopted in these cities except for Ahmedabad and Raipur. The water charge for domestic users starts from a small amount at approximately Rs.6-7/m^3 considering the affordability to pay by users living under the poverty condition, and the rate increases as consumption increases.

The cost for industrial users is set around three times higher than the price of domestic users so that the major users are financially motivated to minimize consumption. If compared carefully, the price level in Chennai and Bangalore, where the full recovery of O&M cost is achieved, the tariff level is set higher at around Rs.35–80/m^3. It implies that the significant amount of cross-subsidy from industries to domestic users is implemented, and it contributes to improve the financial condition.

The sewerage charge is levied in Hyderabad and Delhi in proportion to the water charge.

(2) Characteristics of the Present Tariff in RMC

Comparing the present tariff system of RMC with that of other cities, the minimum tariff rate for domestic users (Rs.6/m^3) is set around the similar level as other cities, and the present tariff level is retained at reasonable level for users, as it will be explained in the later part of this chapter.

The ITB system is generally adopted in India, and its introduction to RMC's tariff system should be considered. The introduction contributes saving the wastage of water, as well as increasing the total revenue of water charge.

The rate for industrial users (Rs.10 or 15/m^3) is set lower than other cities. In comparison of the tariff rate for industrial sector with the one for domestic users (Rs.6/m^3), the rate is set at 166% or 250% higher. This proportion rate is smaller than the other cities, and hence, there may be a possibility to hike the rate in order to increase the cross-subsidy and improve the financial condition of RMC.

5.1.3 Willingness to Pay and Affordability to Pay of Users and Present Tariff Level

In this chapter, the willingness to pay and affordability to pay of users on sewerage charge is estimated based on the social survey conducted by the Japan International Cooperation Agency (JICA) Study Team. Secondly, the present tariff level is compared to evaluate the financial capacity of users.

(1) Willingness to Pay

In this study, the interview survey was conducted to 120 samples. The average of willingness to pay for the monthly charge becomes Rs.37.6/month/household. The annual amount is Rs.451.2/year/household. The willingness to pay for the connection charge is also questioned, and the result becomes Rs.418.7/household.

Table 5.1.2 Willingness to Pay the Monthly Payment on Sewerage Service

Range of Payable Amount	Number of Respondents	Weighted Average
Less than Rs.20	20	Rs.37.6/household
Rs.20-40	31	
Rs.40–60	22	
Rs.60–80	6	
Rs.80–100	5	
More than Rs.100	1	
Total	**85**	

Note: Weighted average is estimated assuming that the respondents chose the middle number of the range, Rs.10, 30, 50, 70, 90, and 100/month, as the answer in each range of answers.
Source: JICA Study Team

Table 5.1.3 Willingness to Pay the Connection Charge for Sewerage Service

Range of Payable Amount	Number of Respondents	Weighted Average
None	2	Rs.418.7/household
Less than Rs.100	25	
Rs.100–500	20	
Rs.500-1,000	30	
More than Rs.1,000	6	
Follow the Regulation	2	
Total	**85**	

Note: Weighted average is estimated assuming that the respondents chose the middle number of the range, Rs.0, 50, 250, 750 and 1,000/month, as the answer in each range of answers.
Source: JICA Study Team

(2) Affordability to Pay (ATP)

Several international donor agencies recommended that the real sewerage charge should not exceed the ATP. Referring to the Guideline of economic analysis of JICA (JICA methodology of economic analysis for master plan survey - wastewater category), the International Bank for Reconstruction and Development (IBRD) set the ATP at 1.0% of disposable income, and the Pan American Health Organization (PAHO) set it at 1.5% of the total household income.

In this study, standing on the conservative side, the ATP is set at 1.0% of total income of users. From the social survey result, the average and median household income became Rs.33,104/month and Rs.16,000/month, respectively. Therefore, the ATP is calculated to be Rs.331/month/household.

Basically, the willingness to pay for sewerage service will be increased as the knowledge of users about the service deepens, and comes close to the ATP amount. The present willingness to pay amount is only 11% of the ATP amount, and further enlightenment of the users on the potential benefit of sewerage service is necessary for smooth project implementation.

(3) Justification of Expected Sewerage Tariff Level

In general, the sewerage charge levied is incorporated to the water charge in many countries. The multiplied coefficient figure which is multiplied on the water charge can be set at approximately 30-60% as considering the acceptance level of users. People tend to pay more

on water than sewerage as they need water to live. Therefore, the sewerage tariff is mostly set lower, and the collected amount is sometimes not enough to cover the total cost for sewerage service. In such cases, the cross-subsidy from water service to sewerage service has taken place in many cities.

From the present tariff system for water service, the customers are charged by consumption basis or fixed tariff basis. In consumption basis, if the average household with five members consumes 135L/c/d, the monthly tariff becomes Rs.122. In fixed tariff basis, the minimum monthly tariff for houses with less than 100 m^2 built-up area is Rs.200/month.

In the conducted social survey, 19 out of 120 surveyees (16%) answered the water charge expenditure. The average water tariff amount of the above answers became Rs.231/month/household.

If the sewerage charge is levied at 60% of water charge, the sewerage tariff can be around Rs.73 to Rs.139. Comparing this amount with the estimated ATP amount at Rs.331/month, the present tariff level is set at the acceptable level of users, and could have much potential to be increased.

5.2 Financial Evaluation of the Project

In this section, the appropriate tariff level in the future is analyzed by predicting the revenue and expenditure related to water supply and sewerage services.

The tariff level is set in alternative cases based on the different increase rates on the present tariff. The revenue and expenditure were calculated including the present roles of both RMC and the Drinking Water and Sanitation Department (DWSD) of water supply and sewerage services. The estimated recovery rate of O&M cost (and total cost) is shown as a result of the future financial prediction based on the assumptions made by the JICA Study Team.

5.2.1 Basic Assumptions of the Calculation

The analysis was conducted based on the assumptions discussed below.

1) Target of the Tariff Setting

   The target of the tariff setting is to achieve the full cost recovery of O&M cost in middle term, and full cost recovery of the total cost (O&M cost and capital cost).

2) Evaluation Period

   The evaluation period is set until 2035, as the JICA Study Team defines the middle term as 10 years and the long term as 20 years.

3) Inflation

   Influence of inflation is not considered in the calculation. As stipulated in the regulation of RMC, the tariff level is revised every three years corresponding to the CPI figure, and

the increase in O&M by inflation is supposed to be offset by its tariff revision.

4) Revenue and Expenditure

The revenue and expenditure of water supply and sewerage services are calculated including the present roles of RMC and DWSD. The water service in the whole Ranchi City is considered. Regarding the sewerage service, the revenue and expenditure in Zone 2 are only considered, and the service in other area is excluded from estimating as its difficulty of forecasting.

5.2.2 Revenue Prediction

Owing to the lack of manpower in the revenue department and water board of RMC, the present condition of facilities and water supply could not be sufficiently studied. Firstly, the consumption amount is not clear as the metered rate is quite low (only 16% of end users, from Appendix A2.4). The condition of water use in Ranchi City has not been studied, and the number of users of private wells, free public wells/stand posts, and illegal connections is not known. Under such situation, the revenue forecast is conducted based on the following rough assumptions:

1) Population

The number of individuals in the population follows the estimation prescribed in Table 4.1.4.

2) Consumption per Capita

The consumption of 135 L/c/d is applied.

3) Water Consumption of Institutional Users and Industrial Users

The domestic consumption for institutional use and industrial use is 4% and 16%, respectively.

4) Collected Rate of Consumed Water

From the evaluation of the present tariff amount, 45% of the whole water demand is assumed to be charged by RMC. Users supplied by private wells (-30%), non-charged users (-15%), and illegal connections (-10%) are excluded from the billing.

5) Coverage Rate of Water Supply Service

Coverage rate of water supply service is assumed to increase at 3% every year from 2018, and will achieve 80% in 2027.

Table 5.2.1 Coverage Rate of Water Supply Service

	2015 -17	**2018**	**2019**	**2020**	**-**	**2023-**	**2024-**	**2025**	**2026**	**2027 -35**
Coverage Rate	50%	53%	56%	59%	-	68%	71%	74%	77%	80%

* The present coverage rate of water supply service is assumed at 50% as estimated by the billed charge amount in 2012-2013.
Source: JICA Study Team

6) Collection Rate of Tariff (Collected amount/billed amount)

Collection rate of tariff (water supply and sewerage service) and tax is assumed to be improved up to 90% in 2022 by the implementation of human development program and outsourcing of the revenue collection work.

Table 5.2.2 Collection Rate of Tariff

	2014	2015	2016	2017	2018	2019	2020	2021	2022-35
Collection Rate of Tariff	50%	55%	60%	65%	70%	75%	80%	85%	90%

Source: JICA Study Team

7) Different Increase Cases in Tariff Rate

Three tariff revision plans are made based on different increase rates on the present tariff level. The increase rates of future tariff under different cases, and tariff rates under each case are shown in Table 5.2.3 and Table 5.2.4, respectively.

The tariff revision is planned to be done two times in 2017 and 2020. The proportion among categories (domestic, institutional, industrial) is retained the same as the present setting.

