CHAPTER 8 Scope of Work for Ganga Rejuvenation Project

<Objective of the Study>

Scope of work was confirmed based on existing DPR. Confirmation of projects, drawings, calculation sheets, description of details were done in the work.

<Result of the Study>

For the sewers, both cases of ID/T and Comprehensive were reviewed for Mirzapur, Chunar, and Ramnagar without decision of selection of the type of sewer network. Saidpur was excluded due to no submission of DPR. Ghazipur submitted only comprehensive plan although NMCG instructed to submit ID/T plan.

For the STPs, since NMCG instructed to submit DPR which is compliant with new effluent standard in CPHEEO, DPRs according to the instruction were dealt in this study.

8.1 Plan of Sewers

Refer to Chapter 7 regarding to the sewage flow. Refer to Appendices for review of DPR drawings and calculation sheets.

8.1.1 Proposed Sewer Works in Varanasi City District-I

Table 8.1.1 shows the bill of quantities for sewer works in Varanasi District-I proposed in the DPR for the same district. Three septic tanks and one lift pumping station were proposed in draft DPR for District-I but there are no available lands for those facilities. Hence sewerage system was remodelled without those facilities.

Figure 8.1.1 shows the general sewerage map and **Figure 8.1.2** shows the locations of micro-tunnelling sections, septic tanks and lift pumping station in District-I.

Table 8.1.1 Proposed Sewer Works in Varanasi District-I

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	193,294	840
RCC	250	9,862	309
RCC	300	4,808	0
RCC	350	2,010	18
RCC	400	2,069	268
RCC	450	1,609	30
RCC	500	2,081	99
RCC	600	1,638	192
RCC	700	84	30
RCC	800	317	90
RCC	900	0	0
Sub-total		**217,772**	**1,876**
Total		**219,648**	

(2) Manhole

Dia. (mm)	Nos.
900	10,898
1200	27
Total	**10,925**

(3) House Connection

Transfer of Exist. (nos.)	New Pipe (nos.)	New Chamber (nos.)
38,288	**9,804**	4,902

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
400	265	(30% of 883m)
600	218	(30% of 728m)
Total	**483**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
88

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
300	795
600	664
Total	**1,459**

Source: Draft DPR Varanasi District-I revised by JICA Survey Team

8.1.2 Proposed Sewer Works in Varanasi City District-II

The draft DPR for Varanasi District-II included an issue of too deep and wide open excavation in a narrow main road with heavy traffic that may cause much impact to traffic circumstance due to closed road. After the discussion between DPR consultant, UPJN, and JICA Study Team it was agreed that the micro-tunnelling method for laying the sewer will be applied for the section. Consequently the DPR was completed and finally submitted to UPJN.

The following table shows the bill of quantities for sewer works in Varanasi District-II proposed in the DPR for the same district. The number of house connections was estimated based on projected population 570,252 for year 2020 in District-II Zone 2A, 5 persons/household, and 70% existing house connections in the area. The existing house connections will be transferred to new sewer after proper repairs of existing connection chambers and reconnections to new manholes. Any pumping station is not proposed in DPR for District-II.

Table 8.1.2 shows the proposed sewer works in the DPR. Figure 8.1.3 shows the general sewerage map and Figure 8.1.4 shows the detail on micro-tunnelling locations.

Table 8.1.2 Proposed Sewer Works in Varanasi District-II

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	236,690	332
RCC	250	11,062	0
RCC	300	6,018	269
RCC	350	3,788	145
RCC	400	4,132	499
RCC	450	2,427	311
RCC	500	2,875	540
RCC	600	1,366	368
RCC	700	1,924	90
RCC	800	570	439
RCC	900	1,244	918
Sub-total		**272,096**	**3,911**
Total		**276,007**	

(2) Manhole

Dia. (mm)	Nos.
900	12,983
1200	145
Total	**13,128**

(3) House Connection

Exist. (nos.)	New (nos.)	New Chamber (nos.)
79,836	**34,216**	17,108

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
450	256	(30% of 852m)
600	145	(30% of 484m)
900	309	(30% of 1,031m)
Total	**710**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
24

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
250	3,850
300	3,451
400	567
600	813
Total	**8,681**

Source: Draft DPR Varanasi District-II compiled by JICA Survey Team

8.1.3 Proposed Sewer Works in Varanasi City District-III

The following table shows the bill of quantities for sewer works in Varanasi District-III proposed in the DPR for the same district. The sewer network is shown in **Figure 8.1.5**.

Table 8.1.3 Proposed Sewer Works in Varanasi District-III

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	109,441	0
RCC	250	1,993	0
RCC	300	1,333	0
RCC	350	572	0
RCC	400	298	0
RCC	450	1,411	554
RCC	500	288	39
RCC	600	729	49
RCC	700	2,603	165
RCC	800	867	0
Sub-total		**119,535**	**807**
Total		**120,342**	

(2) Manhole

Dia. (mm)	Nos.
900	5,159
1200	149
Total	**5,308**

(3) House Connection

Nos.
5,987

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)
225-300	22,700
Total	**22,700**

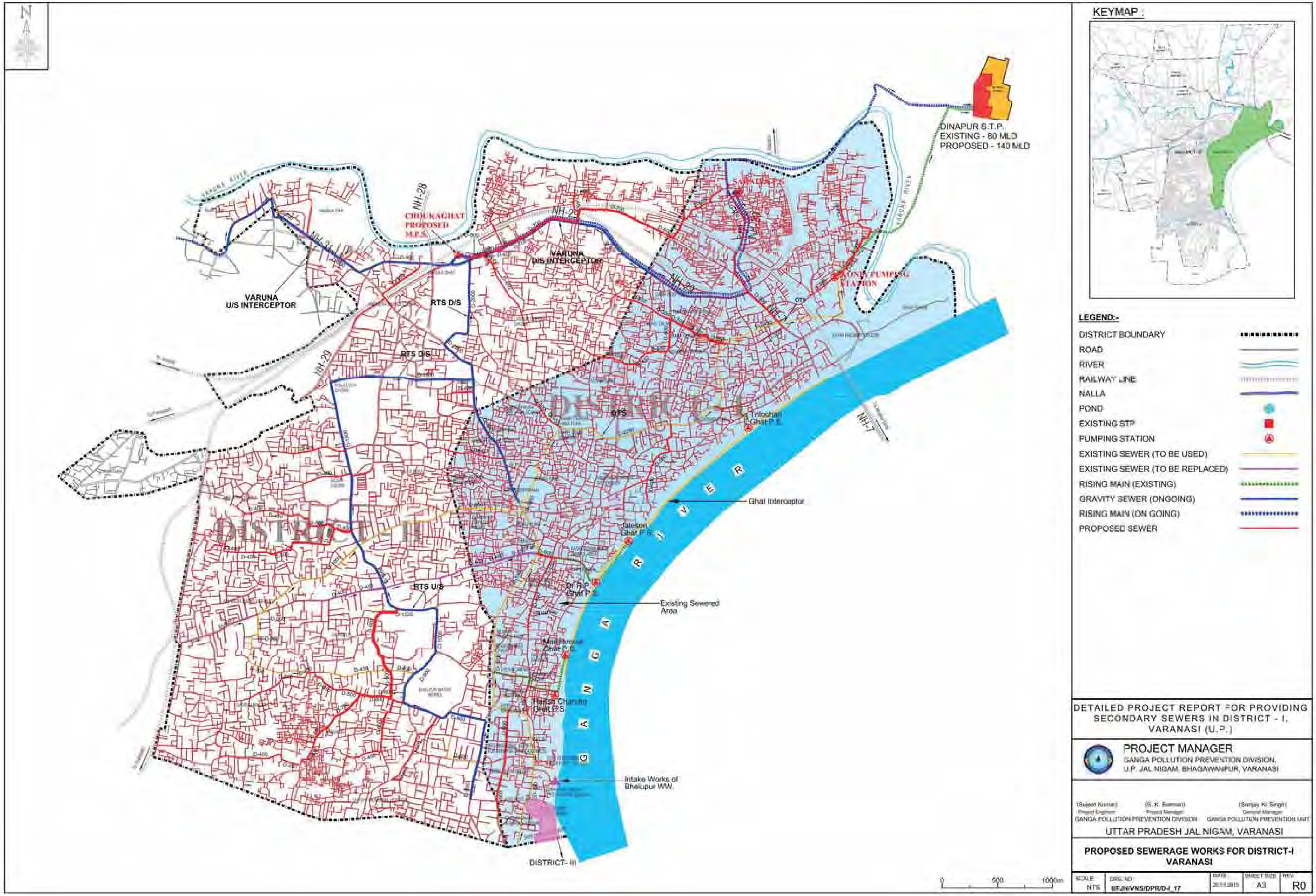
(5) Repairs/Rehabilitation of Existing Manhole

Nos.
500

(6) Dismantling of Existing Sewers

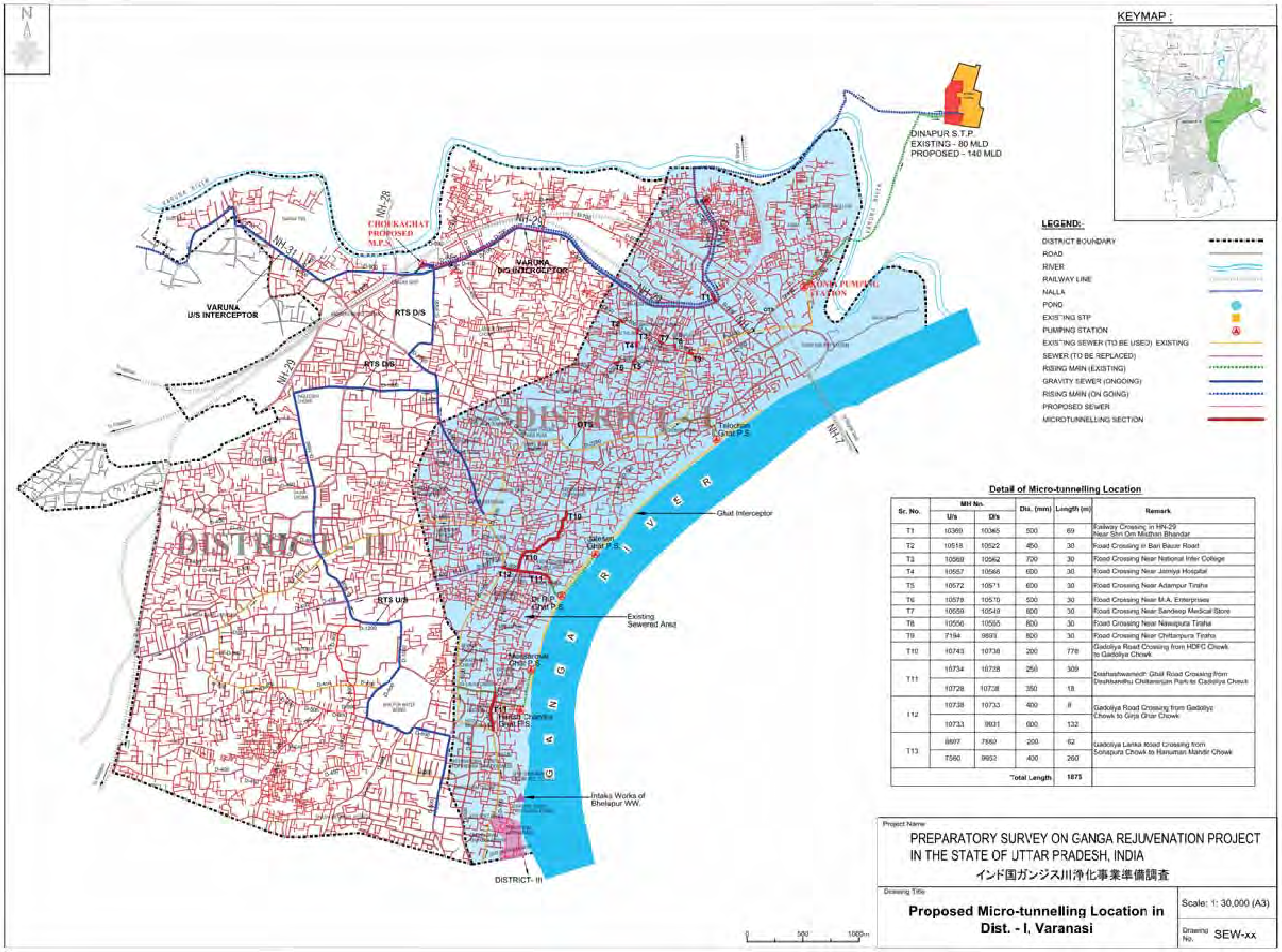
Dia. (mm)	Length (Rm)
150	10,000
200	10,000
Total	**20,000**

Source: DPR Varanasi District-III revised by JICA Survey Team



Source: DPR Varanasi District-I compiled by JICA Survey Team

Figure 8.1.1 Proposed Sewer Network in Varanasi City District-I

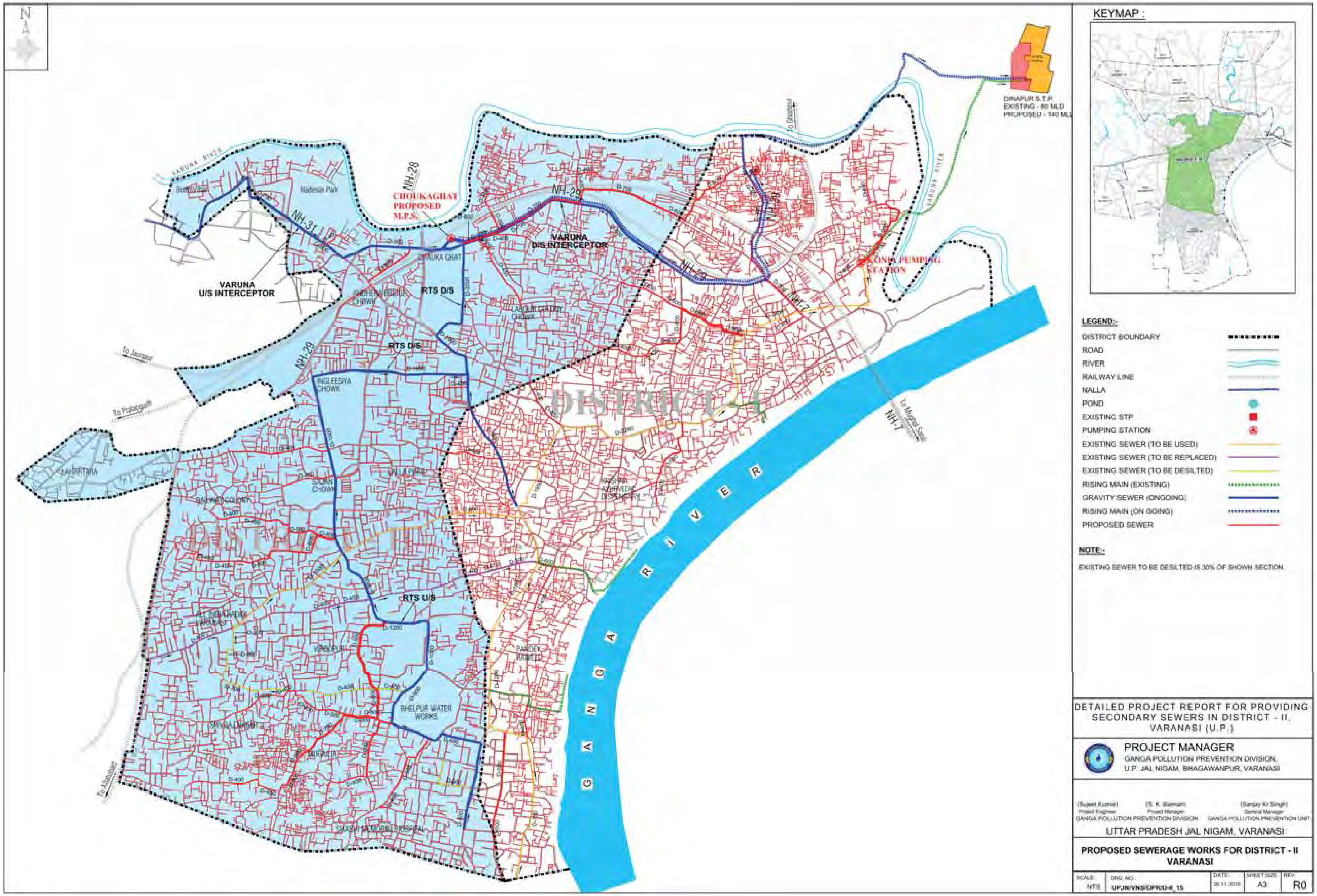


Detail of Micro-tunnelling Location

Sr. No.	MH No. U/s	MH No. D/s	Dia. (mm)	Length (m)	Remark
T1	10369	10365	500	69	Railway Crossing in HN-29 Near Shri Om Misthan Bhandar
T2	10518	10522	450	30	Road Crossing in Bari Bazar Road
T3	10569	10562	700	30	Road Crossing Near National Inter College
T4	10567	10566	600	30	Road Crossing Near Jamiya Hospital
T5	10572	10571	600	30	Road Crossing Near Adampur Tiraha
T6	10578	10570	500	30	Road Crossing Near M.A. Enterprises
T7	10559	10549	600	30	Road Crossing Near Sandeep Medical Store
T8	10556	10555	800	30	Road Crossing Near Nawapura Tiraha
T9	7194	9893	800	30	Road Crossing Near Chittanpura Tiraha
T10	10743	10738	200	778	Gadoliya Road Crossing from HDFC Chowk to Gadoliya Chowk
T11	10734	10728	250	309	Dashashwamedh Ghat Road Crossing from Deshbandhu Chittaranjan Park to Gadoliya Chowk
	10728	10738	350	18	
T12	10738	10733	400	8	Gadoliya Road Crossing from Gadoliya Chowk to Girja Ghar Chowk
	10733	9831	600	132	
T13	8597	7560	200	62	Gadoliya Lanka Road Crossing from Sonapura Chowk to Hanuman Mandir Chowk
	7560	9952	400	260	
			Total Length	1876	

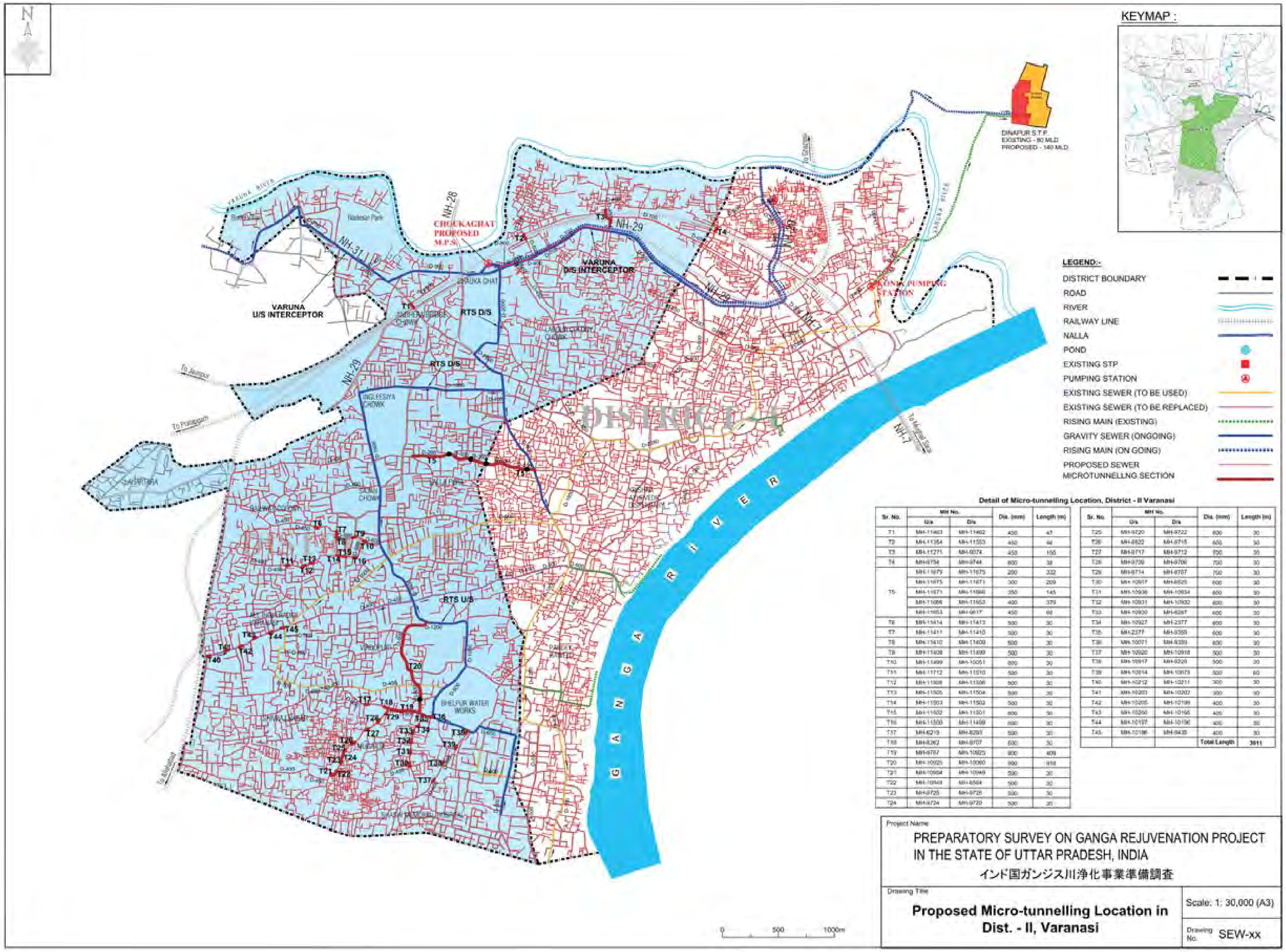
Source: JICA Survey Team based on DPR Varanasi District-I