Table 5.2.3 Increase Rates of Future Tariff Plan in Different Cases

Year	2014–16	2017–2019	2020-
Low Case	Same as present	+25% from present level	+50% from present level
Base Case	Same as present	+50% from present level	+100% from present level
High Case	Same as present	+75% from present level	+150% from present level

Source: JICA Study Team

Table 5.2.4 Tariff Rates under Each Case

Category	Present tariff (Rs./kL)	Tariff from 2017 to 2019 (Rs./kL)			Tariff in 2020 and after (Rs./kL)		
		Low	Middle	High	Low	Middle	High
Domestic Use	6.00	7.50	9.00	10.50	9.00	12.00	15.00
Organization Use	10.00	12.50	15.00	17.50	15.00	20.00	25.00
Commercial Use	15.00	18.75	22.50	26.25	22.50	30.00	37.50
Industrial Use	(S.S.I. Unit) 15.00	18.75	22.50	26.25	22.50	30.00	37.50
	(Other) 20.00	25.00	30.00	35.00	30.00	40.00	50.00

* Impact of inflation is excluded from the tariff table.
Source: JICA Study Team

8) Sewerage Tariff Rate

60% of the water supply tariff is charged as the sewerage tariff from 2022, after the completion of the Project. The tariff rates under three cases are shown in the Table 5.2.5.

Table 5.2.5 Sewerage Tariff Rates of Each Case

Category	Present	2022 -		
		Low	Middle	High
Domestic Use	None	5.40	7.20	9.00
Organization Use	None	9.00	12.00	15.00
Commercial Use	None	13.50	18.00	22.50
Industrial Use	(S.S.I. Unit) None	13.50	18.00	22.50
	(Other) None	18.00	24.00	30.00

* Impact of inflation is excluded from the tariff table.
Source: JICA Study Team

Under the high tariff case, the expected sewerage tariff amount of average household with 5 members who consume 135L/c/d, becomes Rs.182 /month. The said tariff amount is approximately 55% of the estimated ATP at Rs.331/month, and hence, the proposed tariff increase could be socially accepted.

9) Coverage Rate of Sewerage Service

After the completion of the Project, STP starts the operation. The coverage rate of sewerage service is assumed to increase gradually by 6% each year up to 80% after 2031 as the progress of connection and other related construction work out of the project scope.

Table 5.2.6 Coverage Rate of Sewerage Service

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031 -
Coverage Rate	20%	26%	32%	38%	44%	50%	56%	62%	68%	74%	80%

Source: JICA Study Team

10) Revenue of Tax

Billed amount of water and latrine tax is assumed to be the same as fiscal year 2012-13 at Rs.42.5 million. The same collection rate of water and sewerage tariff, shown in Table 5.2.2, is adopted.

5.2.3 Prediction of Expenditure

The capital cost and O&M cost are predicted as described below.

(1) Capital Cost

1) Average Capital Cost

The past capital cost of RMC and DWSD is shown in Table 2.2.12. The amount of capital cost spent each year significantly varies depending on the project budget provided by the central and state governments, and the progress of construction work.

For the financial analysis, the volume of average annual capital cost of Rs.328 million by RMC and Rs.274 million by DWSD are assumed to continue until year 2035.

Generally, the major part of capital cost is provided by the government, and the responsibility of payment to RMC is assumed to be 20% of the whole amount.

2) Addition Capital Cost by the Project

The project cost is shown in former Table 3.7.8. The total project cost of Rs.11,260 million, which excludes the influence of inflation and VAT, will be spent during the life period of constructed facilities for 50 years. To simplify, the annual capital cost is estimated to be Rs.225 million (Rs.11,260 million /50 years) during the evaluation period.

(2) Operation and Maintenance (O&M) Cost

1) Existing O&M Works

The annual O&M cost is assumed to be Rs.433 million, the same as the O&M cost of RMC and DWSD during fiscal year 2012-13 as shown in Table 2.2.12.

2) Cost for the Project Implementation Unit (PIU)

In Subsection 4.1.2 (2), the creation of PIU is recommended during the preparation and construction period of the Project. The PIU should be employed additionally to the existing O&M framework, and its annual labor cost is estimated at Rs.10,965,000 for 39 members (Table 4.1.3). Adding the miscellaneous cost at 50% of labor cost, Rs.16.2 million is added in the estimation in total.

3) Additional O&M Work of the Project

1) Additional Labor Cost

In the proposed organizational plan previously shown in Table 4.1.5, the additional members for water supply and sanitation services is 130 (proposed 184 – present 54 members). As the average annual salary of the group is Rs.362 thousand, and including the 50% for miscellaneous cost (office supply, training, transport cost, etc.), the additional labor cost is estimated at Rs.70.6 million/year.

2) Sewerage Treatment Cost (Project Scope)

The treatment cost is estimated by quoting the average O&M cost provided in the "Performance Evaluation of Sewerage Treatment Plants" issued by the Central Pollution Control Board (CPCB) in 2013. The unit cost for power, repairmen, and chemical cost for the condition assessment survey (CAS) method is as follows;

Table 5.2.7 Treatment Cost of Sewerage Water by CAS Method

Cost Items in the Sewerage Treatment Plant	(Rs. Million/MLD)
(i) Power Cost/MLD (Rs.6.3/kWh, high tension category)	0.479
(ii) Repair Cost/MLD	0.151
(iii) Chemical Cost/MLD	0.610
Total Treatment Cost	**1.240**

Source: JICA Study Team

In case the designed capacity of 86 MLD (design capacity) is treated, the treatment cost will become Rs.107 million. The cost is estimated based on the forecast of treatment

amount previously shown in Table 4.1.4.

3) Electricity Cost for Pumps (Project Scope)

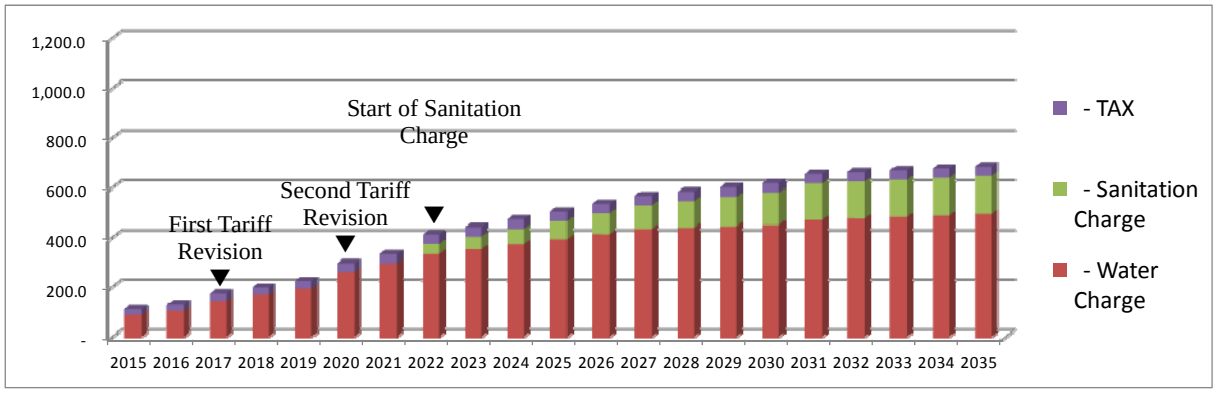
The electricity cost of 16 manhole pumps and 21 pumps at the pump stations is estimated. The working time of pumps are assumed to be 8,000 hours/year for normal operation and 500 hours/year for pumps operated during rainy season. Multiplying Rs.3.7/kWh for manhole pumps (for utility use) and Rs.6.3/kWh (high tension users) for pumps installed at the pump stations, the annual cost is estimated to be Rs.39.7 million/year.

5.2.4 Results of the Financial Analysis

The prediction of revenue, expenditure, and coverage rate is indicated below. The detailed calculation tables of three difference cases are attached as Appendices D1.1 to D1.3.

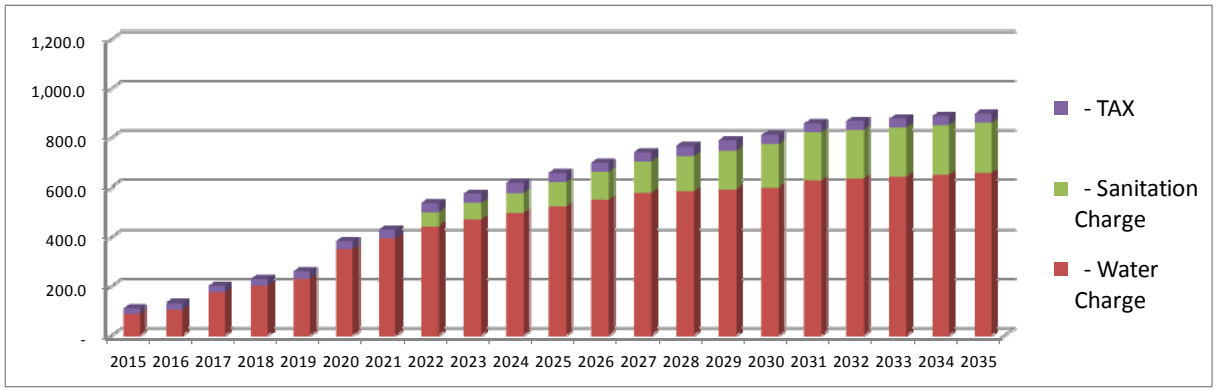
The predicted revenue amounts of three different cases are shown in Figures 5.2.1 to 5.2.3. The water charge will increase after the first and second tariff revisions in 2017 and 2020, and gradually increases corresponding to the increase in population. The collection of sanitation charge starts from year 2024. The tax revenue is assumed to remain the same amount.

Figure 5.2.1 Predicted Revenue Amount of Low Case (Rs. in millions)



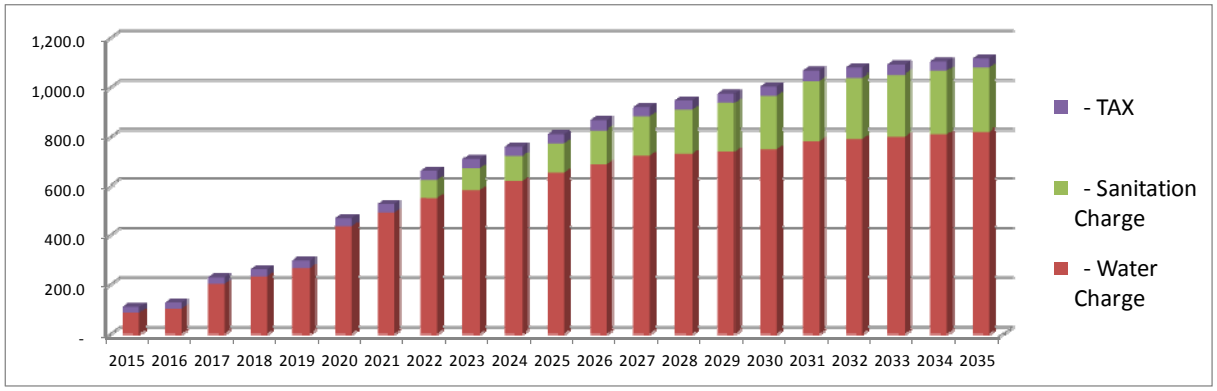
Source: JICA Study Team

Figure 5.2.2 Predicted Revenue Amount of Middle Case (Rs. in millions)



Source: JICA Study Team

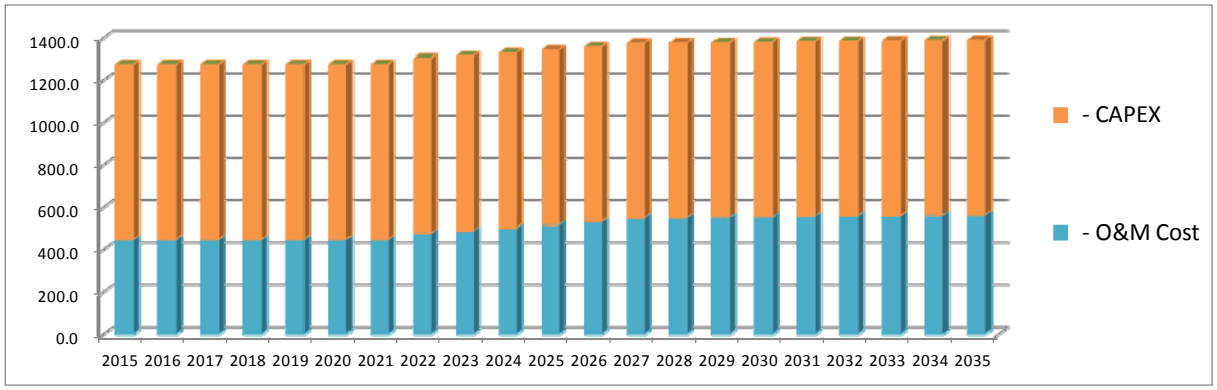
Figure 5.2.3 Predicted Revenue Amount of High Case (Rs. in millions)



Source: JICA Study Team

The expenditure of O&M cost and capital expenditure (CAPEX) is shown in Figure 5.2.4. The O&M cost increases from 2022 as influenced by the start of the sewage treatment plant (STP) operation. The CAPEX amount remains the same during the evaluation period as the amount is assumed to remain flat to simplify the calculation.

Figure 5.2.4 Predicted Expenditure Amount (Rs. in millions)

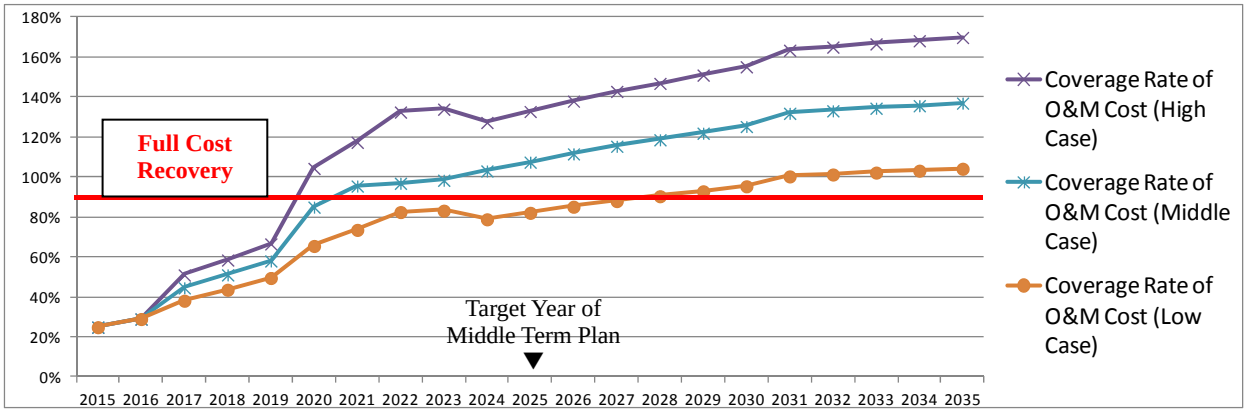


Source: JICA Study Team

Based on the former prescribed assumption the coverage rates of O&M cost and total cost (O&M cost and CAPEX) of both water supply and sewerage services under different tariff cases are calculated as shown in Figures 5.2.5 and 5.2.6.

In 2025, which is the target year of the middle-term plan, full recovery of O&M cost is achieved in the high case and middle case. The coverage rate of high, middle, and low cases is 133%, 108%, and 82%, respectively.

Figure 5.2.5 Coverage Rates of O&M Cost of Both Water Supply and Sewerage Services under Three Tariff Cases

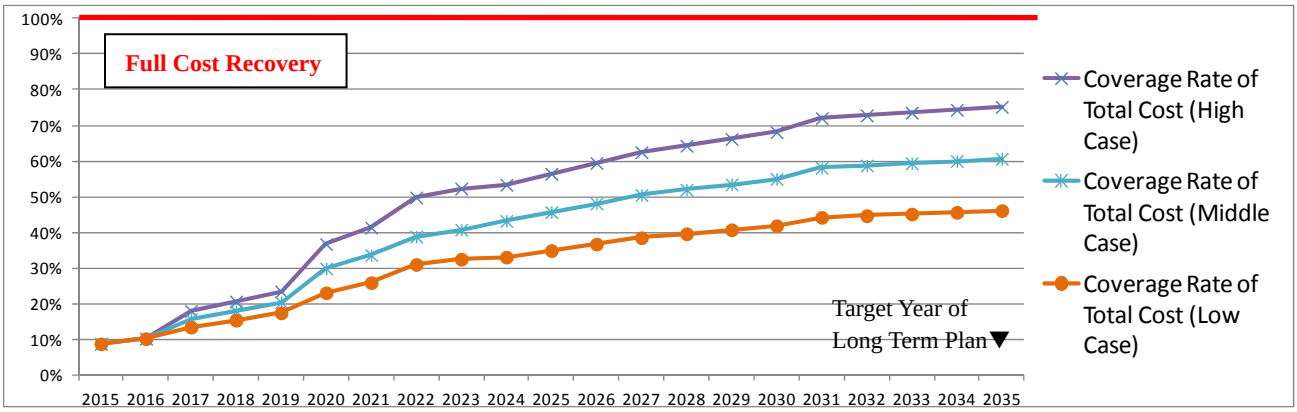


Source: JICA Study Team

Regarding the coverage rate of total cost of both water supply and sewerage services, none of the three cases could achieve the full cost recovery at the target year of the long-term plan in 2035. The coverage rate of the total cost in 2035 becomes 75%, 61%, and 46% under high, middle, and low cases, respectively, under the present assumptions.

It implies the necessity of subsidy on capital cost of the water and sewerage project in India, where the tariff level is retained at a low rate considering the people living under poverty.

Figure 5.2.6 Coverage Rate of Total Cost (O&M Cost and Capital Cost) of Both Water Supply and Sewerage Services under Three Tariff Cases



Source: JICA Study Team

The necessary subsidy rate to achieve the full cost recovery of the total cost is calculated under different tariff cases. The subsidy rate of the whole capital cost should be more than 96%, 70%, and 44% under low, middle, and high cases, respectively. Under low case, almost all construction budget should be granted to RMC by the government for free even in 2035. The assumption under middle case and high case seems reasonable considering the present budget rules, wherein the subsidy amount varies from 80% to 90%, depending on the project.