Figure 8.1.2 Proposed Micro-tunneling Locations in Varanasi City District-I



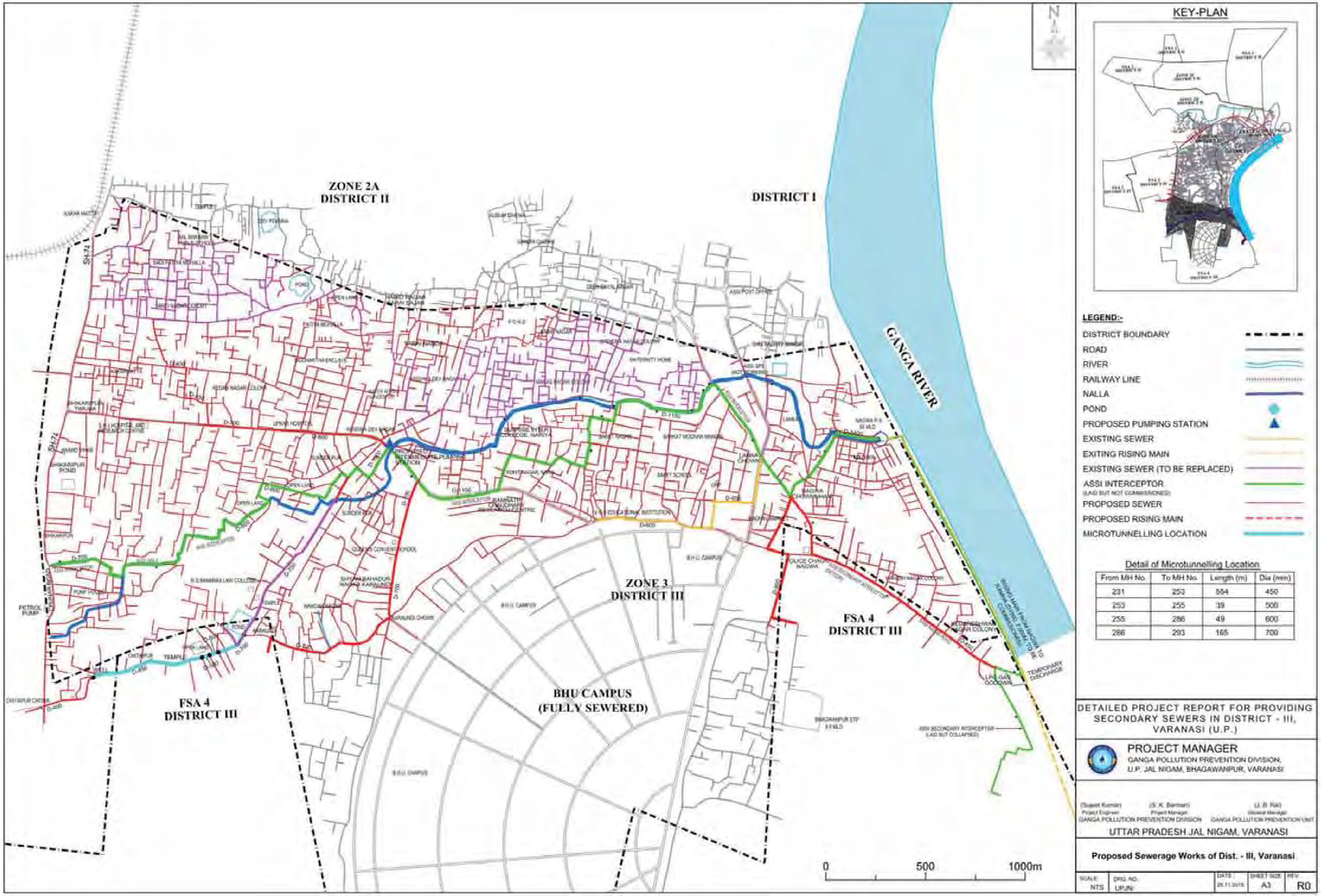
Source: DPR Varanasi District-II compiled by JICA Survey Team

Figure 8.1.3 Proposed Sewer Network in Varanasi City District-II



Source: JICA Survey Team based on DPR Varanasi District-II

Figure 8.1.4 Proposed Micro-tunnelling Locations in Varanasi City District-II



Source: DPR Varanasi District-III compiled by JICA Survey Team

Figure 8.1.5 Proposed Sewer Network in Varanasi City District-III

8.1.4 Proposed Sewer Works in Ramnagar City

In common with the cases of Mirzapur and Chunar mentioned later, two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga for sewer have been prepared for Ramnagar City in Varanasi District. From the scale of Ramnagar City of which the population is less than 100,000 the ID&T method will be adopted for this city and sewer network would not be developed in future.

1) Comprehensive Case

The proposed BOQ of sewer related works in Ramnagar City with comprehensive method is tabulated as follows. The proposed sewer network is shown in **Figure 8.1.6**.

Table 8.1.4 Proposed Sewer Works in Ramnagar City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)				
1) Gravity Sewer			Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
RCC	NP3	200	6,901	3,428	4,930	6,327	21,586
RCC	NP3	250	1,410	797	655	889	3,751
RCC	NP3	300	531	514	116	173	1,335
RCC	NP3	350	96		202	0	298
RCC	NP3	400	155		203	356	713
RCC	NP3	450	0		347	204	551
RCC	NP3	500	0			276	276
RCC	NP3	600	0				0
RCC	NP3	700	0	782			782
RCC	NP3	800	2,200				2,200
RCC	NP3	900	0				0
Sub-total			**11,292**	**5,522**	**6,452**	**8,224**	**31,489**
2) Rising Main							
DI	K9	100					3,700
DI	K9	150					0
DI	K9	200					0
DI	K9	250					0
DI	K9	300					0
DI	K9	350					150
DI	K9	400					50
Sub-total							3,900
Total							**35,389**

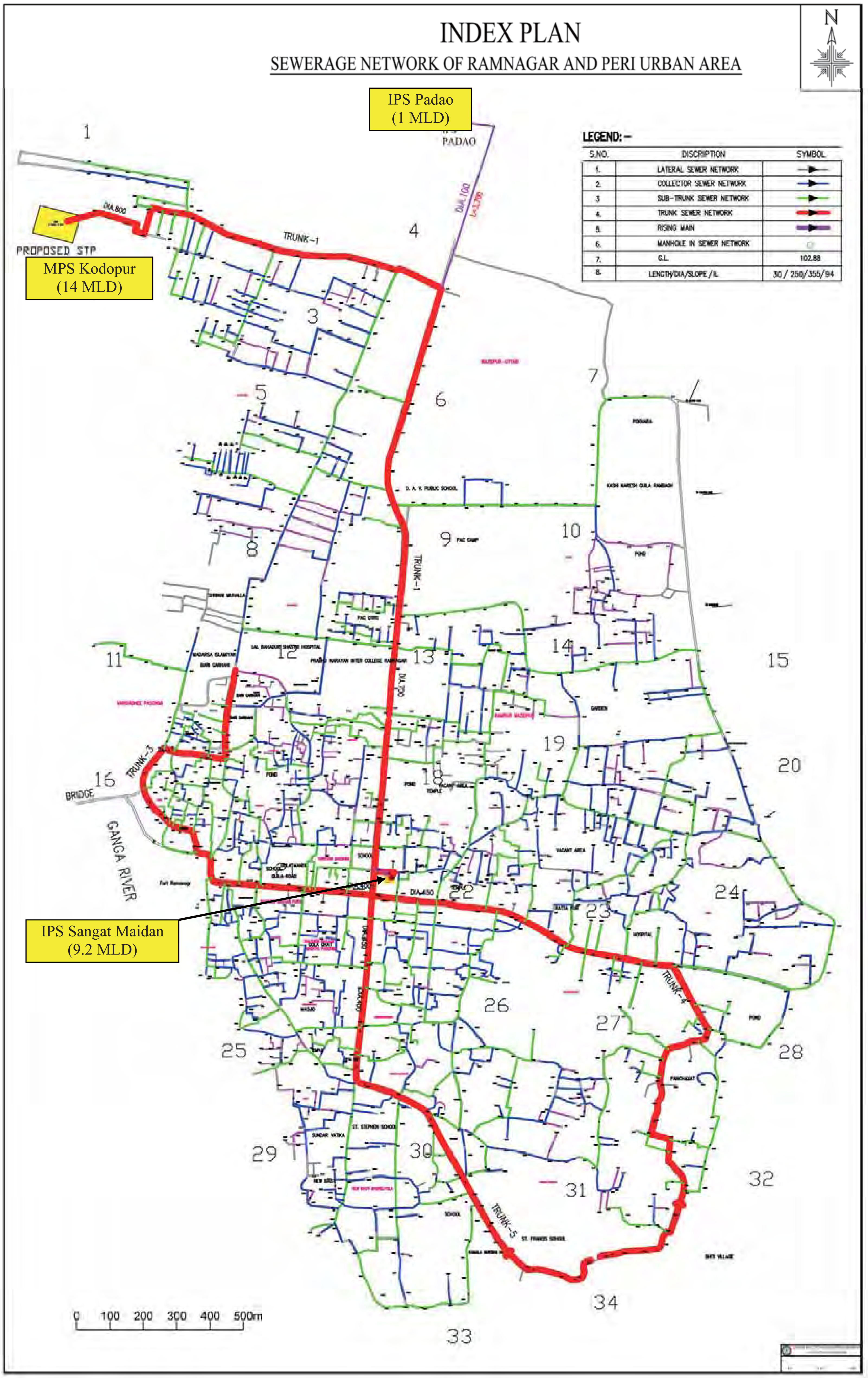
(2) Manhole

Dia. (mm)	Nos. Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
900	261	195	416	412	1,284
1200	112	91	100	118	421
1500	296	170	183	264	913
1200x900	29	22	47	46	144
1500x1500	13	4	4	13	34
Total	**711**	**482**	**750**	**853**	**2,796**

(3) House Connection

Nos. Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
1,396	957	1,493	1,679	**5,525**

Source: DPR Ramnagar Comprehensive compiled by JICA Survey Team



Source: DPR Ramnagar Comprehensive compiled by JICA Survey Team

Figure 8.1.6 Proposed Sewerage System in Ramnagar City (Comprehensive)

2) ID&T Case

Table 8.1.5 shows the list of existing drains in Ramnagar City with projected population and wastewater generations for 2020 (base year) and 2050 (ultimate year) in DPR ID&T. Out of 5 existing drains only Hanuman Ghat Drain was excluded from interception since it flows in remote area and there is no wastewater flow in dry season.

Table 8.1.5 List of Drains with Projected Population and Wastewater Generation in Ramnagar City (ID&T)

No.	Name of Drain	Population		Average Flow (MLD)		IC No.
		2020	2050	2020	2050	
1	Balua Ghat Drain	2,319	4,251	0.28	0.50	BGD
2	Salotri Ghat Drain	334	612	0.04	0.07	SLD
3	Shakti Ghat Drain	1,992	3,651	0.24	0.43	SHD
4	Ram Bagh Drain	54,698	100,257	6.50	11.91	RBD
5	Hanuman Ghat Drain	502	920	0.06	0.11	Not intercepted
Total		59,845	109,692	7.11	13.03	
Intercepted & Treated		59,343	108,771	7.05	12.92	

Source: DPR Ramnagar ID&T compiled by JICA Survey Team

The proposed BOQ of sewer related works in Ramnagar City with ID&T method is tabulated in Table 8.1.6 and the alignment of interceptor is shown in **Figure 8.1.7**. Any drawing with rising main alignment to STP was not prepared in DPR.

The longitudinal profile (L-section) of interceptor in the DPR is shown in Appendix 8.1.1 and proposed interception structure is shown in Appendix 8.1.2.

Table 8.1.6 Proposed Sewer Works in Ramnagar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)
1) Gravity Sewer			Total
RCC	NP3	200	0
RCC	NP3	250	0
RCC	NP3	300	0
RCC	NP3	350	80
RCC	NP3	400	150
RCC	NP3	450	0
RCC	NP3	500	120
RCC	NP3	600	0
RCC	NP3	700	0
RCC	NP3	800	0
RCC	NP3	900	30
Sub-total			**380**
2) Rising Main			
DI	K9	400	**2,700**
Sub-total			**2,700**
Total			**3,080**

(2) Manhole

1200x900	0
1500x1500	10
Total	**10**

(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Ramnagar ID&T compiled by JICA Survey Team

Source: DPR Ramnagar ID&T

Figure 8.1.7 Proposed Interceptor in Ramnagar City (ID&T)

8.1.5 Proposed Sewer Works in Mirzapur City

Two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga have been prepared for Mirzapur City.

1) Comprehensive Case

The proposed BOQ of sewer related works in Mirzapur City with comprehensive method is tabulated in as below. The proposed sewerage system is shown in **Figure 8.1.8** and the locations of sewer installations with micro tunnelling method is shown in **Figure 8.1.9**.

Table 8.1.7 Proposed Sewer Works in Mirzapur City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length		
			Replacement (Rm)	Open (Rm)	Micro Tunneling (Rm)
1) Sewer Line					
RCC	NP3	200		217,181	110
RCC	NP3	250		3,814	0
RCC	NP3	300		9,141	25
RCC	NP3	350		1,716	0
RCC	NP3	400		4,219	30
RCC	NP3	450		1,275	25
RCC	NP3	500		1,908	0
RCC	NP3	600		586	20
RCC	NP3	700		1,899	0
RCC	NP3	800		1,199	0
RCC	NP3	900		970	0
RCC	NP3	1000		1,537	20
RCC	NP3	1200		0	30
Sub-total			**4,500**	**245,445**	**260**
2) Rising Main					
DI	K9	150		333.7	
DI	K9	200		730	
DI	K9	250		334	
DI	K9	300		66	
DI	K9	350		1,700	
DI	K9	600		-	
DI	K9	700		1,370	
DI	K9	800		30	
DI	K9				
Sub-total				4,563	
Total			**4,500**	**250,008**	**260**
Grand total					**250,268**

(2) Manhole

Dia. (mm)	Nos.
900	2,729
1200	162
Total	**2,891**

(3) House Connection

Nos.
5,726

(4) Septic Tank Soak Pit

Nos.
8

Source: DPR Mirzapur Comprehensive revised by JICA Survey Team

2) ID&T Case

The population projection in catchments of existing drains and the wastewater flow projection to be intercepted from each drain are shown in the following table. The flow calculations of interceptor and connecting sewers from interception chambers (ICs) were made based on these flows and peak factors.

Table 8.1.8 List of Drains with Projected Population and Wastewater Generation to be intercepted in Mirzapur City (ID&T)

No.	Drain Name	Population		Flow (MLD)		Note
		2020	2050	2020	2050	
Mirzapur Zone						
1	Bisundarpur Drain	14,703	21,947	1.747	2.607	IC1
2	Hanumanghat Drain	9,110	13,339	1.082	1.585	IC2
3	Public Club Drain	5,617	8,490	0.667	1.009	IC3
4	Barahmiliah Drain	3,744	5,660	0.445	0.672	IC4
5	District Judge Drain	3,052	4,378	0.363	0.520	IC5
6	Lift Canal Drain	3,052	4,378	0.363	0.520	IC6
7	Irrigation Colony Drain	690	990	0.082	0.118	IC7
8	Morcha Ghar Drain	15,268	20,131	1.814	2.392	IC8
9	Ghoreshahid Drain	66,252	89,480	7.871	10.630	IC9
10	Kachari Drain	14,408	21,272	1.712	2.527	Existing IC
11	Oliyar Drain	24,345	31,089	2.892	3.693	Existing IC
12	Sundar Drain	5,180	6,795	0.615	0.807	Existing IC
13	Bandali Drain	11,247	15,707	1.336	1.866	Existing IC
14	Konia Drain	2,238	3,172	0.266	0.377	IC10
15	Narghat Drain	10,899	14,029	1.295	1.667	Existing IC
16	Balaji Temple Drain	21,260	29,526	2.526	3.508	IC11
17	Khandawa Drain	37,796	53,922	4.490	6.406	IC13
18	Chorawa Drain	2,403	3,632	0.285	0.432	IC12
	Sub-total	**251,262**	**347,938**	**29.850**	**41.335**	
Vindhyanchal Zone						
19	Basvariya Drain	8,359	23,490	0.993	2.791	IC15
20	Diwan Ghat new Drain	277	598	0.033	0.071	IC16
21	Diwan Ghat old Drain	923	1,993	0.110	0.237	Existing IC
22	Balughat Kacha Drain	92	199	0.011	0.024	IC17
23	Balughat Pakka Drain	1,569	3,387	0.186	0.402	Existing IC
24	Parasuram Drain	9,586	20,484	1.139	2.434	Existing IC
25	Gudara Drain	1,845	3,985	0.219	0.473	Existing IC
26	Malhaya Drain	2,532	5,360	0.301	0.637	IC14
27	Patengra (Manasarovar) Drain	9,842	16,190	1.169	1.923	IC14
	Sub-total	**35,025**	**75,686**	**4.161**	**8.991**	
Total		**286,287**	**423,624**	**34.011**	**50.326**	

Source: DPR Mirzapur ID&T arranged by JICA Survey Team

The proposed BOQ of sewer related works in Mirzapur City with ID&T method is tabulated as below. The proposed sewerage system is shown in **Figure 8.1.10.**

Table 8.1.9 Proposed Sewer Works in Mirzapur City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Interceptor				
RCC	NP3	200	750	0
RCC	NP3	250	400	0
RCC	NP3	300	800	0
RCC	NP3	350	0	0
RCC	NP3	400	555	0
RCC	NP3	450	550	0
RCC	NP3	500	1,659	0
RCC	NP3	600	2,211	0
RCC	NP3	700	0	0
RCC	NP3	800	210	0
RCC	NP3	900	1,700	0
RCC	NP3	1000	0	0
RCC	NP3	1200	0	0
Sub-total			**8,835**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	**370**	
DI	K9	250	-	
DI	K9	300	**3,550**	
DI	K9	350		
DI	K9	600	**80**	
DI	K9	700	**1,370**	
Sub-total			**5,370**	
3) Treated Effluent Reuse Line				
RCC	NP3	800	**7,000**	
Total			**21,205**	