Table 5.2.8 Necessary Subsidy Rate for Full Cost Recovery of Both Water Supply and Sewerage Services under Different Tariff Cases

Case	Increase Rate of the Tariff	Necessary Subsidy Rate
(1) Low Case	+50% from present tariff level	96%
(2) Middle Case	+100% from present tariff level	70%
(3) High Case	+150% from present tariff level	44%

Source: JICA Study Team

The coverage rate for O&M cost and total cost per each service is shown in the Table 5.2.9 to understand the balance of water and sewerage tariff.
The coverage rate for O&M cost of each service is calculated by the following formula.

"Coverage rate of O&M/Total Cost of water supply service" =
"Revenue from water supply service" / "O&M/Total Cost of water supply service"
"Coverage rate of O&M/Total Cost of sewerage service" =
"Revenue from sewerage service" / "O&M/Total Cost of sewerage service"

The revenue/cost of water supply service and those of sewerage service are estimated based on the following assumptions.

- Revenue of sewerage service includes estimated sewerage tariff and half of TAX revenue.
- Cost of sewerage service includes present O&M cost for sanitation sector (Table 2.2.12), capital cost of the project, labor cost for PIU, sewerage treatment cost, electricity cost, and half of additional labor cost (assumed in chapter 5.2.3(2)).
- The rest of revenue and cost is considered as the revenue/cost of water supply service

Under middle case, the coverage rate of O&M cost of water supply exceeds 100% during whole period, whereas the one of sewerage service exceeds 100% after 2030. The coverage rate is smaller in sewerage service, and it implies the existence of cross subsidy from water supply service to sewerage service especially at the beginning stage of operation of STP until 2030. The subsidy amount is limited, and JICA Study Team believes it as an acceptable level in a society.

Table 5.2.9 Trend of Coverage Rate of O&M/Total Cost under Different Tariff Case

Cost	Service	Low			Middle			High		
		2025	2030	2035	2025	2030	2035	2025	2030	2035
Coverage Rate of O&M cost	Whole (Water and Sewerage)	82%	96%	104%	108%	125%	137%	133%	155%	170%
	-Water Supply	89%	102%	111%	117%	134%	147%	146%	167%	182%
	-Sewerage*	61%	80%	89%	78%	104%	115%	94%	127%	141%
Coverage Rate of Total cost	Whole (Water Supply and Sewerage)	35%	42%	46%	46%	55%	61%	56%	68%	75%
	-Water Supply	40%	46%	50%	53%	60%	66%	65%	75%	82%
	-Sewerage*	22%	33%	38%	28%	43%	49%	34%	53%	60%

.Source: JICA Study Team

5.2.5 Recommendations for Future Tariff Revision

First of all, to have the said financial result, increase in the "service coverage rate" and "collection rate of tariff charge" is inevitable. The implementation of the related technical activities is quite important.

From the result of the analysis, the JICA Study Team suggests to increase the tariff level following the middle case to achieve the target of full cost recovery of O&M cost until 2025. It means that the water tariff rate should be doubled, and 60% of tariff will be added on the said water charge as the sewerage charge before 2025. The said amount excludes the influence of inflation.

Subsequently, if more than 70% of future capital cost is subsidized by the government, the expected revenue can cover the capital cost of RMC until 2035.

As recommended in the former part, the introduction of IBT system and the tariff rate increase of industrial users can support making the financial condition healthier.

It should be noted that this estimation is conducted based on the rough assumptions of service improvement and future capital cost, and the JICA Study Team recommends RMC to conduct the study to make the future technical and financial plans periodically.

If the basic technical condition (service coverage area, supply period, water quality, and water pressure) will be improved by the implementation of the planned activities, the user's satisfaction level is expected to increase by 2025. Then, the user's acceptance level of tariff increase could be widened, and the implementation of further tariff increase could become much easier.

5.3 Economic Evaluation of the Project

In this section, the economic analysis is conducted to evaluate the economic viability of the project. The normal cost-benefit analysis method is applied for the analysis by assuming the conditions of the "With Project" and "Without Project". The result of analysis is evaluated using indicators of the economic internal rate of return (EIRR), net present value (NPV), and benefit/cost ratio (B/C).

5.3.1 Basic Assumptions

The analysis was conducted based on the assumptions discussed below.

1) Assumption of the Project

The construction of STP is completed following the planned schedule. Owing to the mentioned project execution, the living condition in the project area will be improved.

2) Evaluation Period

The evaluation period is set for 40 years which includes 7 years of preparation/construction period from 2015 to 2021, and 33 years after the completion of the project component from 2022 to 2054.

3) Cost of Initial Construction and O&M

The cost of initial construction and O&M is estimated based on the price in June 2014 excluding any tax. Physical contingency is included in the estimated cost, and the price contingency is excluded from the estimates. The conversion factor of 0.9 is applied to the local cost obtained in financial cost to convert to economic cost.

4) Number of Beneficiaries

The number of beneficiaries is estimated by multiplying the forecast of population in Zone 2 and the service coverage rate shown in Table 5.2.6.

5) Viability of the Project

In terms of domestic economics, the project is considered viable if the EIRR exceeds 10%, which means that the NPV becomes positive at a discount rate of 10%.

5.3.2 Economic Cost

The initial investment cost and O&M cost are indicated below.

(1) Initial Investment Cost

The disbursement schedule of the initial investment cost, excluding price escalation and tax cost, is shown in the table below, based on the project schedule prescribed in Chapter 3.7.

Table 5.3.1 Disbursement Schedule of Initial Investment Cost (Financial Cost)

(Rs. in millions)

Year	Total	1	2	3	4	5	6	7	8	9
		2015	2016	2017	2018	2019	2020	2021	2022	2023
Local Cost	9,268.5	204.8	238.0	81.9	2,173.9	2,172.8	2,180.3	2,199.6	16.1	1.0
Foreign Cost	1,978.3	56.0	135.3	69.7	424.2	419.4	419.1	430.3	19.6	4.6
Total Cost	11,246.8	260.8	373.3	151.7	2,598.1	2,592.3	2,599.5	2,629.9	35.7	5.7

Source: JICA Study Team

Table 5.3.2 Disbursement Schedule of Initial Investment Cost (Economic Cost)

(Rs. in millions)

Year	Total	1	2	3	4	5	6	7	8	9
		2015	2016	2017	2018	2019	2020	2021	2022	2023
Local Cost	8,341.6	184.3	214.2	73.7	1,956.6	1,955.5	1,962.3	1,979.6	14.5	0.9
Foreign Cost	1,978.3	56.0	135.3	69.7	424.2	419.4	419.1	430.3	19.6	4.6
Total Cost	10,319.9	240.3	349.5	143.4	2,380.8	2,374.9	2,381.4	2,409.9	34.1	5.5

Note: Conversion factor (CF) of 0.9 is applied on financial cost
Source: JICA Study Team

The standard conversion factor (SCF) of 0.90, which is commonly used by international donor agencies, is applied to obtain the economic cost.

The replacement cost and residual value are calculated based on the following assumptions below:

- The replacement cost of equipment facility of Rs.292 million is added in 2043 after 20 years of operation. The cost is estimated by summing the 15% of initial investment cost of the "Pump Station and Rising Main" and 20% of STP.
- The residual value of facilities is put at the final year as benefit. The lifetime of concrete facility and building (which is considered as the whole facility except for equipment) is set at 50 years, and that of equipment is set at 20 years.

(2) Operation and Maintenance (O&M) Cost

Referring to the previous Subsection 5.2.4 (2), the O&M cost is estimated as follows:

The SCF of 0.9 is multiplied to the whole cost to have the economic price.

1) Labor Cost: Rs.7.7 million/year from 2015 to 2021 for PIU, Rs.31.8 million/year after 2022 for proposed staffs (half of additional labor cost for water supply and sewerage services)
2) Treatment Cost: Rs.1.12/MLD/year after 2023 (Rs.96.3 million/year by design capacity)
3) Electricity Cost: Rs.35.7 million/year after 2024

5.3.3 Economic Benefits

The potential economic benefits procured by the project execution are summarized below.

1) Improvement of living welfare: Better hygiene and sanitary condition contribute to the better living conditions of service users.
2) Reduction of medical expenditure: Illness in the project area will be reduced, and the medical cost is saved as influence of the project.
3) Increase of productive works: Time loss due to illness will be reduced, and the time is spent in alternative productive work.
4) Land price escalation around the project area: Land price can be increased as the living condition will be improved in the project area.
5) Human resource development of RMC and DWSD: The training activities will contribute for the enhancement of human resource development in related organizations.
6) Cost reduction by reusing treated water: The treatment cost of water supply service can be reduced as the emitted water quality of sewerage will be improved.
7) Increase of tourism: Better environmental condition may attract more tourists in Ranchi City, and will increase the income of related commercial sectors.