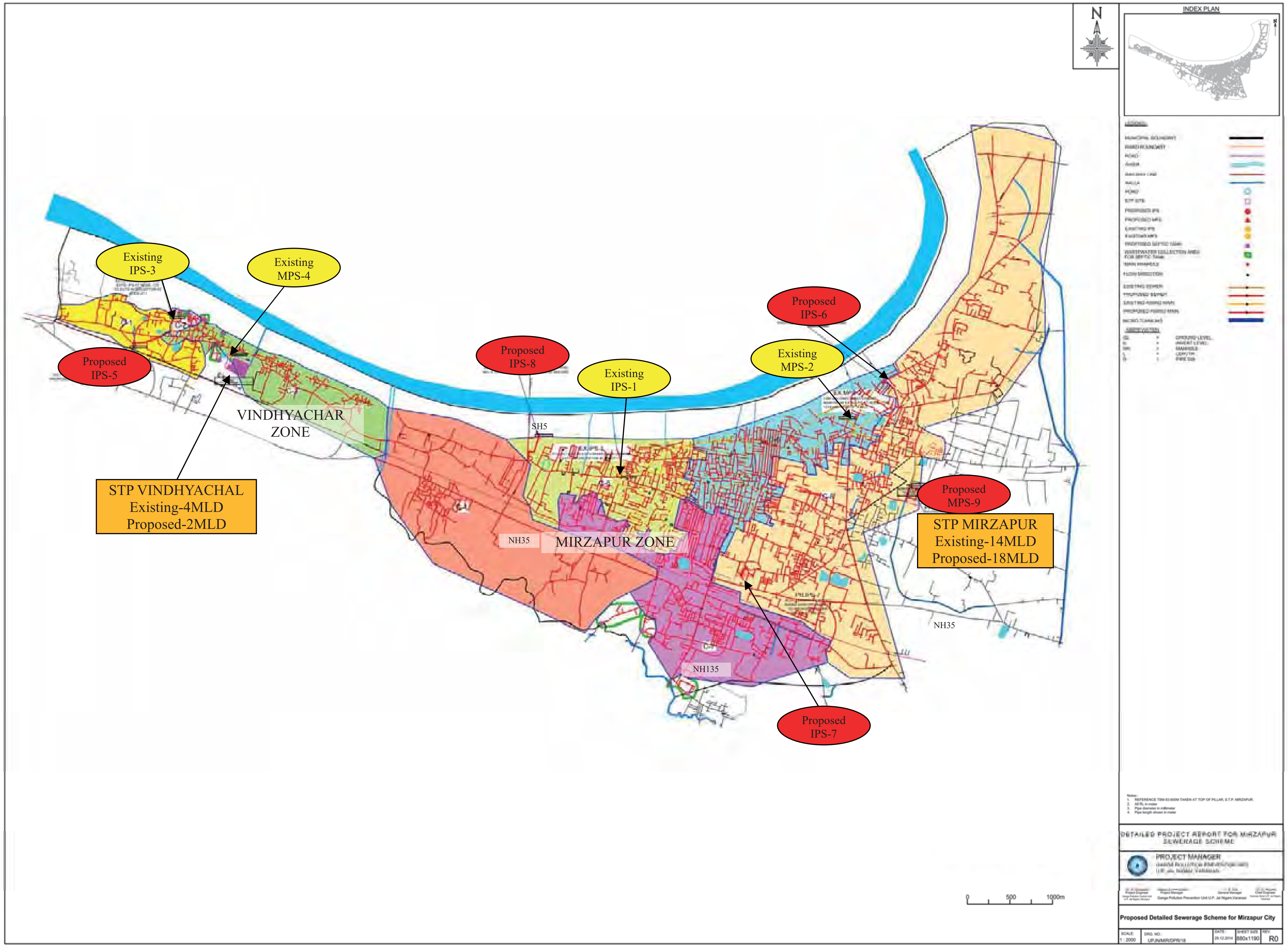
(2) Manhole

1) Interceptor	
900	241
1200	65
Sub-total	306
2) Treated Effluent Reuse Line	
900	38
Total	**344**

(3) Interception Structure (Nala Tapping Structure)

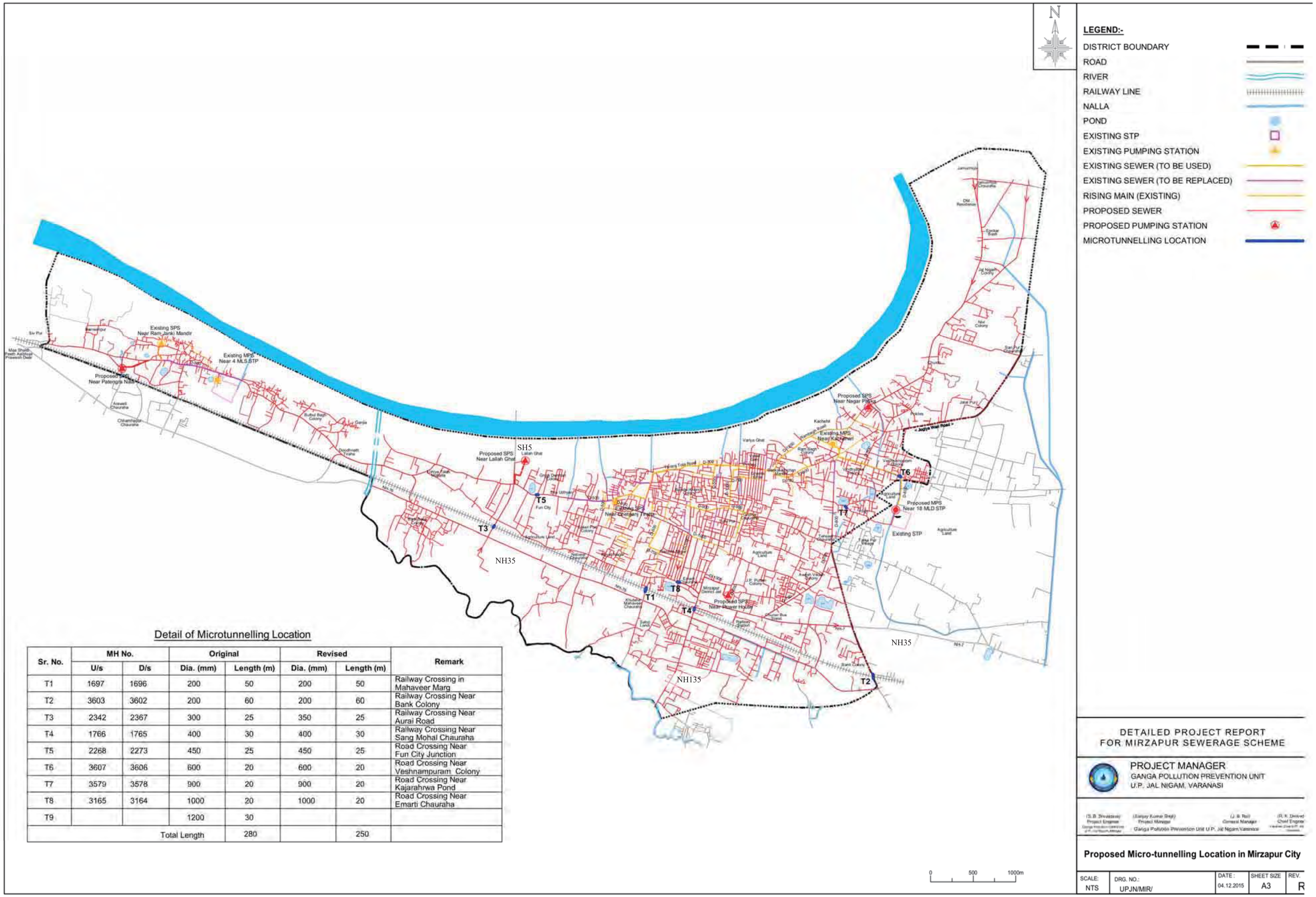
Zone	Nos.	
	New	Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

Source: DPR Mirzapur ID&T revised by JICA Survey Team



Source: DPR Mirzapur Comprehensive revised by JICA Survey Team

Figure 8.1.8 Proposed Sewer Network in Mirzapur City (Comprehensive)

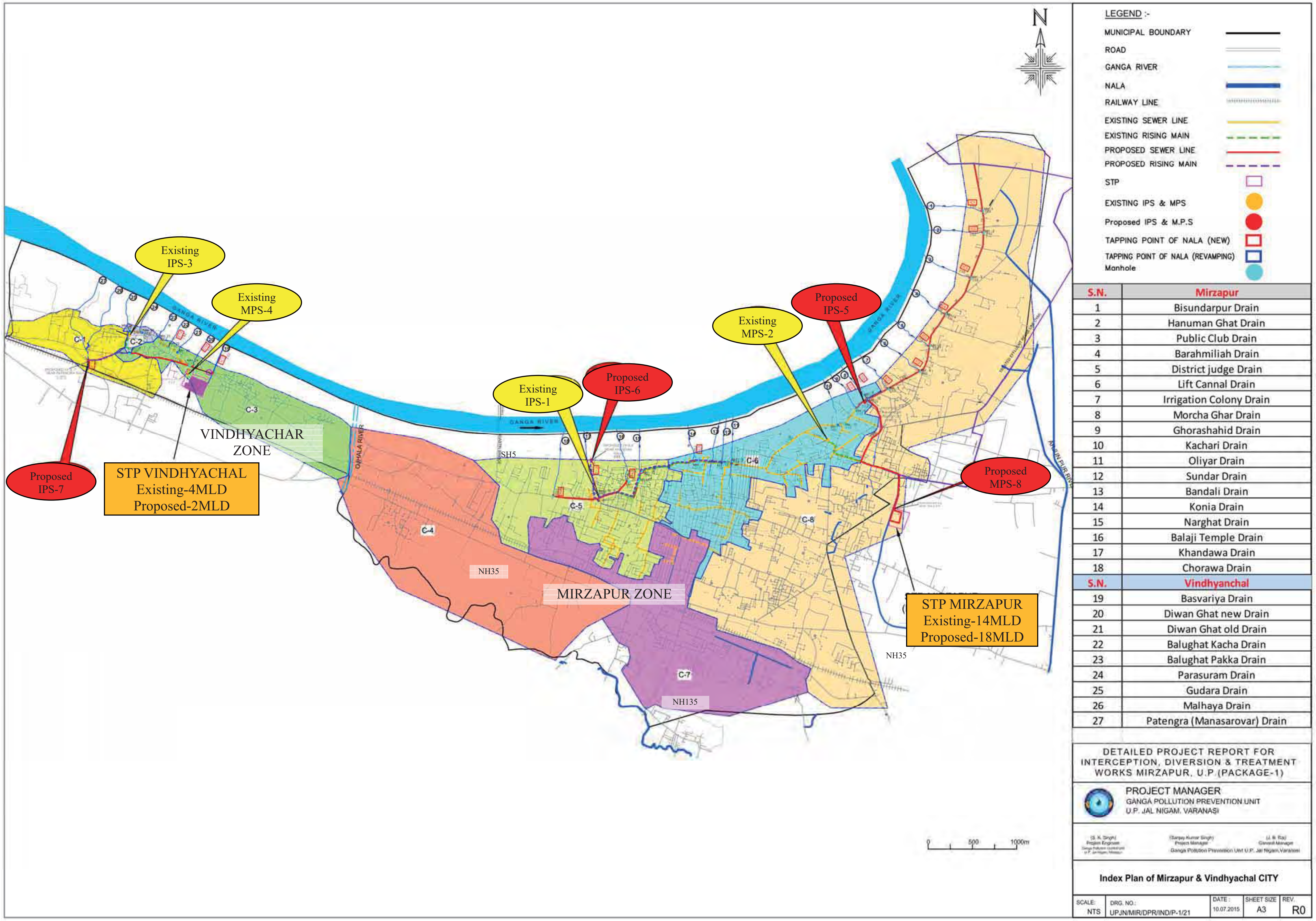


Detail of Microtunnelling Location

Sr. No.	MH No.		Original		Revised		Remark
	U/s	D/s	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	
T1	1697	1696	200	50	200	50	Railway Crossing in Mahaveer Marg
T2	3603	3602	200	60	200	60	Railway Crossing Near Bank Colony
T3	2342	2367	300	25	350	25	Railway Crossing Near Aurai Road
T4	1766	1765	400	30	400	30	Railway Crossing Near Sang Mohal Chauraha
T5	2268	2273	450	25	450	25	Road Crossing Near Fun City Junction
T6	3607	3606	600	20	600	20	Road Crossing Near Veshnampuram Colony
T7	3579	3578	900	20	900	20	Road Crossing Near Kajarahrwa Pond
T8	3165	3164	1000	20	1000	20	Road Crossing Near Emarti Chauraha
T9			1200	30			
Total Length				280		250	

Source: JICA Survey Team based on DPR Mirzapur Comprehensive

Figure 8.1.9 Proposed Micro Tunnelling Locations in Mirzapur City (Comprehensive)



Source: DPR Mirzapur ID&T revised by JICA Survey Team

Figure 8.1.10 Proposed Sewer Network in Mirzapur City (ID&T)

8.1.6 Proposed Sewer Works in Chunar City

In common with the case of Mirzapur, two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga have been prepared for Chunar City.

1) Comprehensive Case

The proposed BOQ of sewer related works in Chunar City with comprehensive method is tabulated as follows and the sewerage map is shown in **Figure 8.1.11**. The proposed micro tunneling locations are shown in **Figure 8.1.12**.

Table 8.1.10 Proposed Sewer Works in Chunar City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200	49,017	70
RCC	NP3	250	2,033	27
RCC	NP3	300	3,399	15
RCC	NP3	350	1,069	470
RCC	NP3	400	1,252	0
RCC	NP3	450	126	50
RCC	NP3	500	1,377	0
RCC	NP3	600	615	0
RCC	NP3	700	1,916	0
Sub-total			**60,804**	**632**
2) Rising Main				
DI	K9	150	1,670	
DI	K9	200	900	
DI	K9	250		
DI	K9	300		
DI	K9	350	1,250	
Sub-total			3,820	
Total			**65,256**	

(2) Manhole

Dia. (mm)	Nos.
900	2,582
1200	73
Total	**2,655**

(3) House Connection

Nos.
2,285

Source: DPR Chunar Comprehensive revised by JICA Survey Team

2) ID&T Case

Table 8.1.11 shows the list of existing drains in Chunar City with projected population and wastewater generations for 2020 (base year) and 2050 (ultimate year) in DPR ID&T. The wastewater from colonies around No. 2, 3, 5, and 6 drains were designed with primary treatment in septic tanks because of the low lands where are difficult to connect to interceptor and ones around No. 17 to 22 drains towards Jargo River were left since water in Jargo River has been utilized for farm land and no wastewater does not flow into Ganga River at present.

Table 8.1.11 List of Drains with Projected Population and Wastewater Generation in Chunar City

No.	Name of Drain	Population		Flow (MLD)		IC No.	Treatment
		2020	2050	2020	2050		
Towards Ganga River							
1	Tambal Ganj	8,151	20,771	0.97	2.47	IC1	STP
2	Bhairam Ganj East	944	2,193	0.11	0.26	IC2	Septic Tank
3	Bhairam Ganj West	734	1,706	0.09	0.20	IC3	Septic Tank
4	Dargah Sharif	6,354	12,963	0.75	1.54	IC4	STP
5	Tekaur Basti North	2,946	4,779	0.35	0.57	IC5	Septic Tank
6	Tekaur Basti South	1,158	2,180	0.14	0.26	IC6	Septic Tank
7	Santoshi Mata Mandir	657	906	0.08	0.11	IC7	STP
8	Post Office South	3,217	4,093	0.38	0.49	IC8	STP
9	Post Office North	2,268	2,583	0.27	0.31	IC9	STP
10	Gangeshwar (Nishad Park)	1,337	1,265	0.16	0.15	IC10	STP
11	Balu Ghat	1,322	2,992	0.16	0.36	IC11	STP
12	Belbeer Ghat	331	748	0.04	0.09	IC12	STP
13	Choura Mata Mandir (Ramghat)	331	748	0.04	0.09	IC13	STP
14	Kasi Ram Awas	1,322	2,992	0.16	0.36	IC14	STP
Towards Jargo River							STP
15	Parade Ground	1,965	1,901	0.23	0.23	IC15	STP
16	Nagar Palika	1,334	1,265	0.16	0.15	IC16	STP
17	Nagarpur	1,408	2,300	0.17	0.27		Used for farm land
18	Tekaur Nagarpur (Chunar Fort)	1,318	1,757	0.16	0.21		Used for farm land
19	Bharatpur Kabristan	1,621	1,699	0.19	0.20		Used for farm land
20	Bharatpur Trimohani	986	1,179	0.12	0.14		Used for farm land
21	Saddupur Naipurwa (Ganda)	6,861	7,619	0.80	0.88		Used for farm land
22	Pashu Chikitsalaya	1,436	1,361	0.17	0.16		Used for farm land
Total		**48,000**	**80,000**	**5.68**	**9.48**		
Intercepted		**34,370**	**64,085**	**4.08**	**7.61**		
Treated in STP		**28,588**	**53,226**	**3.40**	**6.32**		

Source: DPR Chunar ID&T Flow-I Main Report compiled by JICA Survey Team

The proposed BOQ of sewer related works in Chunar City with ID&T method is tabulated in Table 8.1.12 and the sewerage map is shown in **Figure 8.1.13**. Since the longitudinal profile (L-section) for interceptor was not prepared in DPR the JICA Survey Team prepared the drawing based on flow calculation sheet as shown in Appendix 8.1.3.

Table 8.1.12 Proposed Sewer Works in Chunar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200		
RCC	NP3	250	700	
RCC	NP3	300		
RCC	NP3	350	250	
RCC	NP3	400		
RCC	NP3	450		
RCC	NP3	500		
RCC	NP3	600	1,550	
RCC	NP3	700	1,808	
Sub-total			**4,308**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	2,130	
DI	K9	250	-	
DI	K9	300	-	
DI	K9	350	30	
Sub-total			**2,160**	
3) Treated Effluent Reuse Line				
RCC	NP3	350	**3,695**	
Total			**10,163**	