The first three factors are quantified as economic benefits and the rest of the benefits are considered as intangible benefits and are excluded from the calculation.

The number of beneficiaries is assumed to increase in corporation to the population growth

and coverage rate of sewerage service in Zone2.

(1) Improvement of Living Welfare

The living welfare of users will be improved as the sewerage and hygiene conditions of users will be improved after completion of the Project.

The benefit amount is calculated by multiplying the number of households connected to the sewerage service and willingness to pay (Rs./month/household) for the benefit. Moreover, ATP is also applied for the calculation, as the willingness to pay for sewerage project tends to be lower due to the difficulty of user's recognition on the benefit.

i) Benefit using Willingness to Pay (Case 1)

Benefit = "Number of Beneficiaries" x "Willingness to Pay"

ii) Benefit using ATP (Case 2)

Benefit = "Number of Beneficiaries" x "Affordability to Pay (ATP)"

As mentioned in Subsection 5.1.1, the willingness to pay is calculated at Rs.451.2 /year/household by the conducted social survey, and ATP becomes Rs.3,972 /year/household.

(2) Reduction of Medical Expenditure

The expenditure on medical treatment of household in the Project area is calculated by summing up the medical cost spent by each patient and the cost paid by public sector. The patient's medical cost is estimated by the result of the social survey conducted by the JICA Study Team. The cost by public sector is estimated by the annual budget data of relevant department of Jharkhand State.

The social survey data showed that the average monthly expenditure on medical treatment is Rs.1,203/month. As the average family number is 4.92 members/household, the annual medical cost per person is estimated to be Rs.2,934.

The budget amount of the Health, Medical Education, and Family Welfare Department of Jharkhand State in the fiscal year of 2013-14 is Rs.6,488 million. As the total population was 32,966,238 in 2011, the public cost for annual medical service is estimated at Rs.197/person.

Since there are no reliable statistics, it is assumed that 30% of all expenditure can be caused by the waterborne and water-related diseases, and the cost can be saved by the project implementation. The annual benefit per person is estimated at Rs.940.

(3) Increase of Productive Works

Illness can lead to substantial losses in productivity, welfare, and income both for patients and for the family members who care for them. Project implementation results in the reduction of its economic loss.

The survey report "Economic Impacts of Inadequate Sanitation in India (2010)" indicates the "occurrence number" and "time lost" due to water-borne diseases in whole India at 750 million cases and 9,960,000 years, based on the 2005 and 2006 observations. In this survey, diarrhea, helminthes, trachoma, acute lower respiratory infection (ALRI), measles, malaria, and others are defined as water-borne diseases.

As the total population in India was 1,143 million in 2006, the annual number and time lost of water-borne disease cases per person is estimated at 0.66 cases/person/year and 3.18 days/person/year.

Referring to the result of the social survey, 15 out of 120 households replied that there were members in the house who got acute illness during the last two years. These illnesses were six cases of malaria, four cases of typhoid, four cases of dysentery, one case of cholera, and three other cases. This corresponds to 0.031 case/person/year.

Due to the limitation of the data sample, the former study result is adopted to estimate the average time lost due to water-borne diseases.

"Benefit of reduction of production loss"

= "saved time lost" x "daily production value" x "employment rate"

"The daily production value" is estimated by dividing the GDP per capita (US$1,503 in 2012) by annual working days (250 days). Adopting the exchange rate of Rs. and US$ is Rs.60.1 /US$ in June 2014, the "daily production value" is estimated to be Rs.361.
The "employment rate" is assumed to be 50% considering the economic condition of the project area. Therefore, the benefit of saved production value is calculated at Rs.574/year/person.

5.3.4 Results of the Economic Analysis and Sensitivity Analysis

(1) Results of the Economic Analysis

The trend of economic benefit and cost is shown in Appendix D1.4. The results of the economic analysis are shown in Table 5.3.4 below.

Table 5.3.4 Results of Economic Analysis

	EIRR	NPV (D.R.=10.0%)	B/C Ratio
Case 1: using willingness to pay	5.6%	Rs.-3,393 million	0.56
Case 2: using ATP	8.3%	Rs.-1,793 million	0.77

Source: JICA Study Team

The EIRR values become positive at 5.6% and 8.3% in each case when applying willingness to pay (Case 1) and ATP (Case 2) for the sewerage connection and improvement of living conditions. The NPV becomes Rs.-3,393 million and Rs.-1,793 million, and B/C becomes

0.56 and 0.77, respectively.

Regarding the result, EIRR of Case 1 (using willingness to pay) shows a lower EIRR than Case 2 (using ATP). Theoretically, it is believed that the willingness to pay value becomes close to the ATP amount as the user's understanding deepens. Hence, the education/enlightenment activity should be conducted to increase the social benefit.

The EIRR became lower than 10.0% in both cases when applying willingness to pay and ATP for the project, and hence, the project is basically not viable from the social economic aspect. However, it is known that EIRR of the sewerage project tends to be low because of its difficulty of recognition of the real benefits by the users, and the sewerage service is recognized as basic human needs to spend a qualified life. Considering the said factors, the implementation of the Project is necessary for the development of the society.

(2) Results of the Sensitivity Analysis

The sensitivity analysis is executed in cases of 10% benefit reduction, 10% cost increase, and in both cases occurring at the same time. The results of each case are summarized in Table 5.3.5.

Table 5.3.5 Summary of Sensibility Analysis

	Condition	EIRR	NPV (D.R.=10.0%)	B/C
Case1 (using willingness to pay)	A: Base case	5.6%	Rs.-3,393 million	0.56
	B: Benefit－10%	4.9%	Rs.-3,825 million	0.50
	C: Cost＋10%	5.0%	Rs.-4,164 million	0.51
	D: Benefit－10%, Cost＋10%	4.3%	Rs.-4,595 million	0.46
Case2 (using ATP)	A: Base case	8.3%	Rs.-1,793 million	0.77
	B: Benefit－10%	7.5%	Rs.-2,388 million	0.69
	C: Cost＋10%	7.6%	Rs.-2,567 million	0.70
	D: Benefit－10%, Cost＋10%	6.8%	Rs.-3,162 million	0.63

Source: JICA Study Team

The 10% benefit reduction and 10% cost increase have similar impact on the EIRR and NPV. In conclusion, to maintain the benefit higher, the education activity should be done sufficiently as mentioned before. To avoid the cost increase, prudent budget/schedule control, and cost economization during operation period is expected.

Chapter VI ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

6.1 Framework for Land Acquisition and Resettlement

6.1.1 Legal Framework of the Environmental Impact Assessment and Social Impact Assessment

(1) Environmental Impact Assessment (EIA)

At present in India, EIA is governed by the "EIA Notification" issued on 14 September 2006" by which the EIA process became a statutory requirement for a number of projects/activities which are likely to have significant environmental impacts and health implications. The purpose of the notification is to impose certain restrictions and prohibitions on new projects and activities, or on the expansion or modernization of existing projects and activities based on their potential environmental impacts. According to the EIA Notification-2006, a prior Environmental Clearance (EC) must be obtained either from the Central Government or the State (or Union Territory) Level Environment Impact Assessment Authority (SEIAA), constituted by the Central Government under the Environment Protection Act, 1986.

An EIA will be conducted as part of the EC obtaining process. The schedule in the EIA Notification-2006 provides the list of projects or activities requiring prior EC. According to the notification, the EC process is required for 39 types of projects/activities and covers aspects like screening, scoping, and evaluation of the upcoming projects/activities. All projects/activities being covered under this notification have been divided into Categories A and B based on their potential environmental impacts. Category A projects require to develop an EIA based on a Terms of Reference (TOR) and presented to the Ministry of Environment and Forest (MoEF). Category B projects will be screened and further subdivided into B1 which requires to submit an EIA report, and B2 which does not require an EIA report. All Categories 'A' and 'B1' projects necessarily have to carry out EIA studies along with "public consultation" as per the procedure stipulated in the notification. The requirements of an EIA and public consultation have been dispensed for B2 projects. Table 6.1.1 summarizes the conditions of Category A and Category B projects/activities.

Table 6.1.1 Conditions of Category A and Category B Projects/Activities

Project Category	Classification		Implementation of EIA, Public Consultation	Appraisal by:	Issuance of EC by:
A	● Classified by the Schedule of EIA Notification-2006		Required	EAC(Note1)	MoEF
B	● Classified by the Schedule of EIA Notification-2006	B1	Required	SEAC(Note2)	SEIAA(Note3)
	● Subdivided into B1 and B2 by Screening (Application of Form 1, Form 1A)	B2	Dispensed	SEAC	SEIAA

Source: JICA Study Team
Note1: Expert Appraisal Committee
Note2: State Expert Appraisal Committee Note3: State Environmental Impact Assessment Authority

According to the EIA Notification-2006, the EC process consists of the following seven main stages:

i. Application for EC - to be made by the project proponent to the concerned authority with Form 1 (and Form 1A with conceptual plan for construction projects only), pre-feasibility report (PFR), and TOR (optional) for conducting an EIA study.

ii. Screening - to be done by SEAC for Category B projects only, to further subdivide as Categories B1 and B2. An EIA will be necessary if classified under Category B1.

iii. Scoping - Determination of TOR for EIA study for Category A and Category B1 projects. To be done by EAC (for Category A) or SEAC (for Category B1).

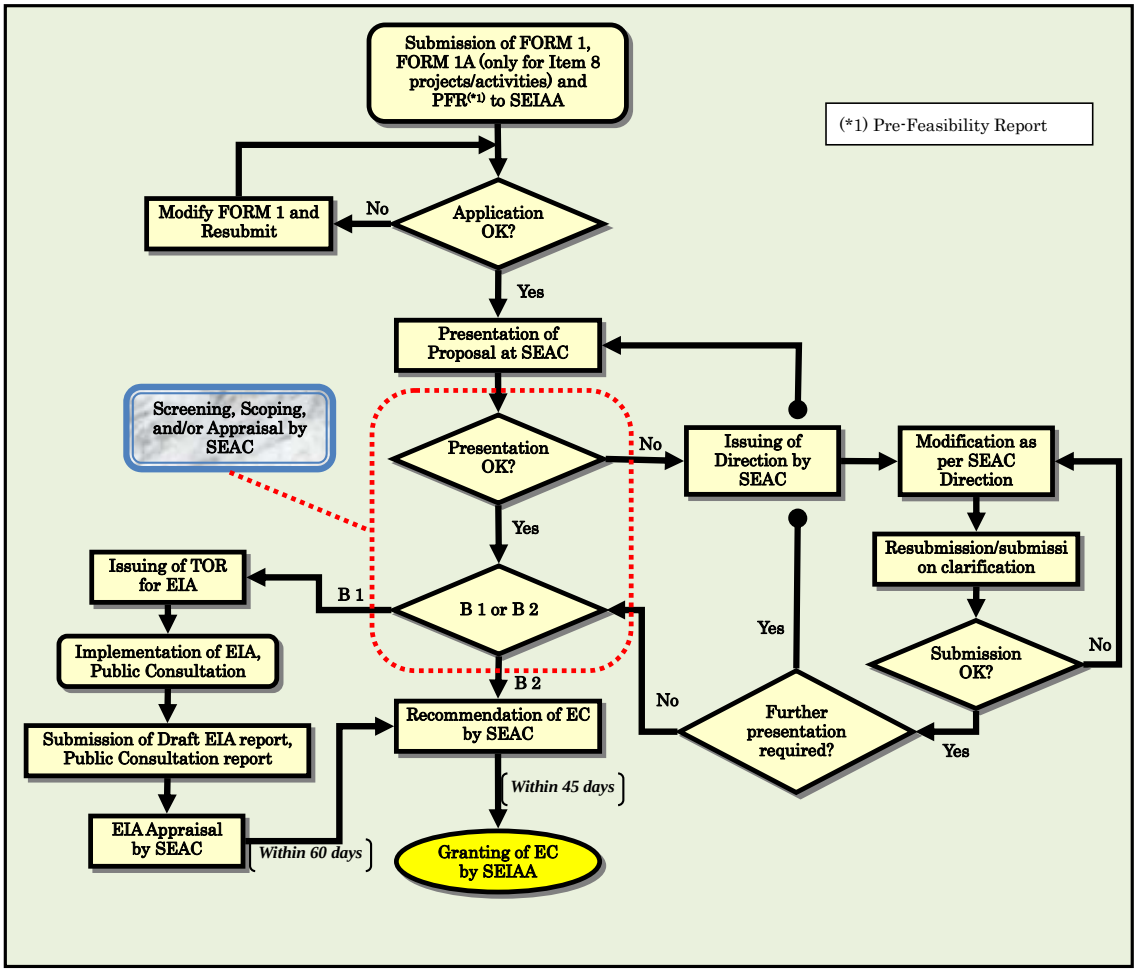
iv. EIA study - Based on the TOR determined above, the project proponent will prepare the draft EIA and environmental management plan (EMP).

v. Public consultation - With the draft EIA and EMP, public consultation will be organized. Issues raised will be addressed in the final EIA and EMP report.

vi. Appraisal - EIA and EMP will be appraised by EAC (for Category A) and SEAC (for Category B1). For Category B2, EIA is not required; appraisal will be done by SEAC on the basis of Form 1 and PFR only.

vii. Decision - On the basis of recommendations by EAC/SEAC, EC will be finally granted or rejected by the MoEF (for Category A)/SEIAA (for Category B).

After obtaining an EC from the concerned authority (MoEF/SEIAA), the project proponent shall apply to the State Board in the prescribed format, along with the copy of EC, for obtaining Consent-to-Establish. The outline of the overall procedure of the EC process is schematically shown in Figure 6.1.1.



Source: Prepared by the JICA Study Team based on the EIA Notification-2006

Figure 6.1.1 General Procedure of the Environmental Clearance Process

(2) Social Impact Assessment (SIA)

Together with the implementation of EIA, if necessary, the Government of India requires the implementation of SIA as part of the resettlement planning and implementation process when a new project is planned. Although there is no generally agreed definition of SIA, it may be defined as a process that seeks to assess, in advance, the social repercussions that are likely to follow from project implementation to promote development such as dams, mines, industries, highways, ports, airports, infrastructures, and power projects. Although EIA and SIA have a close relationship with each other, these are considered as separate activities in India. EIA and SIA in India are regulated by different regulations. SIA has been generally carried out as part of the EIA clearance process.

Although, there are several rules and regulations related to SIA, the main back-supported regulations which govern the SIA are the "National Resettlement and Rehabilitation (R&R) Policy" issued in 2007 (NRRP-2007) and the New Land Acquisition Act, 2013. The objectives of the NRRP-2007 provided in Section 2 of Chapter-II are shown in Appendix E1-1. As for the implementation of SIA, Section 4 of Chapter IV of the NRRP-2007

stipulates that the implementation of SIA is mandatory when 400 or more involuntary displacement families arise caused by the project. In case that the number of displacement families is less than 400, Section 5 of Chapter V of the NRRP-2077 stipulates that adequate administrative arrangements shall be made by the appropriate government for the rehabilitation and resettlement of the affected families as per this policy.

The NRRP-2007 provides the basic requirements of R&R which are needed with the acquisition of lands for the implementation of project/activities. The land acquisition involving involuntary displacement is regulated by the act named "The Right to Fair Compensation and Transparency in Land Acquisition, Resettlement and Rehabilitation Act, 2013", so called New Land Acquisition Act. The act regulates land acquisition and provides laid down rules for granting compensation, rehabilitation, and resettlement to the affected families/persons in India. The act, the New Land Acquisition Act, has provisions to provide fair compensation to those whose land is taken away, brings transparency to the process of acquisition of land to set up factories or buildings, infrastructural projects and assures rehabilitation of those affected. This New Land Acquisition Act will be applied in case land acquisition arises accompanied by the implementation of infrastructure projects.

Sections 4 to 7 of Chapter II of the act also provide the rules and procedures of determination of social impact and public purpose through the implementation of a SIA study. The main part of Chapter II is shown in Appendix E1-2. In case both EIA and SIA are required, the SIA report is submitted to EAC/SEAC with the EIA documents.

At present, the implementation of SIA has become a statutory requirement by the NRRP-2007 in case projects involve an involuntary displacement of more than 400 families. This means that when the project involves an involuntary displacement of less than 400 families, implementation of SIA is not a mandatory requirement. SIA process contains many steps, it should contain the issues enumerated below:

- A detailed assessment of the socioeconomic conditions of the people who may be negatively affected;
- A detailed study of the impacts in terms of the extent of displacement, the loss of lands and livelihoods, the second-order impacts as a result of submergence if any, construction mitigation measures, downstream impacts, and host communities; and
- A detailed plan to mitigate these impacts and an assessment of the costs of such measures.

6.1.2 Procedure of Land Acquisition and Resettlement

Land acquisition for the projects of "public purpose" is carried out as part of the SIA based on the New Land Acquisition Act. In general, problems of resettlement and rehabilitation follow after land acquisition. Together with land acquisition matter, the New Land Acquisition Act deals with the matter of rehabilitation and resettlement, and fair

compensation to the land owner whose land was taken away for the projects. According to the New Land Acquisition Act, the SIA study should include the following:

i. Assessment as to whether the proposed acquisition serves public purpose;

ii. Estimation of affected families and the number of families among them likely to be displaced;