(2) Manhole

Dia. (mm)	Nos.
900	86
1200	63
Total	**149**

(3) Interception Structure

Nos.
16

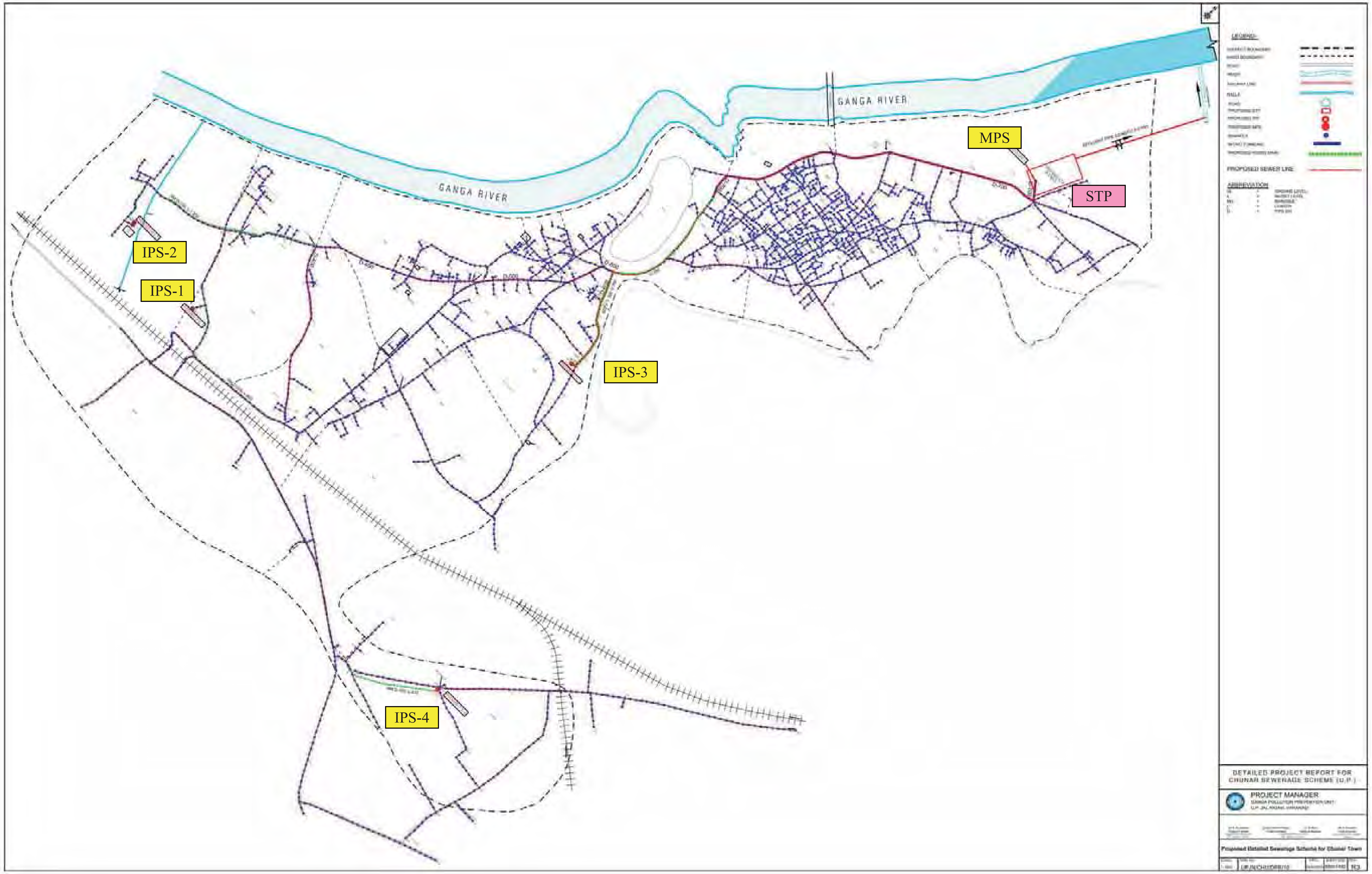
(4) Septic Tank Soak Pit

Nos.
4

(5) House Connection

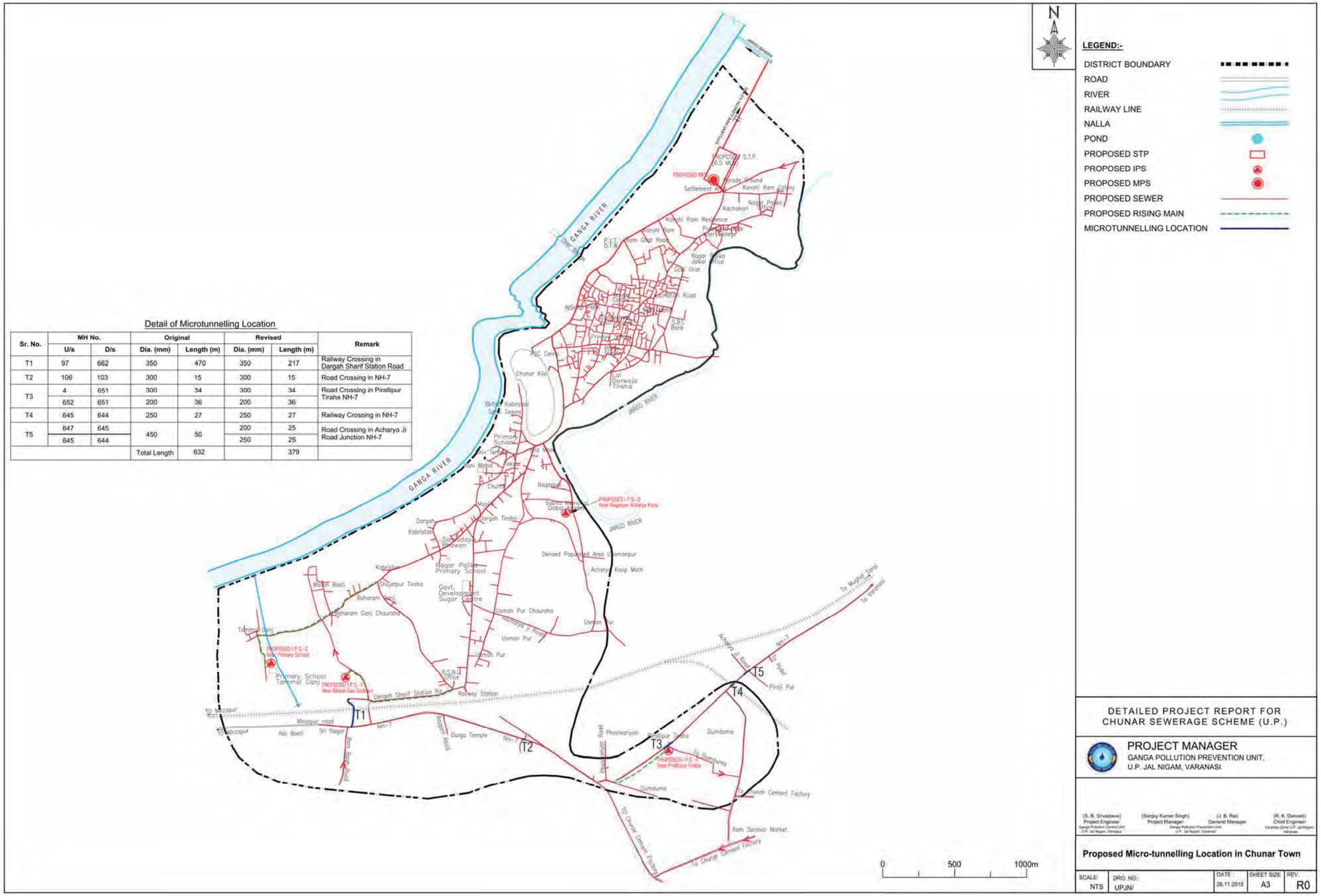
Nos.
0

Source: DPR Chunar ID&T revised by JICA Survey Team



Source: DPR Chunar Comprehensive compiled by JICA Survey Team

Figure 8.1.11 Proposed Sewer Network in Chunar City (Comprehensive)

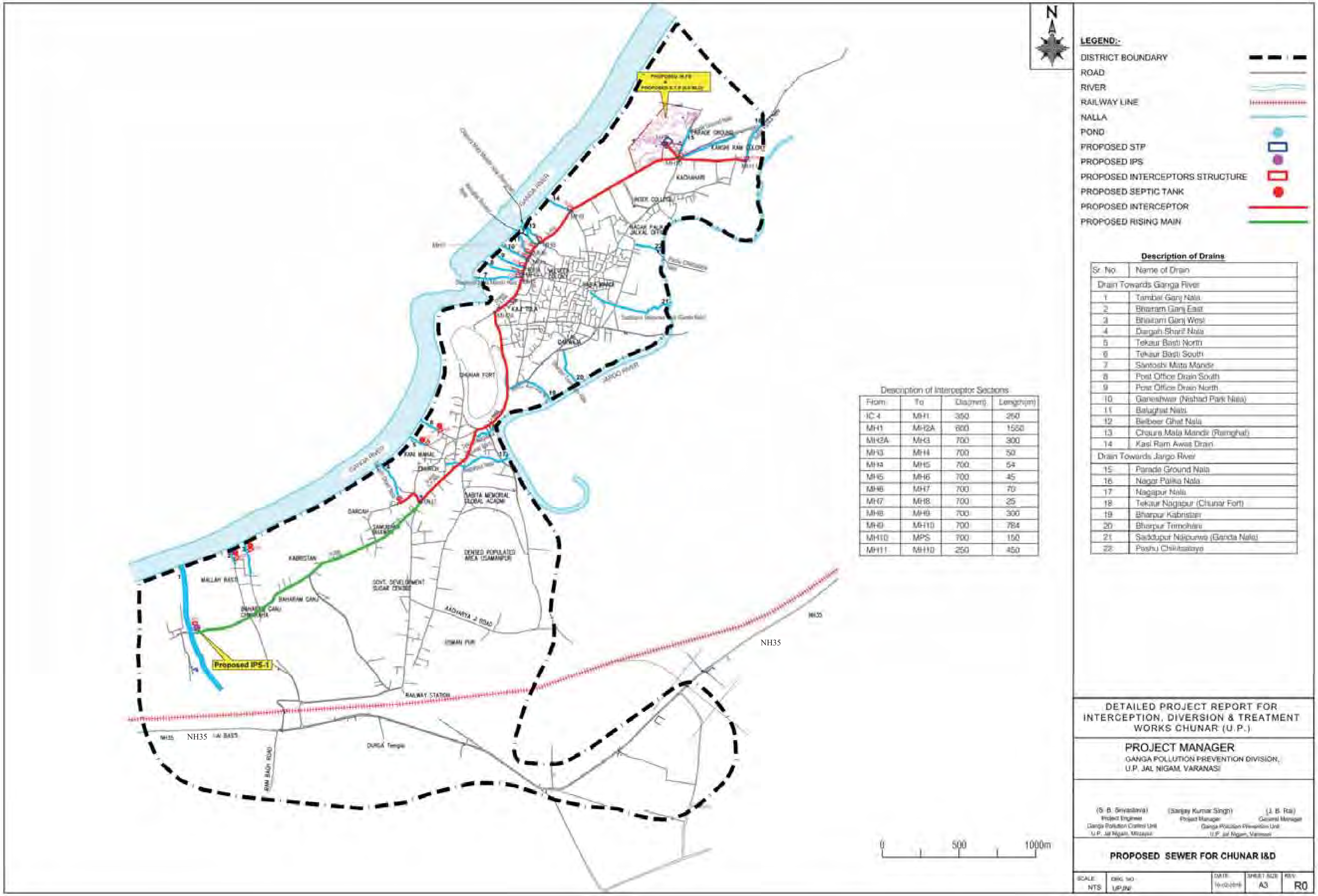


Detail of Microtunnelling Location

Sr. No.	MH No.		Original		Revised		Remark
	U/s	D/s	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	
T1	97	662	350	470	350	217	Railway Crossing in Dargah Sharif Station Road
T2	106	103	300	15	300	15	Road Crossing in NH-7
T3	4	651	300	34	300	34	Road Crossing in Pirallipur Tiraha NH-7
	652	651	200	36	200	36	
T4	645	644	250	27	250	27	Railway Crossing in NH-7
T5	647	645	450	50	200	25	Road Crossing in Acharya Ji Road Junction NH-7
	645	644			250	25	
			Total Length	632		379	

Source: JICA Survey Team based on DPR Chunar Comprehensive

Figure 8.1.12 Proposed Micro Tunnelling Locations in Chunar City (Comprehensive)



Source: DPR Chunar ID&T compiled by JICA Survey Team

Figure 8.1.13 Proposed Sewer Network in Chunar City (ID&T)

8.1.7 Proposed Sewer Works in Ghazipur City

1) Comprehensive Case

The DPR for Ghazipur City was prepared with comprehensive method as shown in **Figure 8.1.14**. Since the original file of sewerage map has not been submitted to UPJN from the DPR consultant, JICA Survey Team recreated the map based on the image file. The following table shows the bill of quantity of sewer works in DPR comprehensive for Ghazipur City.

Table 8.1.13 Proposed Sewer Works in Ghazipur City

(1) Sewer Pipe

Material	Class of Pipe	Dia. (mm)	Length: Open (Rm)				Length: Micro Tunneling (Rm)
			Zone-I	Zone-II	Zone-III	Total	
1) Gravity							
RCC	NP3	150	5,502	5,681	24,559	35,742	
RCC	NP3	200	5,107	3,504	13,621	22,232	
RCC	NP3	250	1,170	751	3,653	5,574	
RCC	NP3	300	176	1,032	2,456	3,664	
RCC	NP3	350	74	249	2,927	3,250	
RCC	NP3	400	492	379	733	1,604	
RCC	NP3	450	0	0	1,169	1,169	
RCC	NP3	500	261	538	1,943	2,742	
RCC	NP3	600	521	487	133	1,141	
RCC	NP3	700			525	525	
RCC	NP3	800			0	0	
RCC	NP3	900			2,415	2,415	
RCC	NP3	1000			264	264	
RCC	NP3	1100			188	188	
RCC	NP3	1200			0	0	
Sub-total			**13,303**	**12,621**	**54,586**	**80,510**	**0**
2) Rising Main							
DI	K-7	200				250	
DI	K-9	350				1,440	
DI	K-9	700				25	
Sub-total						1,715	
Total						**82,225**	

(2) Manhole

Total Nos.	1,721

(3) House Connection

Nos.
3,900

Source: DPR Ghazipur Comprehensive compiled by JICA Survey Team

2) ID&T Case

UPJN says that DPR with ID&T method would be prepared separately from comprehensive as urgent work required by NMCG. However, there are many rivers which flows much groundwater and it makes difficult to intercept only wastewater. UPJN has not started the preparation of DPR ID&T as of end of February 2016.

Source: JICA Survey Team based on DPR Ghazipur Comprehensive

Figure 8.1.14 Proposed Sewerage System in Ghazipur City (Comprehensive)

8.1.8 Proposed Sewer Works in Saidpur City

1) Comprehensive Case

The DPR for Saidpur City in Ghazipur District was prepared with comprehensive method. However, DPR with ID&T method is under preparation by UPJN in accordance with the requirement by UPJN.

The following table shows the bill of quantity of sewer works in the said DPR comprehensive for Saidpur City:

Table 8.1.14 Proposed Sewer Works in Saidpur City

(1) Sewer Pipe

Material	Dia. (mm)	Open (Rm)	Micro Tunneling (Rm)
1) Gravity			
RCC	150	18,885	
RCC	200	18,854	
RCC	250	1,340	
RCC	300	1,270	
RCC	350	50	
RCC	400	1,545	
RCC	450	494	
RCC	500	0	
RCC	600	200	
Sub-total		**42,638**	**0**
2) Rising Main			
DI	N/A	N/A	
DI (Class K-9)	350	30	
Total		**42,668**	

(2) Manhole

Dia. (mm)	Nos.
Sewer connecting chamber	1,091
Ventilating columns	10
Others	349
Total	**1,450**

(3) House Connection

Nos.
N/A

Source: DPR Saidpur Comprehensive compiled by JICA Survey Team

2) ID&T Case

DPR ID&T is under preparation by UPJN as of February 2016. In the course of the preparation UPJN refers to the old DPR ID&T for Saidpur which was prepared in 1997. **Table 8.1.15** shows the bill of quantity of sewer works in the old DPR ID&T for Saidpur City for reference. Obviously the diameter of the interceptor and the number of interception structure (target nalas) will be increased. However, observed from 1) locations of all the nalas in the city, 2) narrow and carving road for candidate interceptor route, 3) no enough space for constructing interception structure, and 4) congested houses between the road and River Ganga which causes difficulty to intercept all the wastewater near the road, it can be said that ID&T method in this city is quite difficult and JICA survey team recommended the comprehensive method in this city. However, since this city is small with the population of less than 100,000 this city will be developed with ID&T method in accordance with NMCG's requirement.

Figure 8.1.15 shows the tentative sewerage map for ID&T which was prepared based on route survey and interview to UPJN.

Table 8.1.15 Sewer Works in Old DPR ID&T Saidpur City (Reference)

(1) Sewer Pipe

Material	Dia. (mm)	Open (Rm)	Micro Tunneling (Rm)
1) Gravity			
RCC	200	560	
RCC	250	180	
RCC	300	190	
RCC	350	160	
RCC	400	145	
Sub-total		**1,235**	**0**
2) Rising Main			
CI	200	500	
Total		**1,735**	

(2) Manhole

Dia. (mm)	Nos.
1.0x1.5x3.0m	29
Total	**29**

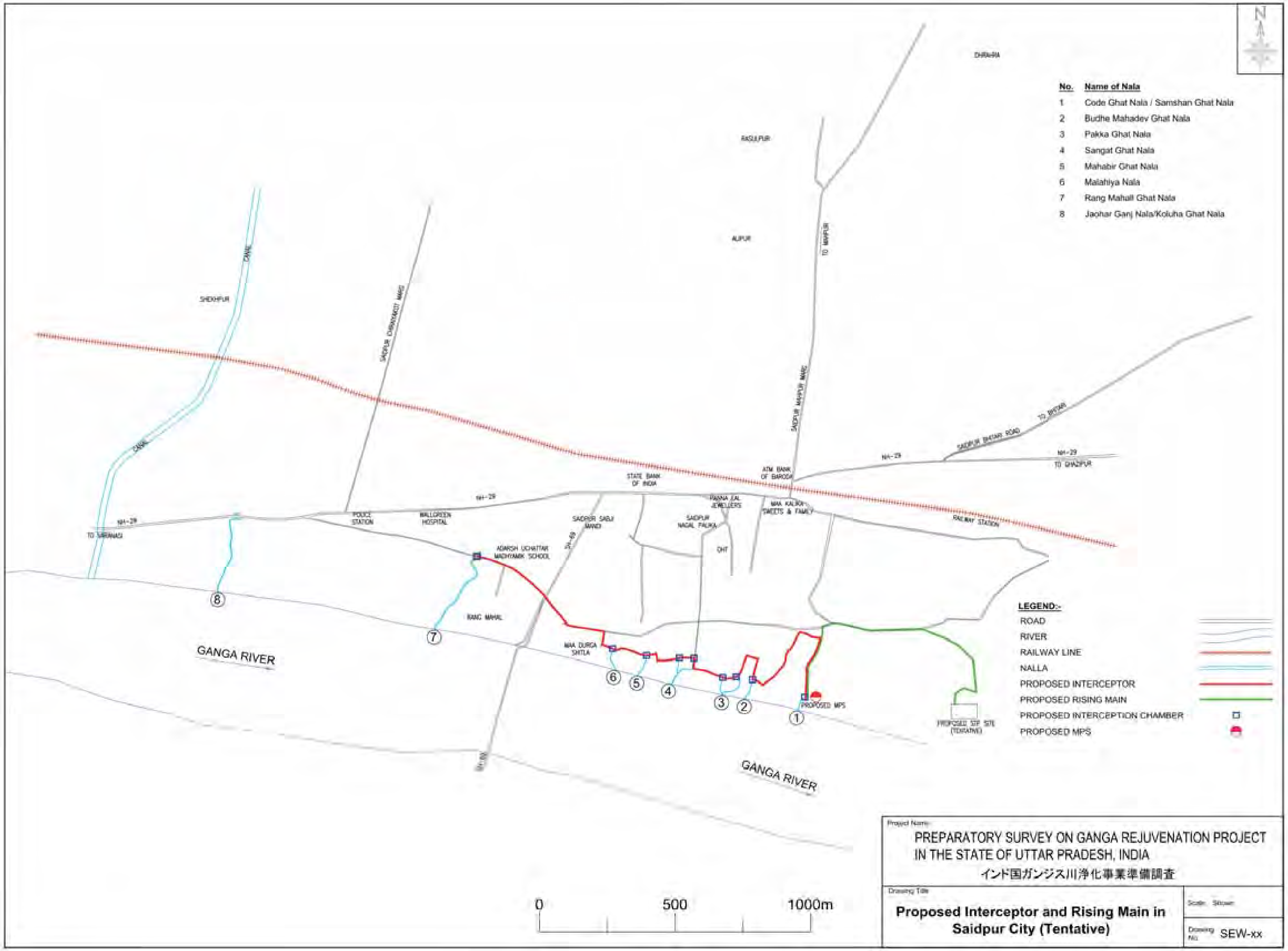
(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Saidpur ID&T compiled by JICA Survey Team



Source: JICA Survey Team based on Interview to UPJN

Figure 8.1.15 Proposed Interceptor in Saidpur City (ID&T): Tentative

8.1.9 Abstract of Proposed Sewer Works in Target Cities

Table 8.1.16 shows the list of proposed sewer works in target cities.