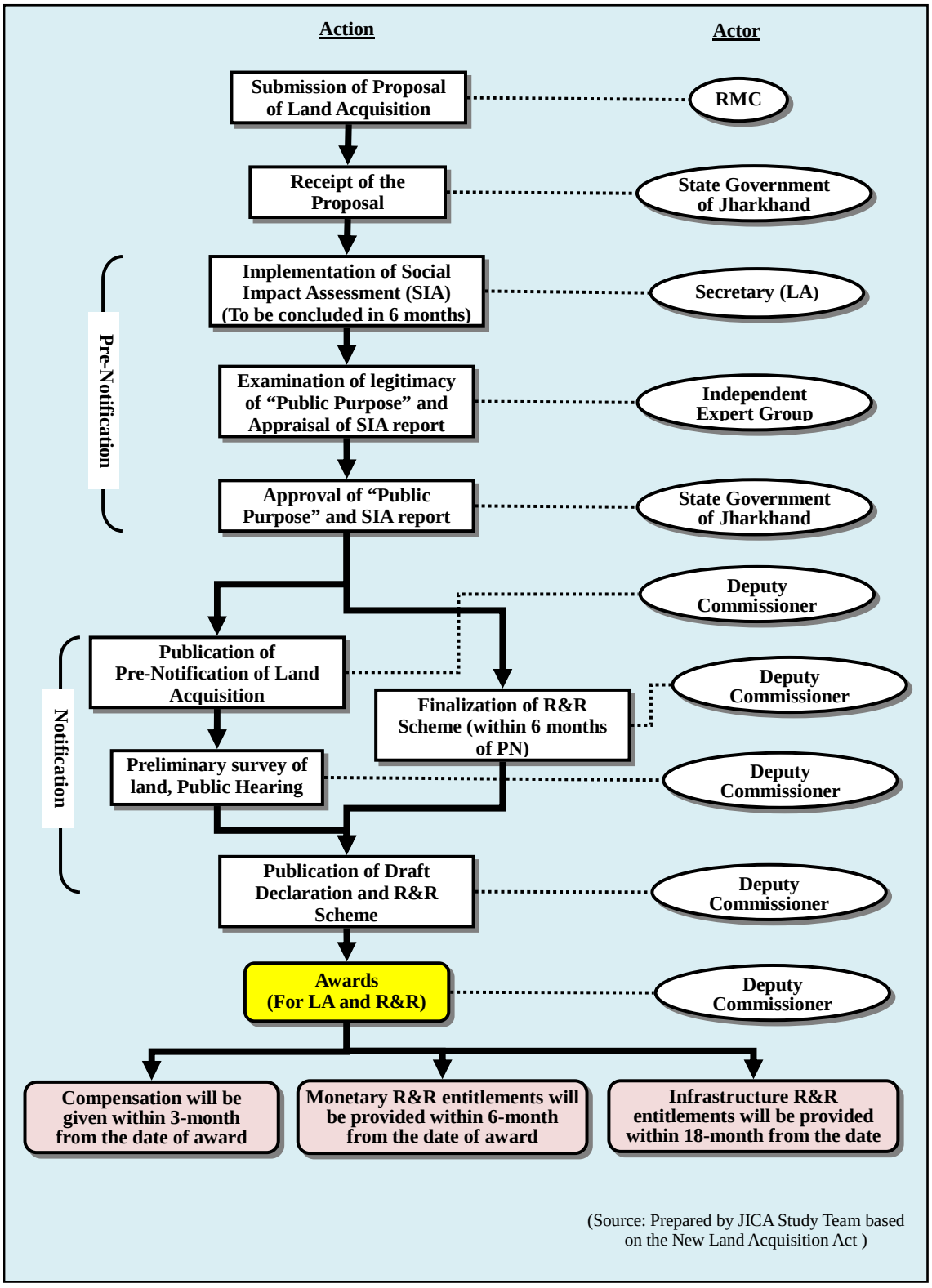
iii. Extent of lands, public and private houses, settlements, and other common properties likely to be affected by the proposed acquisition;

iv. Whether the extent of land proposed for acquisition is absolute bare-minimum extent needed for the project;

v. Whether land acquisition at an alternate place has been considered and found not feasible; and

vi. Study of the social impacts of the project, and the nature and cost of addressing them and the impact of these costs on the overall costs of the project *vis-à-vis* the benefits of the project;

The outline of the general procedure of land acquisition and resettlement to be applied is shown in Figure 6.1.2 below.



Source: Prepared by JICA Study Team based on the New Land Acquisition Act

Figure 6.1.2 General Procedure of Land Acquisition and Resettlement

6.1.3 Category of Sewerage Project

As mentioned, the environmental clearance process is required for 39 types of projects/activities provided in the schedule (List of Projects or Activities Requiring Prior Environmental Clearance) of the EIA Notification-2006. In the list of the schedule, these 39 types of projects/activities are categorized into eight groups of projects/activities as shown in Table 6.1.2 below:

Table 6.1.2 Project/Activities Required Prior EC Process

Group No.	Project/Activity	No. of Subgroups
1.	Mining, extraction of natural resources, and power generation (for a specified production capacity)	5
2.	Primary Processing	2
3.	Materials Production	2
4.	Materials Processing	6
5.	Manufacturing/Fabrication	11
6.	Service Sector	2
7.	Physical Infrastructure including Environmental Services	9
8.	Building/Construction Projects/Area Development Projects and Townships	2
Total		**39**

Source: EIA Notification, 2006

The general configuration of the Land Acquisition Law, EIA Notification-2006 and Application Form is shown in Appendix E1 to E3.

6.2 Preparation of Resettlement and Rehabilitation Action Plan (RAP)

In India, the word "Resettlement and Rehabilitation (R&R) Plan" is used in the meaning same as that of RAP used in JICA Guidelines and OP 4.12 of World Bank.

The resettlement and rehabilitation (R&R) follows after land acquisition. Rules and procedures of R&R are stipulated in the New Land Acquisition Act and NRRP-2007. Preparation of the R&R plan/scheme is obligatory when a resettlement arises due to the implementation of "public purpose" projects. Same as a land acquisition plan, the R&R scheme will be prepared in the course of the SIA process. The R&R scheme is examined by the R&R Authority established by the appropriate government. After the examination of the R&R scheme, the district level deputy commissioner passes the R&R award. Chapter V and Chapter VI of the New Land Acquisition Act provide the R&R award and procedure/manner of R&R. The R&R scheme shall cover the following items:

- Identify project affected people (PAPs) by type and extent of loss;
- Identify the possible adverse effects of the project on people and in the area;
- Suggest culturally and economically appropriate measures for the mitigation of adverse effects of the project;
- Provide an institutional mechanism for the implementation of the R&R scheme;

- Provide a grievance redress mechanism;
- Formulate a time frame for the implementation of the R&R scheme;
- Provide and allocate budget for each activity of the R&R plan; and
- Monitor and evaluate the implementation of the R&R scheme.

6.3 Public Consultation

The Land Acquisition Plan (LAP) and the R&R scheme are prepared through the processes of EC and land acquisition. Public consultation plays an important role in these processes for the preparation of the LAP and R&R scheme. As shown in Figure 6.1.1, the formal public consultation will be held after the EIA and SIA study. In order to support smooth and effective preparation of the LAP and R&R scheme, the JICA Study Team proposed to the RMC to implement a preliminary public consultation to the project affected families in and around the STP II site by RMC in a manner shown in Table 6.1.3.

Table 6.1.3 Objectives and Contents of Public Consultation

Method	- Group consultation. - Interaction with community groups.
Contents	- Explanation of project outline. - Explanation of LAP and the R&R scheme.
Objectives	- To inform the outline of project; - To inform potentially impacted communities/individuals about the probable time of initiation of project; - Time taken for disbursement of compensation; - Nature of compensation; - To solicit the views of affected communities/individuals on social, economic, and environment components and the significance of impacts; - To serve as an important tool for collecting information about the natural and human environments, much of which would never be accessible through more traditional approaches of data collection; and - To ensure an enhanced public cooperation due to creation of awareness about the purpose and benefits of the project.
Target	- All PAPs related to the land to be acquired for the construction of STP in Zone II. (People who are living or whose assets are located in the project area) (If more than two communities exist, community-wise group consultation should be held.)

Source: JICA Study Team

CHAPTER VII PROJECT EVALUATION AND RECOMMENDATIONS

7.1 Technical Evaluation

(1) Trunk Sewer Routes

The trunk sewer system proposed in DPR in 2013 has many critical problems in setting the route allocation. It brought about 113 resettlement households (approximately 620 persons) and 16 km land acquisition (approximately 8 ha, equivalent to Rs.400 million) in Zone II, and 19 resettlement households and 1.5 km land acquisition in Zones III and IV. These environmental problems, particularly in Zone II, resulted in Category "A" under the definition of environmental assessment. In order to solve this problem, the JICA Study Team proposed rearrangement of trunk sewer route as shown in Figure 3.3.4 and Figure 3.3.5. As a result, no resettlement is required for installation of trunk sewers.

However, due to change of the trunk routes, the number of pump facilities has increased from two to six locations as PS type together with five locations as MP type in Zone II and from four to six locations in Zones III and IV, respectively. In addition, due to the change of trunk routes, railway crossing has become necessary in Zone II. The railway crossing has been planned by small-scale microtunneling method with a 400 mm diameter ductile iron pipe with auger type drilling machine.

By conducting additional pump stations and small-scale microtunneling method, the solution of problems of large magnitude of resettlement and land acquisition could be successfully achieved.

(2) Sewer Treatment Plant Site

The proposed Zone II STP site with land area of 6 ha including access road and treated water discharging pipes to the river was approved by RMC at the end of June 2014. The proposed site is currently used as an agricultural land and the north end of the site is currently being developed as a residential area. RMC has not taken any particular action for reserving this proposed STP area. Therefore, RMC should take necessary action with protocol to acquire the proposed land as soon as possible.