Table 8.1.16 Abstract of Proposed Sewer Works in Target Cities in Existing DPRs

No.	Item	Material	Dia. (mm)																								
			District	Varanasi										Mirzapur								Ghazipur					
			City/Town	Varanasi						Ramnagar				Mirzapur				Chunar				Ghazipur		Saidpur			
			Sewerage District	District-I		District-II		District-III		-		-		-		-		-		-		-		-		-	
			Comprehensive/I&D	Comprehensive		Comprehensive		Comprehensive		Comprehensive		I&D		Comprehensive		I&D		Comprehensive		I&D		Comprehensive		Comprehensive		I&D (old)	
	Item	Material	Dia. (mm)	Open (m)	Trenchless (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																										
	1) Gravity	RCC	150																			35,742	0	18,885	0		
		HDPE	160							24,148	0																
		RCC	200	193,294	840	236,690	332	109,441	0	21,586	0	0	0	217,181	110	750	0	49,017	70	0	0	22,232	0	18,854	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	3,751	0	0	0	3,814	0	400	0	2,033	27	700	0	5,574	0	1,340	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	1,335	0	0	0	9,141	25	800	0	3,399	15	0	0	3,664	0	1,270	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	298	0	80	0	1,716	0	0	0	1,069	470	250	0	3,250	0	50	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	713	0	150	0	4,219	30	555	0	1,252	0	0	0	1,604	0	1,545	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	551	0	0	0	1,275	25	550	0	126	50	0	0	1,169	0	494	0		
		RCC	500	2,081	99	2,875	540	288	39	276	0	120	0	1,908	0	1,659	0	1,377	0	0	0	2,742	0	0	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	0	0	586	20	2,211	0	615	0	1,550	0	1,141	0	200	0		
		RCC	700	84	30	1,924	90	2,603	165	782	0	0	0	1,899	0	0	0	1,916	0	1,808	0	525	0				
		RCC	800	317	90	570	439	867	0	2,200	0	0	0	1,199	0	210	0					0	0				
		RCC	900	0	0	1,244	918	0	0			30	0	970	20	1,700	0					2,415	0				
		RCC	1000											1,537	20	0	0					264	0				
		RCC	1200											0	30	0	0					188	0				
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	55,637	0	380	0	245,445	280	8,835	0	60,804	632	4,308	0	80,510	0	42,638	0	1,235	0
			Total	219,648		276,007		120,342		55,637		380		245,725		8,835		61,436		4,308		80,510		42,638		1,235	
	2) Rising Main	DI	100							3,700																	
		DI	150							0				334		0		1,670		0							
		DI	200					30		0				730		370		900		2,130		250					
		CI	200																							500	
		DI	250							0				334		0		0		0							
		DI	300							0				66		3,550		0		0							
		DI	350							150				1,700		0		1,250		30		1,440		30			
		DI	400							50		2,700															
		DI	600													80											
		DI	700											1,370		1,370						25					
		DI	800											30													
			Total	0	-	0	-	30	-	3,900	-	2,700	-	4,563	-	5,370	-	3,820	-	2,160	-	1,715		30	-	500	-
	3) Treated Effluent Reuse Line																										
		RCC	350	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-		
		RCC	800	-	-	-	-	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-	-	-		
	Total of pipe laying work			219,648		276,007		120,372		59,537		3,080		250,288		21,205		65,256		10,163		82,225		42,668		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159		1,284				10,210		279		2,582		86							
			1200	27		145		149		421				162		65		73		63							
			1500							913																	
			1200x900							144																	
			1000x1500																							29	
			1500x1500							34		10															
			Total	10,925	-	13,128	-	5,308	-	2,796	-	10	-	10,372	-	344	-	2,655	-	149	-	1,721	-	1,450	-	29	
3	Desilting of Existing Sewer Pipe			-	483	-	710	-	22,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Interception Structure		Zone											Mirzapur	Vindhyachal	Mirzapur	Vindhyachal										
	1) New		nos.	-	-	-	-	-	-	-	-	4	-	-	-	13	4	-	-	16	-	-	-	-	-	4	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	-	-	4	-	-	-	18	8	-	-	16	-	-	-	-	-	4	-
4	House Connection																										
	1) New		nos.	9,804	-	34,216	-	18,261	-	5,525	-	-	-	28,629	-	-	-	2,285	-	-	-	3,900	-	N/A	-	-	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Septic tank soak pit		nos.	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	4	-	-	-	-	-	-	-
6	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) Rehabilitation		nos.	-	-	-	-	-	-	-	-	-	-	2	2	2	2	-	-	-	-	-	-	-	-		
	2) New		nos.	-	-	-	-	1	-	2	1	0	1	4	1	3	1	4	1	1	1	3	1	1	1	0	1
	Total		nos.	0		0		1		3		1		9		8		5		2		4		2		1	

Source: JICA Survey Team compiled from DPRs for target cities

8.2 Intermediate Pump Stations (IPSs)

8.2.1 Proposed Pumping Stations in Varanasi City District-I

No IPS and MPS works were confirmed in proposed DPR.

8.2.2 Proposed Pumping Stations in Varanasi City District-II

No IPS and MPS works were confirmed in proposed DPR.

8.2.3 Proposed Pumping Stations in Varanasi City District-III

One lift pumping station to transfer the wastewater from the secondary sewer and flow into Assi Interceptor was confirmed. The general specification is shown in the table below. The plan and section confirmed in DPR is shown in Appendix 8.2.1.

Table 8.2.1 General Specification of Proposed IPS in Varanasi District-III

No.	LPS (New)													
	Location	Flow (MLD)		Pumps								Rising Main		
		2035	2050	Total	Duty	Standby	Capacity (m3/hr)	Total Capacity (Duty) (m3/hr)	Total Capacity (Duty) (MLD)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	near Sarai Nandan (MH No. 1295)	3.92	6.45	6	4	2	100	400	9.6	15	10	DI	200	30

Source: JICA Survey Team confirmed from DPR Varanasi District III

8.2.4 Proposed Pumping Stations in Ramnagar City

1) Comprehensive Case

Two IPSs and a MPS were proposed in DPR Ramnagar Comprehensive as specified in following table.

Table 8.2.2 General Specification of Proposed Pumping Stations in Ramnagar City (Comp.)

No.	PS	Location	PS Capacity (MLD)	Required Area (m2)	Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
							Nos.	Duty	Standby						
1	IPS	Padao	1	625	Peak	Submersible	3	2	1	0.75	65	30	DI-K9	100	3,700
					Non-peak	Submersible	2	1	1	0.25	65	15			
2	IPS	Sangat Maidan	9.2	625	Peak	Submersible	3	2	1	5.3	20	60	DI-K9	350	150
					Non-peak	Submersible	2	1	1	3.2	20	35			
3	MPS	Kodopur	14	10000	Peak	Submersible	3	2	1	5.3	15	65	DI-K9	400	50
					Non-peak	Submersible	2	1	1	3.2	15	40			

Source: JICA Survey Team confirmed from DPR Ramnagar Comprehensive

2) ID&T Case

Only a MPS is proposed in DPR Ramnagar ID&T as specified in the table below. The proposed layout is shown in Appendix 8.2.2.

Table 8.2.3 General Specification of Proposed Pumping Stations in Ramnagar City (ID&T)

No.	PS	Location	PS Capacity (MLD)		Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
			Average	Peak			Nos.	Duty	Standby						
1	MPS	Ram Bagh Nala, Mallahi	**13**	29.25	Peak	Submersible non clog	3	2	1	7.84	55	180	DI-K9	400	2,700
					Non-peak	Submersible non clog	2	1	1	3.94	55	100			

Source: JICA Survey Team confirmed from DPR Ramnagar ID&T

8.2.5 Proposed Pumping Stations in Mirzapur City

1) Comprehensive Case

a) IPS

Two existing IPS will be rehabilitated and four new IPS will be constructed as shown in following tables.

Table 8.2.4 General Specification of Rehabilitated IPS in Mirzapur City (Comprehensive)

No.	Rehabilitation of Existing PS												
	Name	Location	Pump							Rising Main			
			Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
				Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur													
1	IPS-1	Imambara	450	3	2	1	17	900	21.6	Existing	DI	350	1700
			220	2	1	1	10	220	5.28	**Proposed**	**DI-K9**	**350**	**1700**
Vindhyachal													
2	IPS-3	Ram Janki Mandir	35	3	2	1	8	70	1.68	Existing	DI	80	250
			15	2	1	1	8	15	0.36	**Proposed**	**DI-K9**	**150**	**333.7**

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

Table 8.2.5 General Specification of New IPS in Mirzapur City (Comprehensive)

No.	Proposed									
	Name	Location	Pump					Rising Main		
			Capacity (cum/hr)	Nos.	Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
						(cum/hr)	(MLD)			
Mirzapur										
1	IPS-6	Sadar Post Office	125	3	13	375	9	DI-K9	200	39
			50	2	13	100	2.4			
2	IPS-7	district jail Mirzapur	280	3	13	840	20.16	DI-K9	300	36
			150	2	13	300	7.2			
3	IPS-8	lalah ghat	160	3	21	480	11.52	DI-K9	200	356
			65	2	17	130	3.12			
Vindhyachal										
4	IPS-5	Patengra Nala	145	3	14	435	10.44	DI-K9	200	335
			60	2	11	120	2.88			

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-9 in Mirzapur Zone.

Table 8.2.6 General Specification of Rehabilitated MPS in Mirzapur City (Comprehensive)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump							Rising Main			
			Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
				Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur													
1	MPS-2	Kutchary	850	3	2	1	10	1700	40.8	Existing	DI	700	1370
			445	2	1	1	9	445	10.68	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal													
2	MPS-4	near Vidyachal STP	150	6	4	2	7	600	14.4	Existing	DI	300	100
										Proposed	**DI-K9**	**300**	**30**

Table 8.2.7 General Specification of New MPS in Mirzapur City (Comprehensive)

No.	Proposed									
			Pump					Rising Main		
	Name	Location	Capacity (cum/hr)	Nos.	Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
						(cum/hr)	(MLD)			
Mirzapur										
1	MPS-9	near Existing STP	830	6	14	4980	119.52	DI-K9	800	30

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

2) ID&T Case

a) IPS

Two existing IPS will be rehabilitated and three new IPS will be constructed as shown in following tables. The proposed plans and sections for the new IPSs in DPR are shown in Appendix 8.2.3 to 8.2.5.

Table 8.2.8 General Specification of Rehabilitated IPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS														
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**
Vindhyachal														
2	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**

Table 8.2.9 General Specification of New IPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal													
3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	50	2	1	1	12	50	1.2			

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed as listed in tables below. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-8 in Mirzapur Zone. The plans and sections for proposed MPS-8 is shown in Appendix 8.2.6.

Table 8.2.10 General Specification of Rehabilitated MPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity (Duty)		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	MPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal														
2	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100
											Proposed	**DI-K9**	**300**	**30**

Table 8.2.11 General Specification of New MPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (m3/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	600	30

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

8.2.6 Proposed Pumping Stations in Chunar City

1) Comprehensive Case

Four IPSs and a MPS are proposed in DPR Chunar Comprehensive as specified in following table.

Table 8.2.12 General Specification of Proposed Pumping Stations in Chunar City (Comp.)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Bhart Gas Godown	Peak	Submersible	3	2	1	105	23	DI-K9	200	900
			Non-peak	Submersible	2	1	1	45	19			
2	IPS-II	Tambal Ganj	Peak	Submersible	3	2	1	60	21	DI-K9	150	1,200
			Non-peak	Submersible	2	1	1	25	14			
3	IPS-III	Nagarpur	Peak	Submersible	3	2	1	300	21	DI-K9	350	1,220
			Non-peak	Submersible	2	1	1	160	19			
4	IPS-IV	Pirallipura Tiraha	Peak	Submersible	3	2	1	30	18	DI-K9	150	470
			Non-peak	Submersible	2	1	1	10	17			
5	MPS	Settlement Area	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar Comprehensive

2) ID&T Case

One IPSs and a MPS are proposed in DPR Chunar ID&T as specified in following table. The layout of proposed IPS-I and MPS are shown in Appendixes 8.2.7 and 8.2.8.

Table 8.2.13 General Specification of Proposed Pumping Stations in Chunar City (ID&T)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Tambal Ganj	Peak	Submersible	3	2	1	105	23	DI-K9	200	2,130
			Non-peak	Submersible	2	1	1	45	19			
					5	3	2					
2	MPS	Near STP	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar ID&T

8.2.7 Proposed Pumping Stations in Ghazipur City

a) IPS

Three IPSs were proposed in DPR Ghazipur Comprehensive as specified in following table. The plans and sections for the proposed IPSs are shown in Appendix 8.2.9 to 8.2.11. As can be confirmed from the 3 drawings, contents for 3 IPSs including even levels in texts are completely same.

Table 8.2.14 General Specification of Proposed IPSs in Ghazipur City (Comp.)

No.	Name	Location	Capacity (mld)	Pumps						Rising Main		
				Nos.	Capacity		Total Capacity	Head (m)	HP	Material	Dia. (mm)	Length (m)
					(lps)	(m3/min)	(mld)					
1	IPS-I	Steamer Ghat	14.374	5	50	3.00	21.60	20	25.0	DI (K-9)	350	450
2	IPS-II	Dadri Ghat	13.334	5	50	3.00	21.60	20	25.0	DI (K-9)	350	990
3	IPS-III	Foxganj	3.171	5	15	0.90	6.48	20	7.5	DI (K-7)	200	250

Source: JICA Survey Team confirmed from DPR Ghazipur Comprehensive

b) MPS

One MPS was proposed in DPR Ghazipur Comprehensive as specified in following table. The plans and sections for the proposed MPS is shown in Appendix 8.2.12.

Table 8.2.15 General Specification of Proposed MPS in Ghazipur City (Comp.)

No.	Name	Location	Capacity (mld)	Pumps						Rising Main		
				Nos.	Capacity		Total Capacity	Head (m)	HP	Material	Dia. (mm)	Length (m)
					(lps)	(m3/min)	(mld)					
1	MPS	near proposed STP	49.815	5	200	12.00	86.40	22	100	DI (K-9)	700	25

Source: JICA Survey Team confirmed from DPR Ghazipur Comprehensive

8.2.8 Proposed Pumping Stations in Saidpur City

1) Comprehensive Case

Only a MPS could be confirmed from the limited photos of pages in the DPR comprehensive as specified in the following table.

Table 8.2.16 General Specification of Proposed Pumping Station in Saidpur City (Comp.)

No.	Name	Location	Pump							Rising Main		
			Area (m2)	Flow	Capacity			Nos.	Head (m)	Material	Dia.(mm)	Length (m)
					(kL/hr)	(LPS)	(m3/min)					
1	MPS	near proposed STP	50.24	Peak	577.13	165	9.6	6	15		350	30
				Average	256.5	75	4.3					
				Non-peak	153.9	45	2.6					

2) ID&T Case - OLD

Only a MPS was proposed in old DPR ID&T as specified in the following table.

Table 8.2.17 General Specification of Proposed Pumping Station in Saidpur City (ID&T-old)

No.	Name	Location	Pump							Rising Main		
			Flow	Nos.	Capacity (lpm)	Total Capacity (lpm)	Discharge (m3/sec)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	MPS	nearby the Pucca Ghat	Peak	2	1350	3375	0.0563	27	13.5	CI	200	500
				1	675			27	7.5			
			Average	1	1350	1350	0.0225	27	13.5			
			Non-peak	1	675	675	0.0113	27	7.5			

Source: JICA Survey Team confirmed from old DPR Saidpur ID&T

8.3 Sewage Treatment Plants (STPs)

8.3.1 Dinapur and Bhagwanpur STPs

Dinapur STP

Existing STPs were designed to achieve BOD:TSS less than 30:50 mg/L respectively. In order to achieve the new treated effluent standards of BOD<10 mg/L TSS<10 mg/l and Total Nitrogen<10 mg/L, it is recommended to demolish the existing 80 MLD Dinapur STP and construct the new STP with the same capacity by single stage circulated nitrification-denitrification (CND) process in the revised DPR on August 20, 2016.

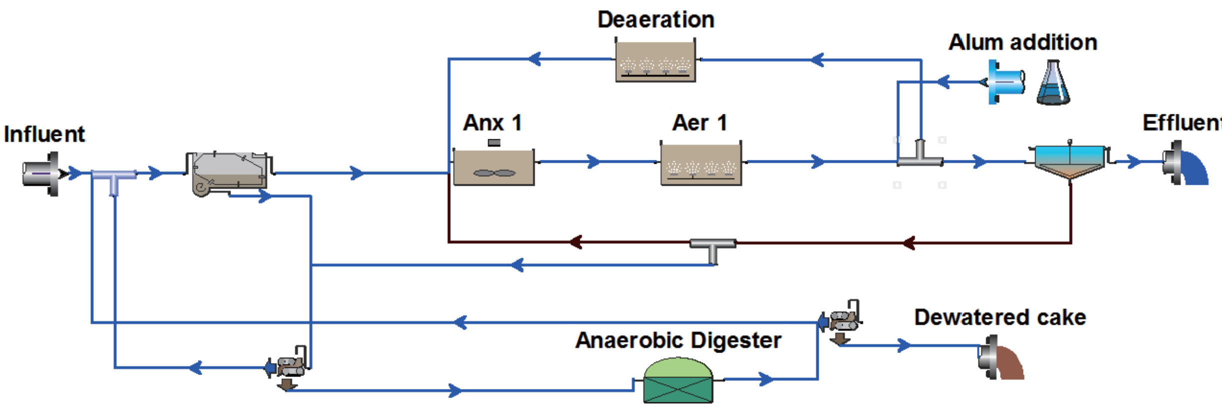


Figure 8.3.1 Flowchart of CND Process for Dinapur STP

Table 8.3.1 Outline of Major Facilities at 8 MLD Bhagwanpur STP

Sr. No.	Process Unit	Flow	Dimensions, in m				
			No	L	W/ Dia	SWD	Total
1	Inlet Chamber	160	1	1.21	7.3	4.2	4.7
2	Screen channel for fine screens	80	3	6	2.00	1.1	1.90
3	Screen channel for Manual screen	80	1	6	1.30	1.10	1.90
4	Grit Distribution Channel	160	1	12	1.23	1.00	1.50
5	Grit Chamber Vortex Type	80	3		6	5	5.5
6	Grit effluent channel including Parshall Flume	160	1	12	1.23	1	1.5
7	Primary Clarifiers		2		34	3.5	4
8	Primary Sludge Pump House		1	6.5	5		
9	Bio-Reactors		2	100	35	7.5	8
10	Blower room for Bio- reactors		1	15	10		5
11	Secondary Clarifiers		2		50	3.5	4
12	Return Sludge Pump House		1	10.5	10		
13	Tertiary System						
14	Sludge Thickener		2		20	4.5	
15	Thickened Sludge Pump House		1				
16	Anaerobic Digesters		2		26	11.2	
17	Thickened Sludge Pump House		1	13	15		5
18	Gas Holders		2		17	4	
19	Centrifuge Building		1	20	12		5

Bhagwanpur STP

Existing STPs were designed to achieve BOD:TSS less than 30:50 mg/L respectively. In order to achieve the new treated effluent standards of BOD<10 mg/L TSS<10 mg/l and Total Nitrogen<10 mg/L, it is recommended to demolish the existing 8 MLD Bhagwanpur STP and construct the new STP with the same capacity by Sequential Batch Reactor (SBR) process in the revised DPR on August 20, 2016.

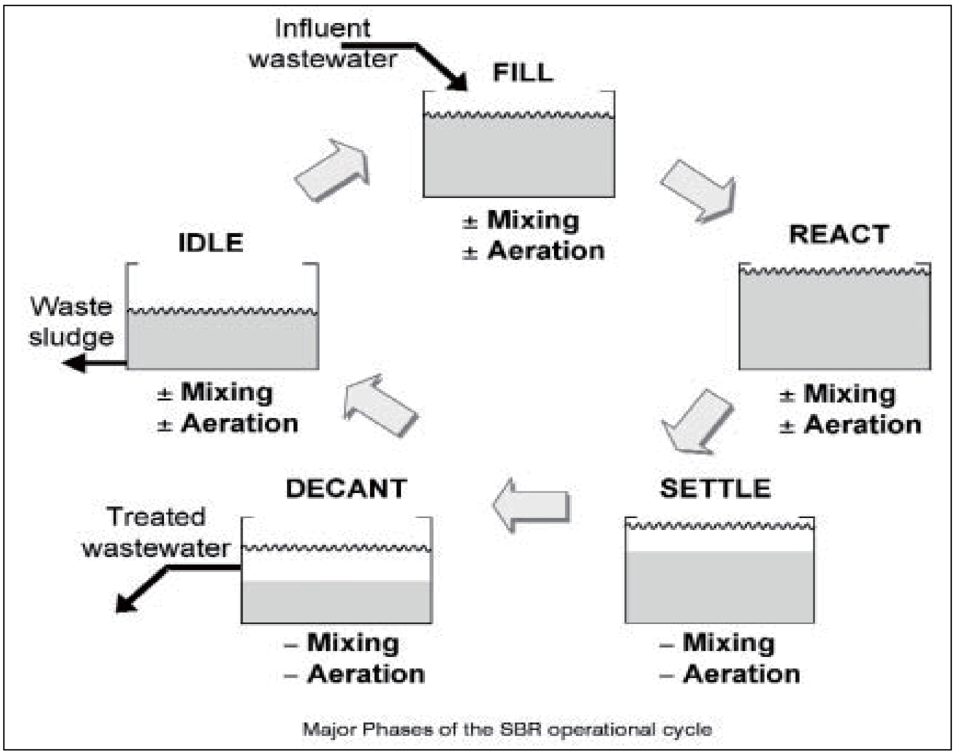


Figure 8.3.2 SBR Process for Bhagwanpur STP

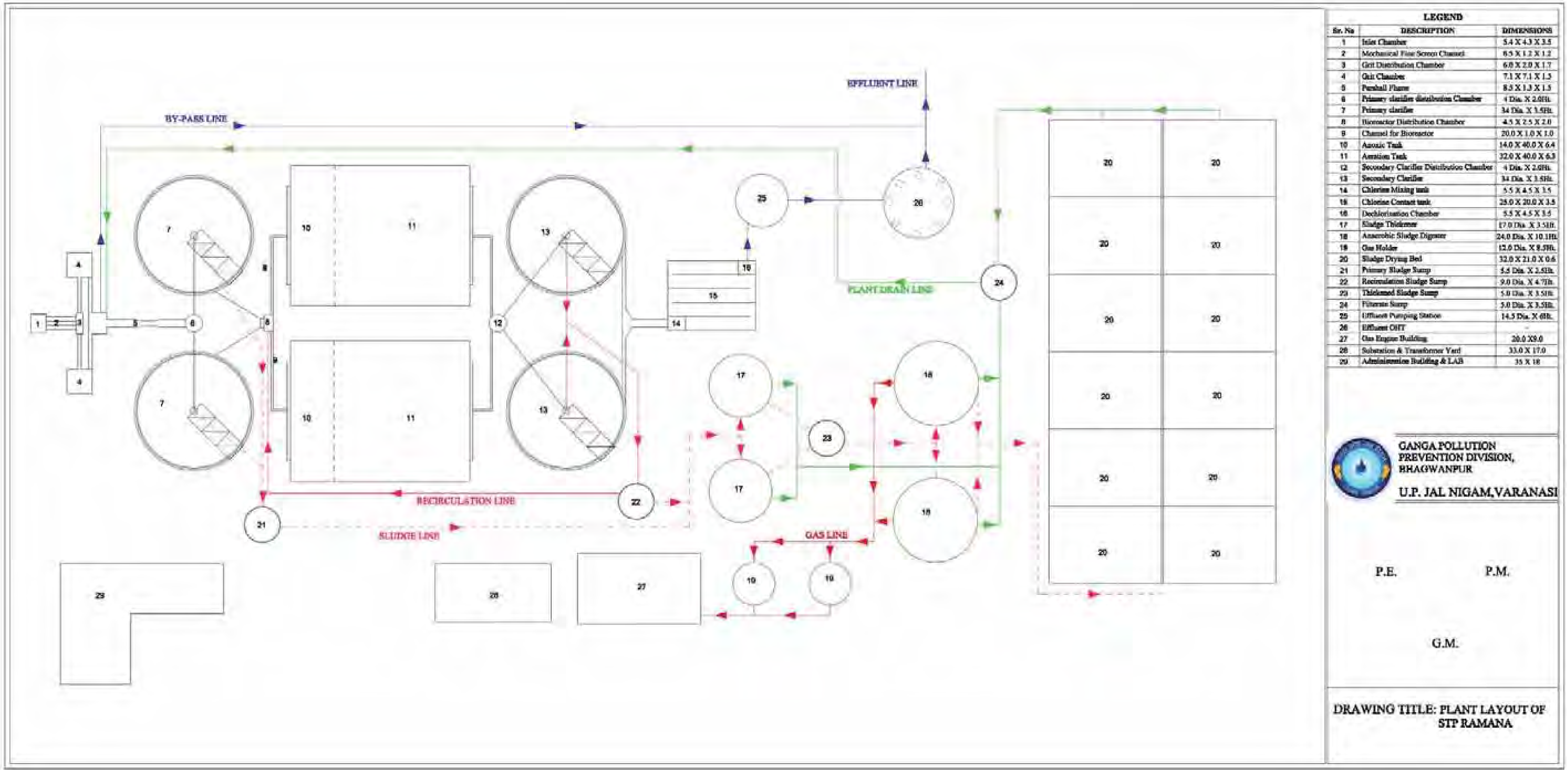
Table 8.3.2 Outline of Major Facilities at 8 MLD Bhagwanpur STP