Meanwhile, Zones III and IV STP site is proposed by the JICA Study Team at the old STP site, which was constructed about 50 years ago and abandoned 20 years ago, and possessed by HEC company immediately outside the RMC jurisdiction. The JICA Study Team already received an acceptance to use this land as STP site from the director of HEC in the beginning of June 2014. Although availability of this land was preliminarily discussed between HEC and RMC in the beginning of July, an official agreement has not been made yet. If this site is available to be borrowed for the proposed STP site of Zones III and IV, the land acquisition for STP of about 3.2 ha and trunk sewage route of about 1.5 km will not be necessary.

Therefore, an official agreement between HEC and RMC and site reconnaissance survey by RMC under the guidance of HEC should be carried out immediately.

7.2 Project Effect

(1) Quantitative Effect

1) Establishment of Operation and Effect Indicators

Regarding the evaluation of the project impact, the effect indicators and operation indicators are set up as shown in Table 7.1.1. The ex-post evaluation is planned to be conducted two years after completion of the commissioning of the project.

Table 7.1.1 Indicators of the Project

	Indicators	Present (2014)	Target (2024)
Effect Indicators	Service population in Zone II	0	285,299*
	Satisfaction of users of sewerage service	0%	80%
Operation Indicators	Treated amount at STP of Zone II	0	34,890 m^3/d**
	House connections in Zone II	0	28,666***
	BOD level of discharged water	Min. 30 mg/L - Max. 226 mg/L	Less than 20 mg/L
	EIRR	-	5.6% (using WTP) 8.3% (using ATP)

Source: JICA Study Team

Note: * : 750,788 (2024 population) x 38% (assumed coverage rate of sewerage service)= 285,299

**: 750,788 (2024 population) x 135 LCD x 1.2 (indust./domes.) x 71% (coverage rate of water supply service) x 38% (coverage rate of sewerage service)+2,075 (groundwater)=34,890

here 71% and 38% : Refer to Chap 5 Table 5.2.1 and Table 5.2.6

***: The number of house connection is based upon the service coverage at the time of completion of the sewer pipe construction on March 2022.

2) Financial Analysis

Basically, financial analysis should be made depending on the capital cost of RMC to calculate an appropriate financial internal rate of return (FIRR) figure to return the loan amount. However, existing income and expenditure of RMC is extraordinarily small and almost all the capital investment is dependent upon the subsidy from the central government and state government. Therefore, possibility to achieve the recovery cost for O&M cost was analyzed. As shown in Section 5.2, if the water tariff rate is doubled from the present level and the sewerage tariff, at 60% of water tariff, is added, the full cost recovery of O&M cost will be achieved in 2025. Under the same condition, in addition to the O&M cost, 30% of project investment can be covered by the collected tariff in 2035.

3) Economic Analysis

The economic analysis was conducted by estimating the economic benefit and cost of the project. The benefits of i) “improvement of livelihood (WTP and ATP)”, ii) “reduction of medical expenditure”, and iii) “increase of productive work” were considered in the calculation. Two different types of economic internal rate of return (EIRR), namely, case 1:

WTP + ii) + iii), and case 2: ATP + ii) + iii), were estimated. The resulting EIRRs were 5.6% and 8.3%, respectively. These figures did not exceed the expected hurdle rate of 10%, to be referred for economic viability. However, the sewerage service is one of the basic human needs to have a quality life; thus, the implementation of the project can be justified.

(2) Qualitative Effect

The following benefits induced by the project are recognized as intangible benefits because of the difficulty of their quantification in economic terms. The impact of the project should be evaluated in qualitative manner during the ex-post evaluation.

1) Land price escalation around the project area

The land price can be increased as the living condition improves in the project area.

2) Human resource development in RMC and DWSD

The training activities will contribute to the enhancement of human resource development in RMC and DWSD.

3) Cost reduction by reusing the treated water

The treatment cost of water supply service might be reduced as the emitted water quality from sewerage will be improved.

4) Increase tourism

Better environmental condition may attract more tourists in Ranchi City.

7.3 Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA)

At present in India, EIA is governed by the EIA Notification-2006 by which the EIA process became a statutory requirement for a number of projects/activities which are likely to have significant environmental impacts and health implications. One of the salient features is that the EIA will be conducted as a part of the prior Environmental Clearance (EC) obtaining processes. The “Schedule of EIA Notification-2006” stipulates eight sectors and 39 activities. Out of these activities, however, the word of “sewerage” is not included. Therefore, the JICA Study Team understood that implementation of the EIA for obtaining EC in this project is not necessary.

Another aspect of the environmental management for new projects/activities in India is that the Social Impact Assessment (SIA) is required. Issues of land acquisition and resettlement are dealt with in the framework of the SIA. Rules of holding of public hearing/consultation to the affected people are provided as a mandatory issue in the New Land Acquisition Act-2013.

7.4 Organizational Strengthening Action Plan for RMC

Organizational action plan was proposed regarding the following major issues.

i) Setting of policy, rules and regulations

- Establishment regulation and fund allocation
- Establish accountability mechanisms

ii) Establishment of water supply and sewerage wing (WSSW)
- Institutional and organizational set up Establish accountability mechanisms
- Transfer of authority, functions and assets from DWSD

iii) Establish administration systems of WWSW
- Establish project steering committee and PIU
- Formulate administration system including decision making
- Develop job description for every position of WSSW
- Establish performance management system for WSSW staff
- Implementation recruitment at various positions
- Develop and conduct training plan of WSSW staff

iv) Development of business plan
- Long term plan
- Medium term plan
- Annual plan

v) Improvement of financial management system
- Review of existing financial/accounting system
- Develop financial management system
- Training for preparation of financial statements

vi) Water and sanitation tariff setting and revenue collection
- Door to door survey on present connection and payment
- Establish tariff rules and regulations
- Carry out campaign against defaulters and illegal connections
- Installation of water meters
- Campaigns for mandatory water supply and sewerage connection
- Develop and implement an improved revenue collection plan
- Prepare and execute tariff revisions for financial sustaibability

vii) Management information system
- Study the current information management/monitoring practices
- Design information system for water supply and sewerage works
- Develop, install and implement the information system

viii) Asset management system
- Preparation of asset inventory of the existing facilities
- Establish and operationalize GIS database of facilities
- Establish and implement data collection/update system
- Establishment of asset management operation

ix) Customer service
- Study on existing public relations and complaint handling system
- Prepare water supply and sewerage service contract document
- Prepare and implement complaint handling system

x) Outsourcing
- Study on possibilities of outsourcing specific functions
- Develop and approve an outsourcing plan
- Implement the outsourcing

The timing of implementation of these action plans should be started prior to the practical procurement stage under the JICA's yen loan processes. In this regard, the contribution of an organization of JUIDCO is indispensable.

7.5 Risk Assessment and Risk Control Measure

(1) Risk Assessment

The major risks which have been observed are enumerated as follows:

1) Land acquisition constraint appears to be a major hurdle and will impact the outcome of the project. New land acquisition law, enacted by the Government of India, protects the right of the landowners. RMC is unable to decide on the course of action which is needed in procuring land for the STP and pump station sites.
2) The absence of a project steering committee and project implementation unit demonstrates the lack of preparedness for a disciplined project management.
3) Absence of appropriate leadership and technical manpower within RMC and Jharkhand State is hindering the proper comprehension of the magnitude of the project and its elements. The lack of a proper understanding of the project requirements will become a project management risk.
4) Current rules and regulations relating to water supply and sewerage do not have the powers to make them enforceable. Water supply metered connections are voluntary and not mandatory. There is every possibility that the revenue recovered may fall short of the required level.
5) Currently, inadequate revenue streams to cover O&M costs, depreciation, and returns on invested capital have led to poor service quality in the city of Ranchi, but what is disheartening is that there are no measures being taken to correct the situation.
6) Water supply and sewerage services have to get a focused attention at RMC; however, the continued duplicity in operations between DWSD and RMC is only adding to the confusion. Until the water supply and sanitation services are given their due importance and taken up as independent operations by RMC, the situation will continue to remain critical.

(2) Risk Control Measure

To mitigate the above, UDD and RMC need to collectively have a focused approach towards the Ranchi Sewerage Project. The project steering committee (PSC) and project implementation unit (PIU) have to be in place within the next couple of months and they have to in turn develop an effective risk management framework that can undertake the following steps:

Step 1: List all risks associated with the project and then analyze these risks in order of importance.

Step 2: For each risk, list corresponding mitigation measures as much as possible, and then examine the availability of mitigating measures in sequence based on their effectiveness. Sometimes, a combination of several mitigating measures is needed to be adopted.

Step 3: For each risk and its mitigating measures, the government and related entities have to incorporate the risk mitigation measures, to ensure that all of these risks are adequately covered.

Step 4: Allocate risks to related agencies according to the principle that risk should be borne by the agency most capable of controlling it.

Step 5: Adopt the risk allocation and security structure with respect to the financing impact on the project.

The risk matrix will have to be evolved by the PIU which can be used for monitoring and mitigation measures and will list the following variables: i) classification or type of risk, ii) reason for the risk mitigation measure adopted, iii) consequences for JICA, and iv) consequences for RMC and UDD.