Sr. No.	Process Unit	Flow	Dimensions, in m				
			No	L	W/ Dia	SWD	Total depth
1	Inlet Chamber	8 MLD	1	2	2	3	
2	Mechanical Fine Bar Screen	8 MLD	2	6	1	0.8	
3	Manual Fine Bar Screen	8 MLD	1	6	1	0.8	
4	Grit Chamber	0.21 m3/s	2		5		
5	Distribution Box	18 MLD	1	3	1.5	2	
6	SBR Basin Feed Channel	0.21m3/s	1	3	2	2	
7	SBR Reactor	8 MLD	1	34	17	5	
8	Chlorine Cintactor	8 MLD	1	6	1	0.8	
9	Sludge Sump	175 m3/d	1		4	2.5	
10	Slufge Thickener	175 m3/d	1		6	3	
11	Centrifuge	30.29 m3/d	2				

8.3.2 Ramna STP

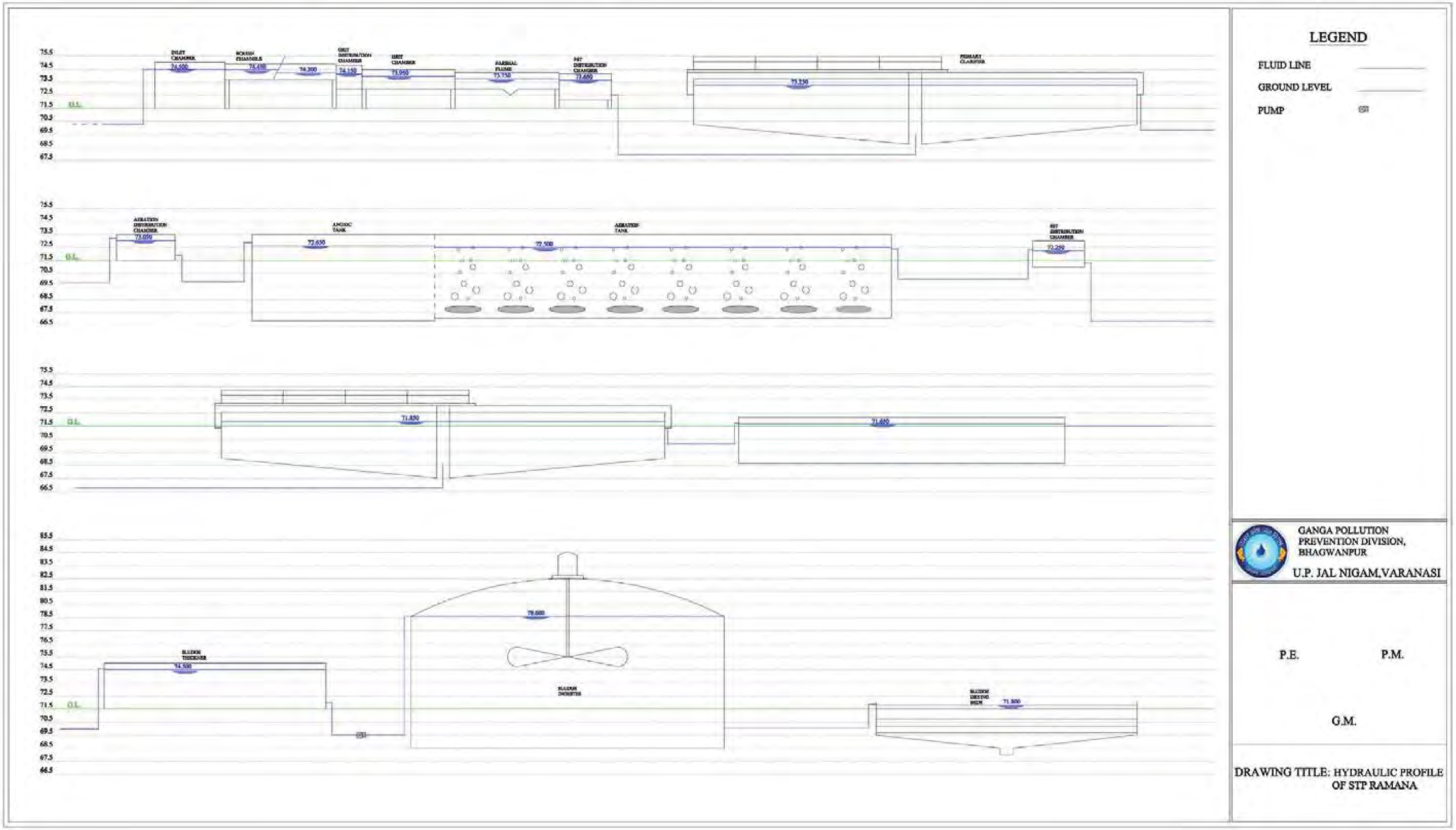
The following is the overview of the DPR.

- New construction of 50MLD STP.
- Water treatment process is based on circulated nitrification / denitrification process (CND) which is modified process of activated sludge process (ASP).
- After CND, new Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener, digester and sludge drying bed.



Source: Ramna STP DPR

Figure 8.3.3 Layout of Proposed Ramna STP



Source: Ramna STP DPR

Figure 8.3.4 Flowsheet of Proposed Ramna STP

8.3.3 Mirzapur STP

The following is an overview of the DPR.

1) Comprehensive Case

- As planned sewage flow is 32MLD, new construction of 18MLD STP based on SBR is required.
- Existing 14MLD STP based on UASB is not concerned.
- Vortex type Grit Chamber will be installed in terms of grit removal.
- MBBR will be installed in terms of BOD removal.
- Dissolved air floatation will be installed in terms of TSS removal.
- New Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- Mechanical dewatering will be installed to produce stabilized sludge.
- Existing oxidation pond will be demolished and this area will be used for some of new construction.
- No attached calculation sheets correspond to 32MLD STP.

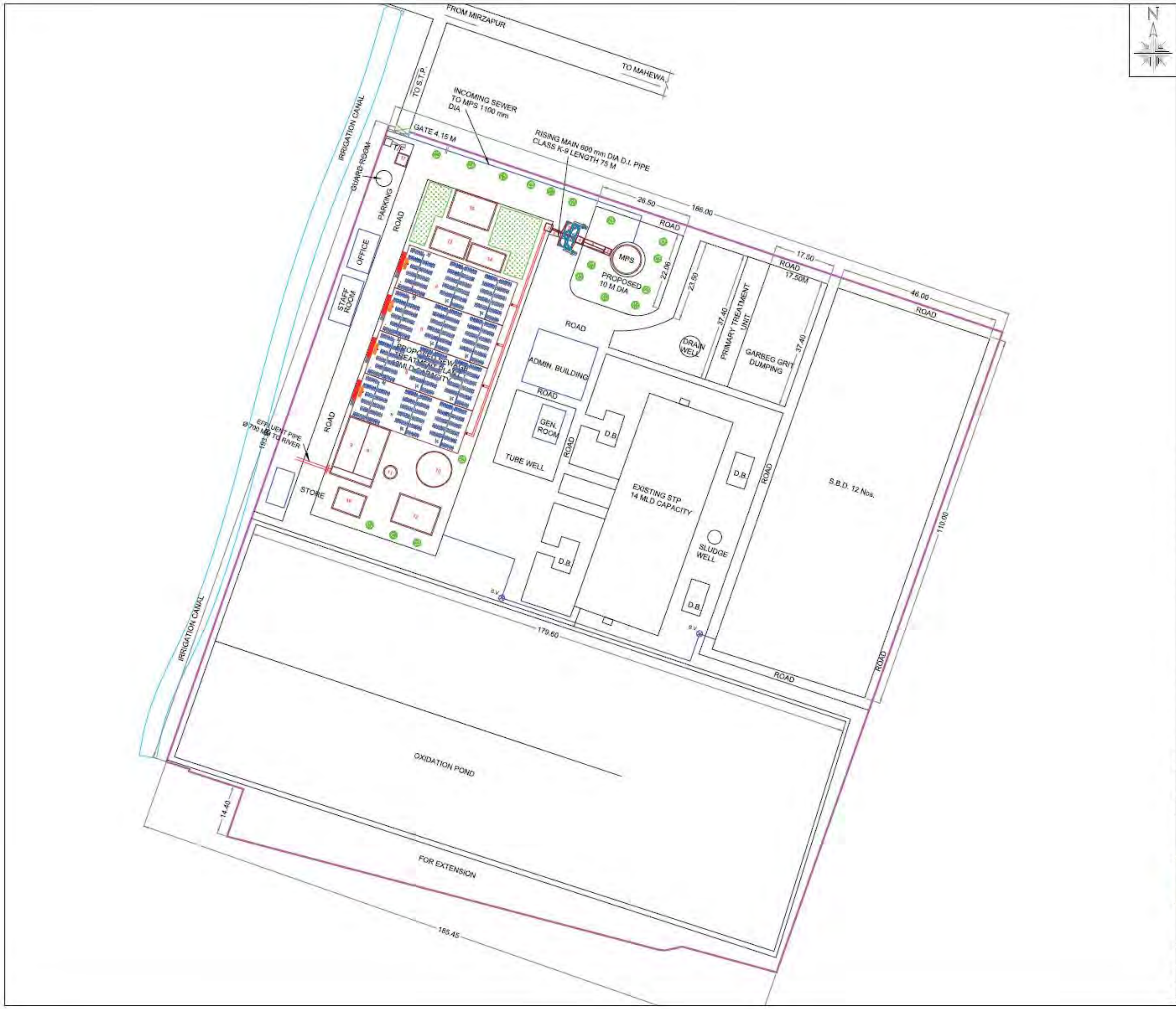
2) ID&T Case

- Two “Alternative plan” are proposed.
- “Alternative 1” is to rehabilitate the existing structures, replace E&M equipment and providing disinfection facility.
- “Alternative 2” is to rehabilitate the existing STP and upgrade the existing STP as per NRGBA/ NMCG directions. That is to say, new 14MLD SBR will be installed at oxidation pond area.
- Attached drawings are correspond to Comp. and “Alternative 2”.
- Attached brief calculation sheets are correspond to 14MLD STP based on “Alternative 2”.
- Both “Alternative plan” isn't mentioned the reason why new 18MLD STP is not necessary in case of ID&T. That is to say, this STP based on “Alternative plan” is not equipped same treatment capacity as comprehensive plan.

Table 8.3.3 Proposed works /Modification of Mirzapur STP by DPR

	Units	Design flow	Existing Spec					Proposed works /Modification			
			Nos.	Process Unit (m)				Civil	Mechanical	Electrical	Instrumentation
				Length	Width	Dia.	SWD				
1	Head Works- Inlet Chamber	-	1	5.5	4.0	-	4.0	Local repairs, painting	Motorised CI Sluice gates for each screen channel (3 Nos)	-	-
2	Head Works-Fine Screens	-	1	5.0	2.0	-	2.0	Local repairs, painting	One numbers of Mechanical Fine screens (6 mm spacing) alongwith conveyor to be provided 1 One numbers of Manual Fine screens to be provided	All I cabling and starters/ panel for the proposed screens mechanism to be provided	Level switches and overload protection switches to be provided
3	Head Works-Grit Removal Mechanism	-	1	9.0	2.0	-	2.0	Present grit removal facility at STP to be demolished and replaced with new grit chambers of Vortex type.	2 Nos Vortex Type Grit removal mechanism (each for 50% of peak flow) including grit classifier/washer, air lift pumps etc to be installed	All I cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
4	Outlet Chamber	-	1	4.0	2.0	-	4.0	-	-	-	-
5	Diversion Box	-	4	1.0	1.6	-	4.0	Local repairs, painting	Motorised CI Sluice gates for each channel (4 Nos)	-	-
6	Distribution Box	-	4	2.5	2.5	-	4.0	Local repairs, painting	-	-	-
7	UASB Reactor	Average Flow :14MLD	2	28.0	17.0	-	5.0	Local repairs, painting	Sluice valves (20 Nos) to be replaced	-	-
8	SBR (Alternative 2 only)	Average Flow :14MLD	(new)2	15.0	30.0	-	5.5	New SBR structure to be constructed	All mechanical items related to SBR to be installed which includes decanters, valves etc	All I cabling and starters/ panel for the proposed SBR mechanism to be provided	Level switches and overload protection switches to be provided
9	Blower Room for SBR (Alternative 2 only)	-	(new)1	10.0	6.0	-	-	New blower room to accommodate blowers to be constructed	6 nos Blowers (4W+2S)with 1500Nm3/hr capacity to be installed. Acoustic enclosures to be provided	All I cabling and starters/ panel for blower room to be provided	-
10	Polishing pond (Alternative 2 only)	-	1	178.0	70.0	-	2.0	To be filled up partially for construction of new structures	-	-	-
11	CCT Feed Sump	Peak Flow :31.5MLD	(new)					New CCT feed sump structure to be constructed	All mechanical items related to CCT feed pump to be installed	All I cabling and starters/ panel for CCT feed sump to be provided	Level switches and overload protection switches to be provided
12	Chlorine contact Tank	Peak Flow :31.5MLD	(new)					New CCT structure to be constructed	All mechanical items related to CCT to be installed.	All I cabling and starters/ panel for the proposed CCT to be provided	Level switches and overload protection switches to be provided
13	Treated Effluent Channel	-	1	240.0	1.5	-	1.0	-	-	-	-
14	Sludge Sump	-	1	-	-	4.0	4.0	-	Replacement of pumps	All I cabling and panel for the proposed primary sludge pumps to be replaced.	1 No Level switch with cables
15	Generator Room	-	1	5.0	5.0	-	4.0	-	-	-	-
16	Gas Holder	-	1	6.0	4.7	-	5.0	Local repairs, painting	Safety equipment to be installed	-	1 No Gas flow meter
17	Sludge Drying Beds	-	12	20.0	20.0	-	1.5	Civil Rehab work for SBD area for 25% of sludge volume	Installation of piping and valves.	<- Note: Same as Dinapur, maybe miswritten.	
18	Mechanical Sludge Dewatering (Centrifuge sump and Building) (Alternative 2 only)	-	(new)					New building to accommodate centrifuges and polydosing system to be constructed	2 nos (1W+1S) centrifuges to be installed 2 nos. (1W+1S) centrifuge feed pumps to be installed	Panel, Cable	-
19	Gas Burner	-	1	3.0	3.0		-	-	-	-	Required automation for flair
20	Miscellaneous	-						Repairs, painting and roads	2 No Air Conditioners for laboratory 1 No Air Conditioner for Control Room 1 No Microscope, 1 No water cooler	-	Lightening Arrester for gas digester and gas holder

Source: JICA Survey Team



S.NO	UNITS	Nos	SIZE IN METER				
			L	W	DIA	SWD	FB
1	Wet Well	1	2.0	2.0		2.0	0.5
2	Inlet Chamber	1	2.0	2.0		2.0	0.5
3	Screen Chamber	1	6.0	2.0		1.2	0.5
4	Distribution Chamber	1	1.5	1.5		1.5	0.5
5	Grit Chamber	2			3.5	3.6	0.5
6	Parshall Flume	1	1.5	0.4			0.5
7	Distribution Chamber for SBR	1	2.0	2.0		1.5	0.5
8	SBR	4	32.9	13.5		5.5	0.5
9	CCT	2	15.0	6.0		3.0	0.5
10	Sludge Thickner	1			10.0	3.5	0.5
11	Sludge Sump cum Pump House	1			4.0	1.5	0.5
12	BFP /Chemical Building	1	12.0	8.0			
13	Blower Room	1	10.0	6.0			
14	Electrical Room	1	10.0	5.0			
15	Administration /Lab Building	1	12.0	8.0			
16	Clorination Building	1	8.0	6.0			
17	Guard Room	1	3.0	3.0			

NOTES :-
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. THE TBM IS SITUATED AT TOP OF PILLAR STP MIRZAPUR AND RL=83.600m
3. THE CONTOUR INTERVAL IS 0.2m
4. STP AREA = 37443.60sqm = 3.74ha

DETAILED PROJECT REPORT FOR MIRZAPUR SEWERAGE SCHEME (U.P.)

PROJECT MANAGER
GANGA POLLUTION PREVENTION UNIT
U.P. JAL NIGAM, VARANASI

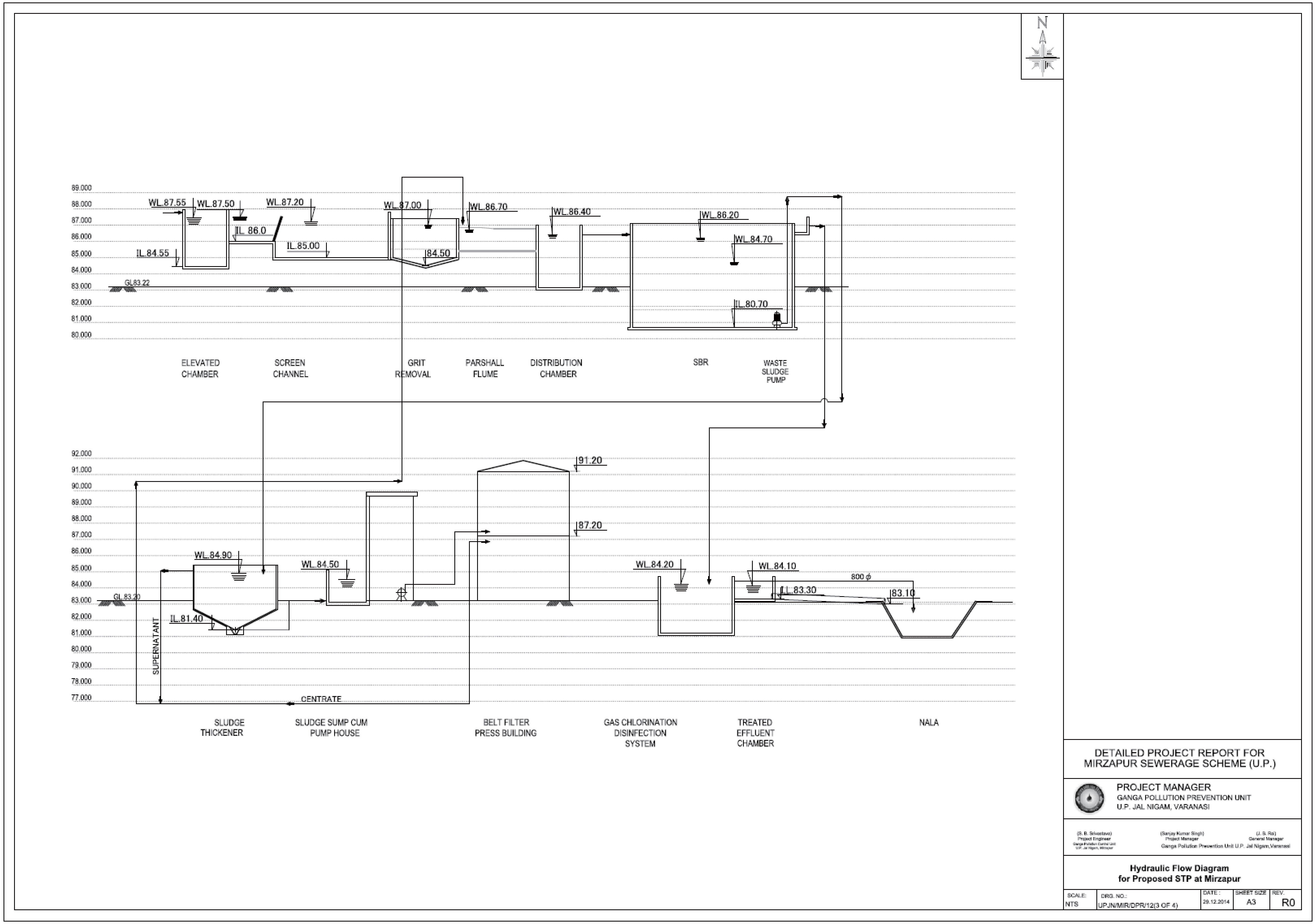
(S. B. Srivastava) Project Engineer — (Sanjay Kumar Singh) Project Manager — (J. B. Rai) General Manager
Ganga Pollution Prevention Unit U.P. Jal Nigam, Varanasi

LAYOUT SHOWING PROPOSED 18 MLD STP AT MIRZAPUR

SCALE:	DRG. NO.:	DATE :	SHEET SIZE	REV.
NTS	UPJN/MIR/DPR/12(1 OF 4)	29.12.2014	A3	R0

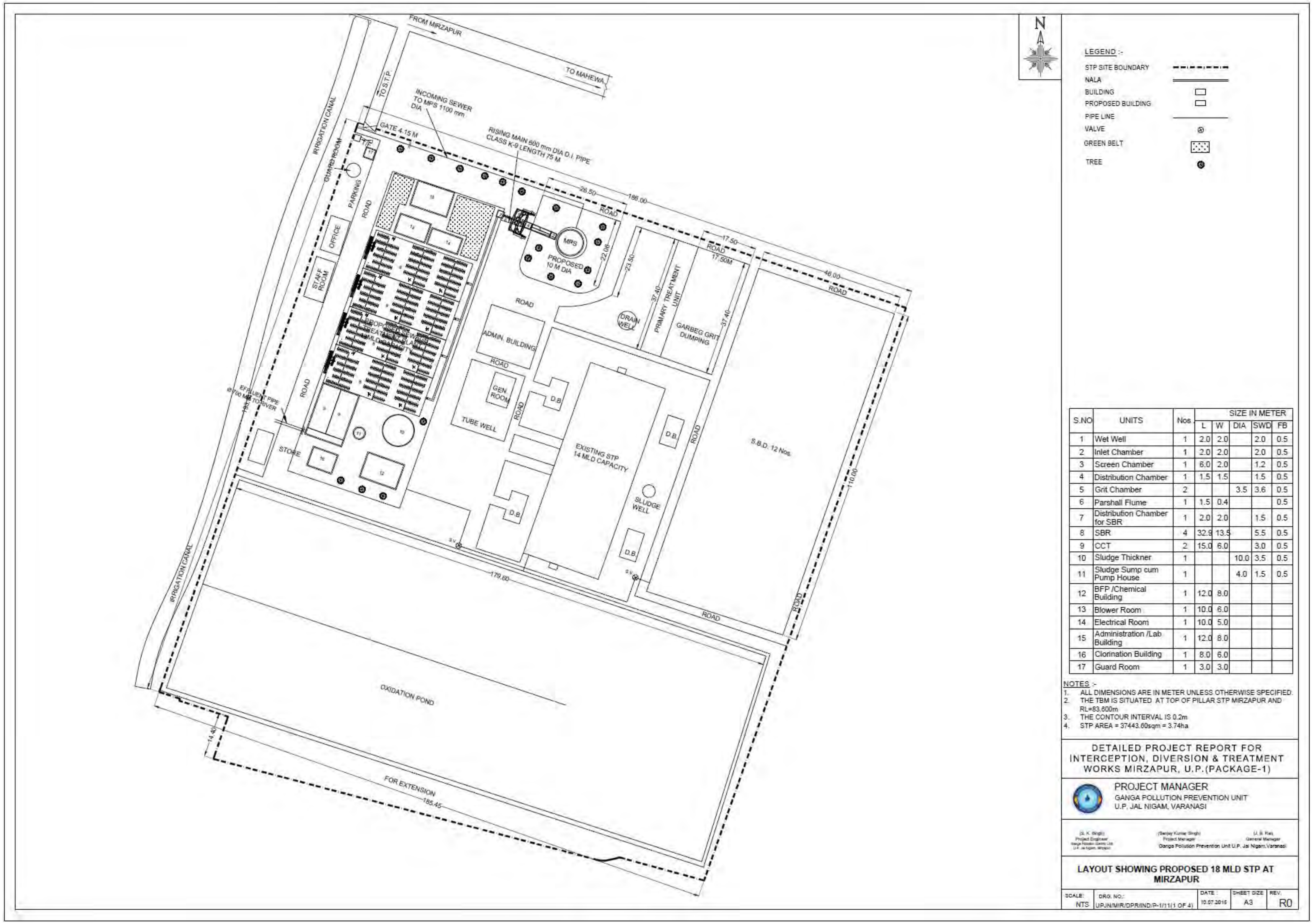
Source: Mirzapur DPR (Comprehensive)

Figure 8.3.5 Layout of Proposed Mirzapur STP (Comprehensive)



Source: Mirzapur DPR (Comprehensive)

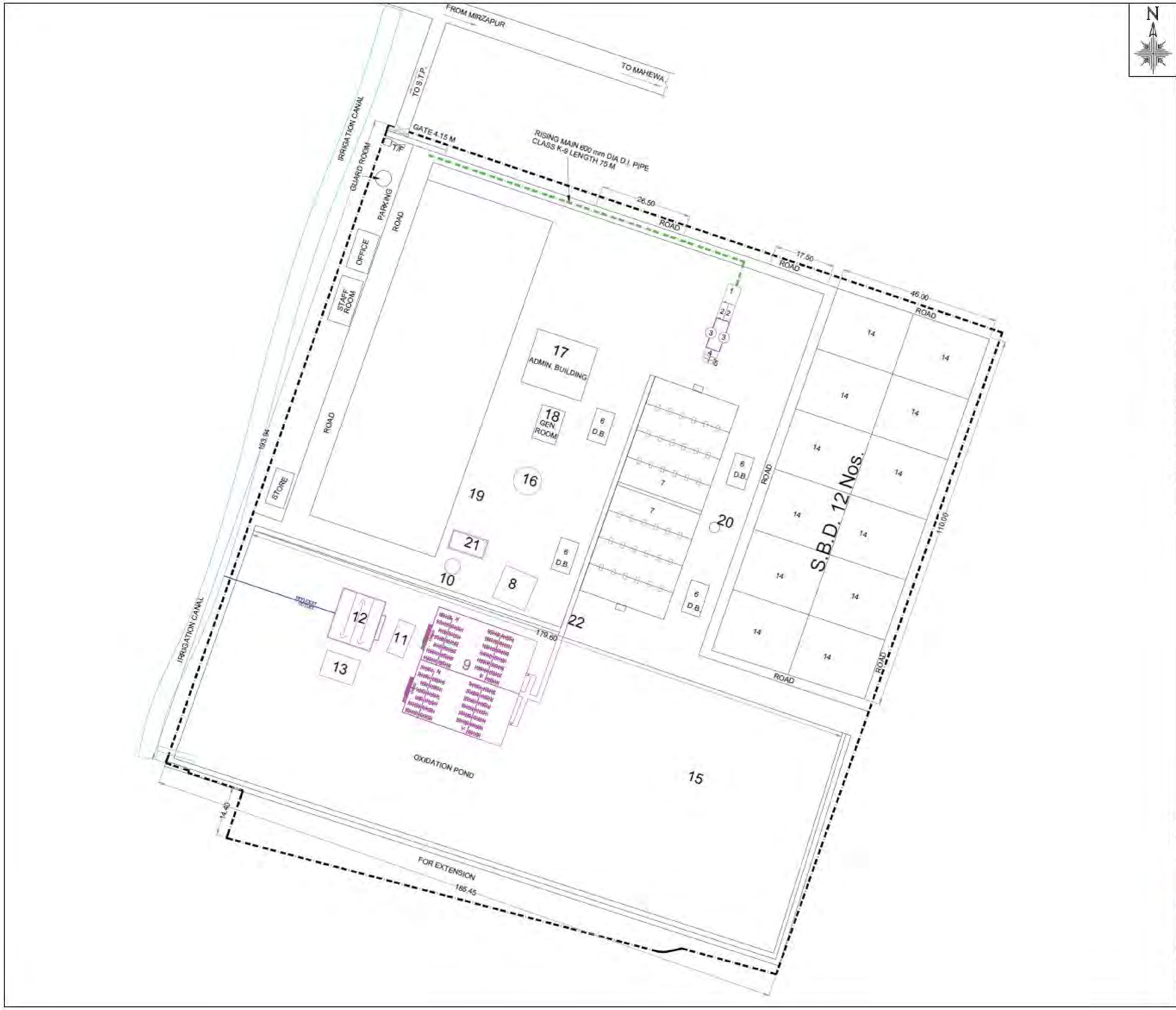
Figure 8.3.6 Flowsheet of Proposed Mirzapur STP (Comprehensive)



S.NO	UNITS	Nos.	SIZE IN METER				
			L	W	DIA	SWD	FB
1	Wet Well	1	2.0	2.0		2.0	0.5
2	Inlet Chamber	1	2.0	2.0		2.0	0.5
3	Screen Chamber	1	6.0	2.0		1.2	0.5
4	Distribution Chamber	1	1.5	1.5		1.5	0.5
5	Grit Chamber	2			3.5	3.6	0.5
6	Parshall Flume	1	1.5	0.4			0.5
7	Distribution Chamber for SBR	1	2.0	2.0		1.5	0.5
8	SBR	4	32.9	13.5		5.5	0.5
9	CCT	2	15.0	6.0		3.0	0.5
10	Sludge Thickner	1			10.0	3.5	0.5
11	Sludge Sump cum Pump House	1			4.0	1.5	0.5
12	BFP /Chemical Building	1	12.0	8.0			
13	Blower Room	1	10.0	6.0			
14	Electrical Room	1	10.0	5.0			
15	Administration /Lab Building	1	12.0	8.0			
16	Clorination Building	1	8.0	6.0			
17	Guard Room	1	3.0	3.0			

Source: Mirzapur DPR (ID&T)

Figure 8.3.7 Layout of Proposed Mirzapur STP (1/2, ID&T)



LEGEND :-

STP SITE BOUNDARY
NALA
BUILDING
PROPOSED STRUCTURE
PIPE LINE
VALVE
GREEN BELT
TREE

Sr. No.	Unit	No.	Process Unit, All dimensions are in meter			
			Length	Width	Dia	SWD
1	Inlet Chamber	1	5.5	4		4
2	Screen Channel	1	5	2		2
3	Grit Chamber	1			3	2
4	Outlet Chamber	1	4	2		4
5	Division Box	4	1	1.6		4
6	Distribution Box	4	2.5	2.5		4
7	UASB Reactor	2	28	17		5.5
8	Blower Room	1	10	15		0
9	SBR	1	30	30		5.5
10	Gravity Thickener	1			4.5	3.5
11	CCT Feed sump	1	5	5		3.5
12	Chlorine Contact Tank	1	35	9		3
13	Chlorination Building	1	10	7.5		5
14	Sludge Drying Beds	4	20	20		1.5
15	Pond	1	178	70		2
16	Gas Holder	1	6	4.7		5
17	Admin Building	1	10	15.0		5
18	Generator Room	1	5	5		4
19	Gas Burner	1				0
20	Sludge Sump	1			4	4
21	Mechanical Dewatering Room	1	12	12		5
22	Effluent Channel	1	240	1.5		1

DETAILED PROJECT REPORT (DPR)
FOR REHABILITAION & PROCESS UPGRADATION
OF EXISTING STPs IN MIRZAPUR(PACKAGE-2)

PROJECT MANAGER
GANGA POLLUTION PREVENTION UNIT
U.P. JAL NIGAM, VARANASI

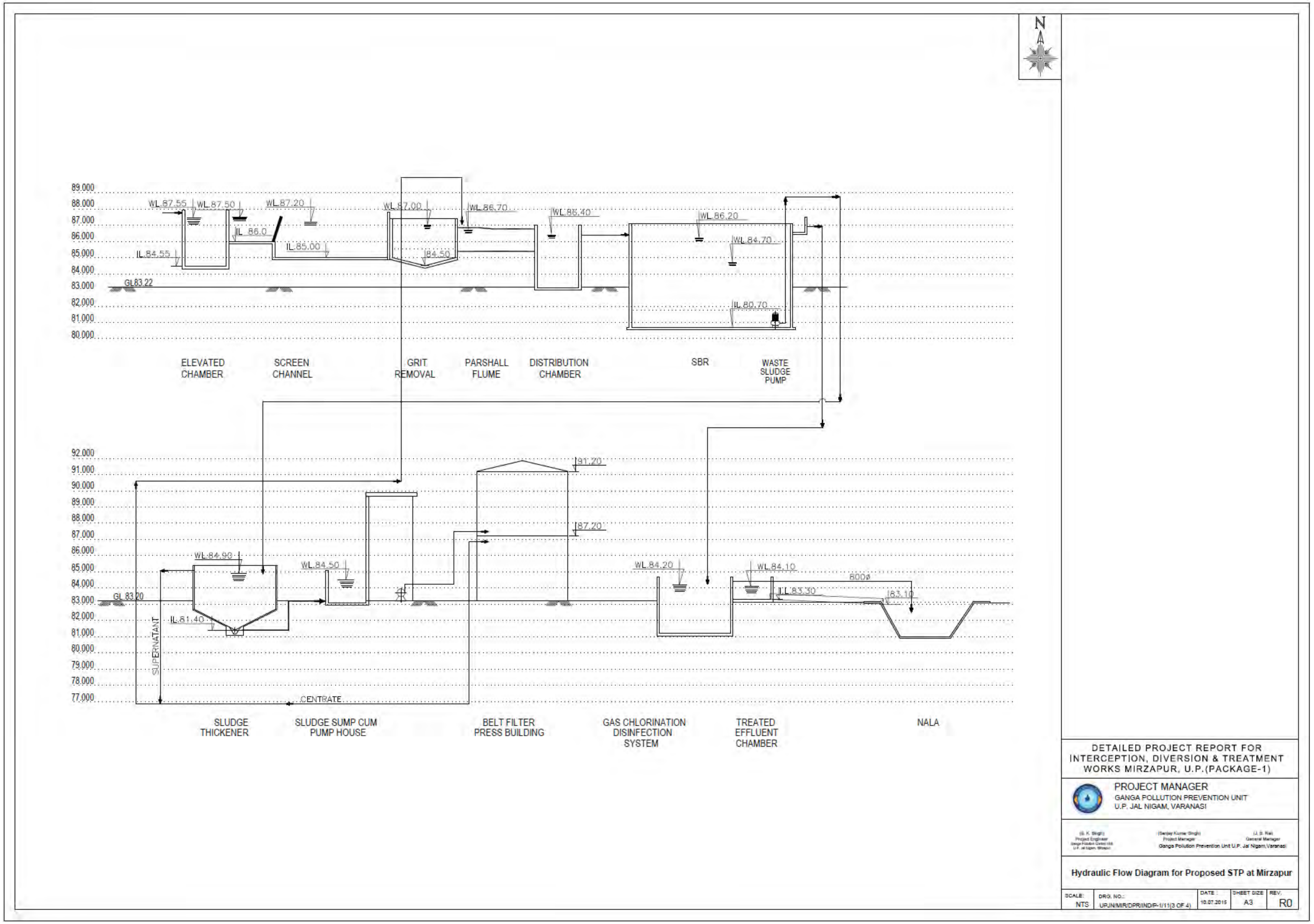
Project Engineer | Project Manager | General Manager
Ganga Pollution Prevention Unit U.P. Jal Nigam Varanasi

Layout Showing Proposed Modifications in Existing 14 MLD STP at Mirzapur

SCALE:	DRG. NO:	DATE :	SHEET SIZE	REV.
NTS	UPJN/MIR/DPR/IND/P-2/06	24.06.2015	A3	R0

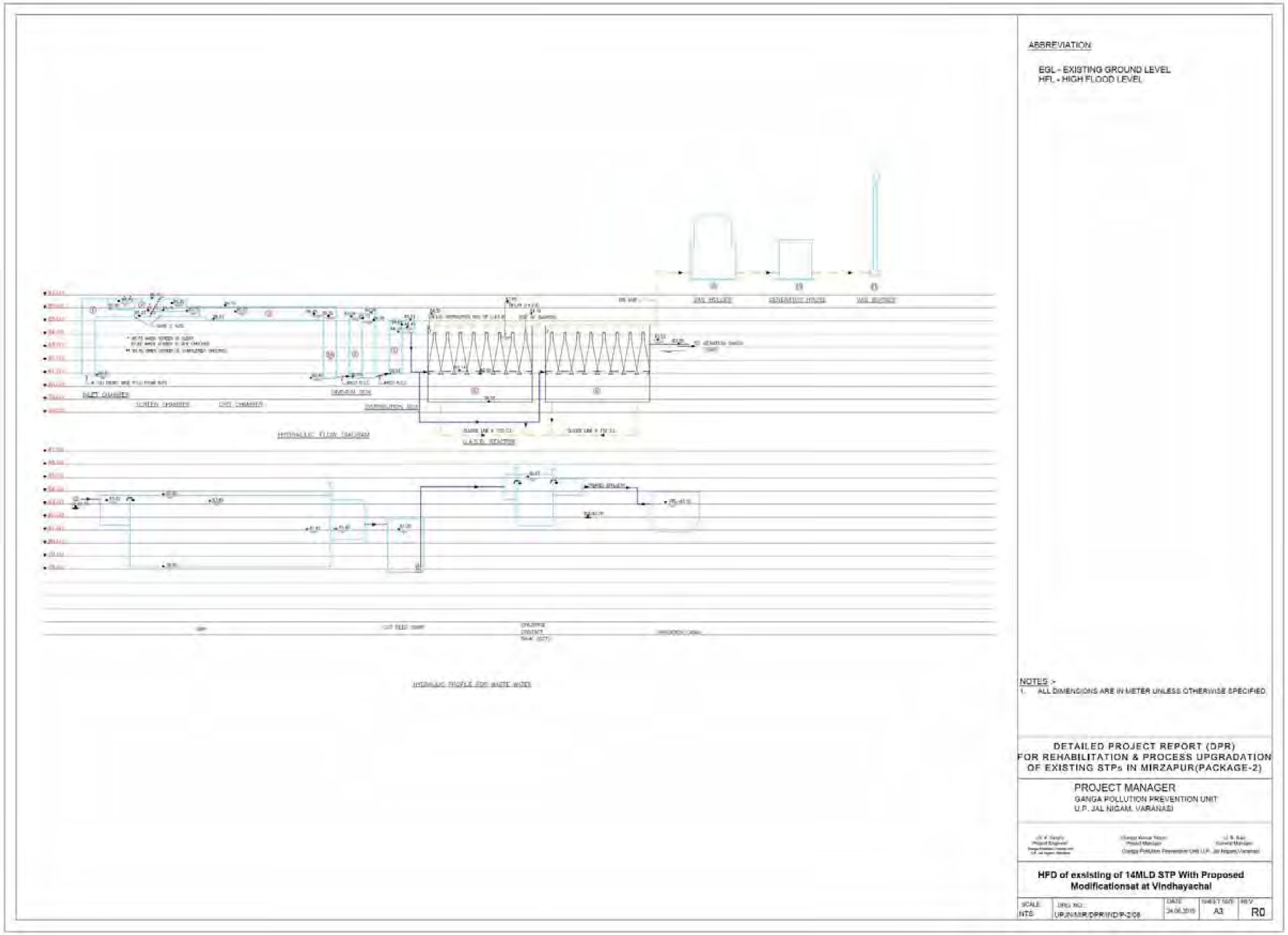
Source: Mirzapur DPR (ID&T)

Figure 8.3.8 Layout of Proposed Mirzapur STP (2/2, ID&T)



Source: Mirzapur DPR (ID&T)

Figure 8.3.9 Flowsheet of Proposed Mirzapur STP (1/2, ID&T)



Source: Mirzapur DPR (ID&T)

Note: "Vindhyachal" of title box is miswritten.

Figure 8.3.10 Flowsheet of Proposed Mirzapur STP (2/2, ID&T)

8.3.4 Vindhyachal STP

The following is the overview of the DPR.

1) Comprehensive Case

- Rehabilitation of 4MLD existing STP.
- As planned sewage flow is 6MLD, augmentation of 2MLD STP is required.
- For this purpose, new construction of SBR and installation of surface aerator are planned.
- New Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- No drawings attached.

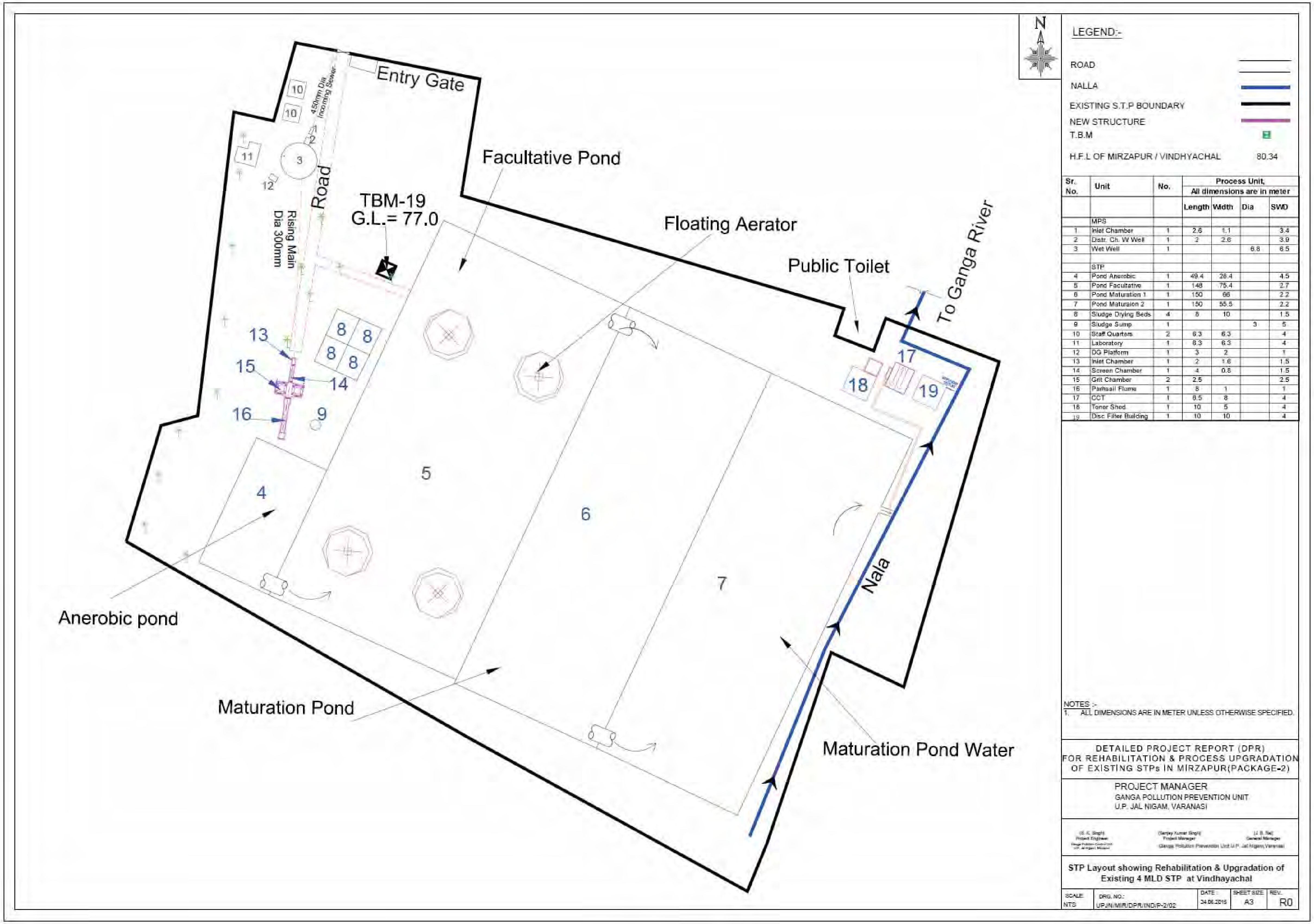
2) ID&T Case

- Main policy is same as Comp. plan.

Table 8.3.4 Proposed works /Modification of Vindhyachal STP by DPR

No.	Units	Design flow	Spec after rehabilitated					Proposed works /Modification			
			Nos.	Process Unit (m)				Civil	Mechanical	Electrical	Instrumentation
				Length	Width	Dia.	SWD				
1	Inlet Chamber	Peak Flow :10MLD	(new for improvement)1	2.0	1.6	-	1.5	**Existing to be demolished and replaced by new**	-	-	-
2	Fine Screens	Peak Flow :10MLD	(new for improvement)1	4.0	0.8	-	1.5	**Existing to be demolished and replaced by new**	2 Nos Mechanical Fine screen to be installed	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
3	Grit Chamber	Peak Flow :10MLD	(new for improvement)2	2.5	-	-	2.5	At present there is no grit removal facility at STP. **New grit chambers** of Vortex type to be constructed.	2 Nos Vortex Type Grit removal mechanism (each for 50% of peak flow) including grit classifier/washer, air lift pumps etc to be installed	All cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
4	Parhsall Flume	Peak Flow :10MLD	(new for improvement)1	8.0	1.0	-	1.0	**Existing to be demolished and replaced by new**	-	-	Flow measurement devices to be installed
5	Distribution Box		(new for improvement)1	-	-	-	-	**Existing to be demolished and replaced by new**	-	-	-
6	Anaerobic Pond	Average Flow :4MLD	1	49.4	28.4	-	4.5	Local repairs	-	-	-
7	Facultative pond	Average Flow :4MLD	(remodeling for improvement)1	148.0	75.4	-	2.7	Local repairs	**Surface Aerator To be installed**	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	-
8	Maturation Pond1		1	150.0	66.0	-	2.2	Local repairs	-	-	-
9	Maturation Pond2		1	150.0	55.5	-	2.2	Local repairs	-	-	-
10	Chlorine Contact Tank	Peak Flow :10MLD	(new for improvement)1	6.5	8.0	-	4.0	**New Structure**	Chlorination unit to be installed	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	-
11	Chlorination Building	-	(new for improvement)1	10.0	5.0	-	4.0	**Toner shed to be installed**	-	-	-
12	Sludge Sump	-	1	-	-	3.0	5.0	Local repairs,Painting	-	-	-
13	Sludge Drying Beds	-	4	8.0	10.0	-	1.5	-	-	-	-
14	Disc Filtration system	Peak Flow :10MLD	(new for improvement)1	10.0	10.0	-	4.0	-	**New Disc filtration system to be installed**	-	-
15	Miscellaneous	Staff Quarters	2	6.3	6.3	-	4.0	Repairs, painting and roads	1 No Air Conditioners for laboratory	-	-
		Laboratory	1	6.3	6.3	-	4.0				
		DG Platform	1	3.0	2.0	-	1.0				

Source: JICA Survey Team



Source: Mirzapur DPR (ID&T)

Figure 8.3.11 Layout of Proposed Vindhyachal STP (ID&T)

Source: Mirzapur DPR (ID&T)

Figure 8.3.12 Flowsheet of Proposed Vindhyachal STP (ID&T)

8.3.5 Ghazipur STP

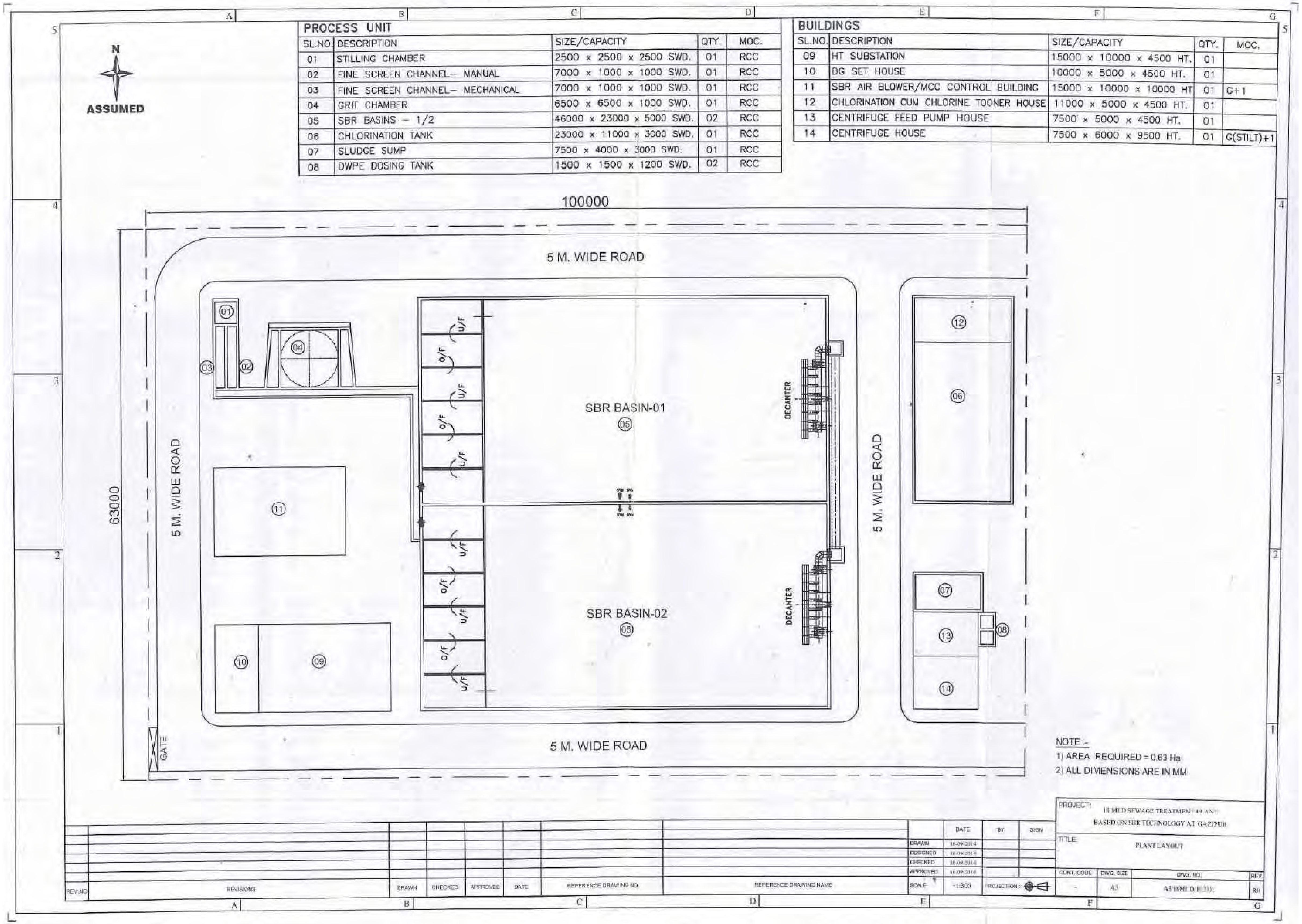
The following is the overview of the DPR.

1) Comprehensive Case

- New construction of 18MLD STP based on cyclic activated sludge process (C-TECH) is required. This process is a type of SBR.
- Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- Centrifuge dewatering will be installed to produce stabilized sludge.

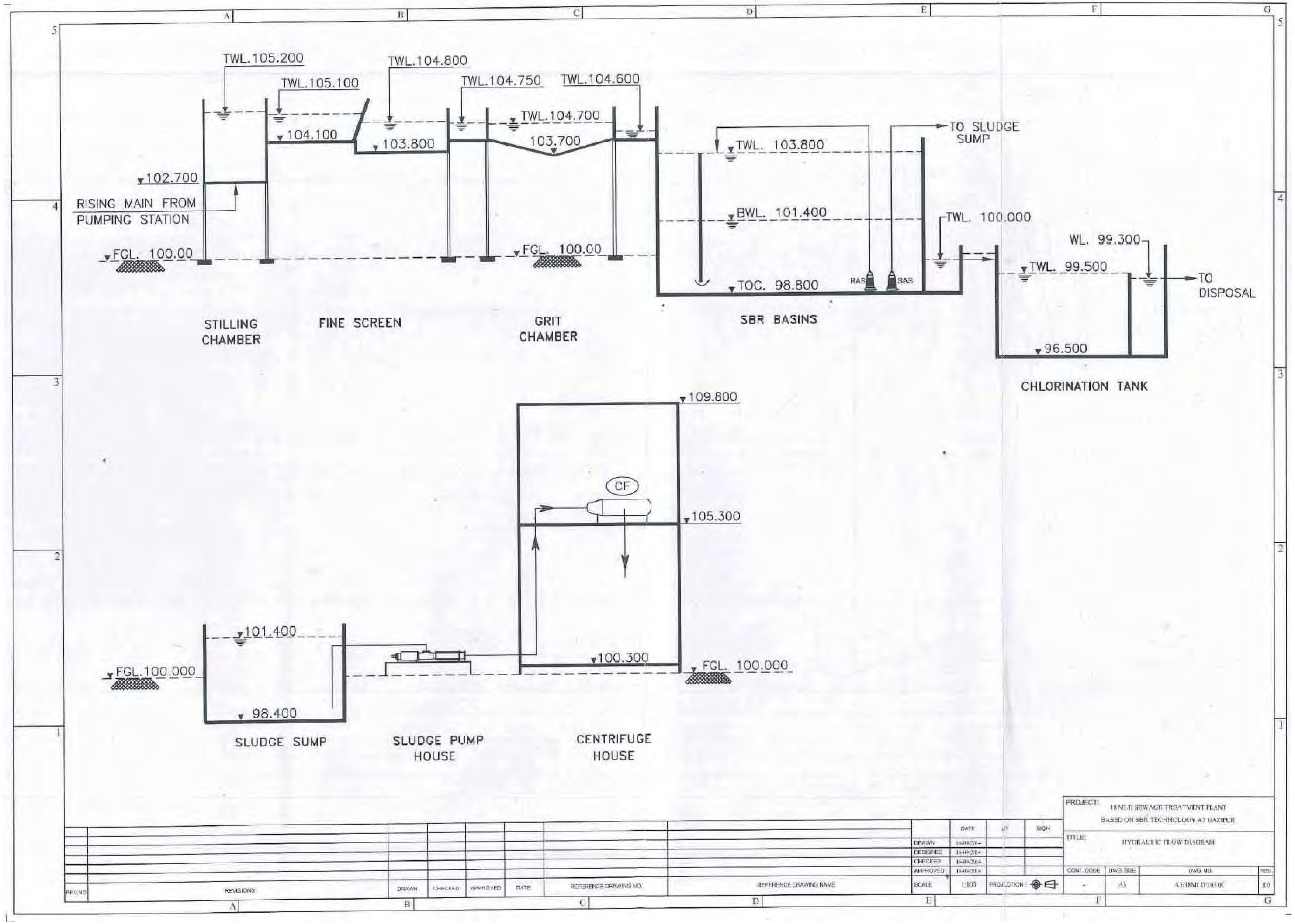
2) ID&T Case

・DPR is not yet available.



Source: Ghazipur DPR (Comprehensive)

Figure 8.3.13 Layout of Proposed Ghazipur STP (Comprehensive)



Source: Ghazipur DPR (Comprehensive)

Figure 8.3.14 Flowsheet of Proposed Ghazipur STP (Comprehensive)

8.3.6 Ramnagar STP

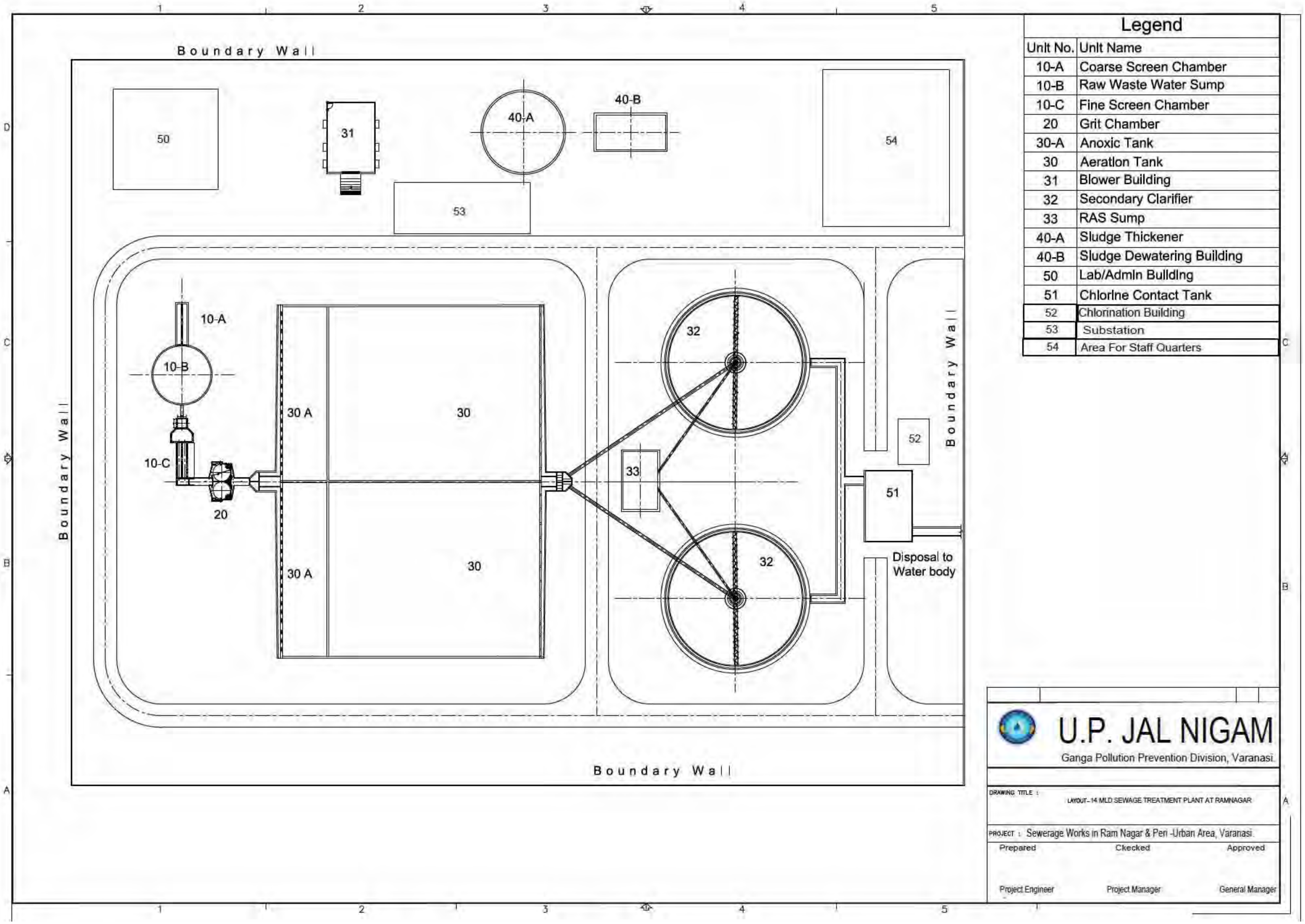
The following is an overview of the DPR.

1) Comprehensive Case

- New construction of 13MLD STP.
- Water treatment process is based on "the extended aeration with an anoxic tank (modified Ludzack Ettinger)" which is same as CND adopted at DPR of Ramna STP.
- After water treatment process, Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener and mechanical dewatering.

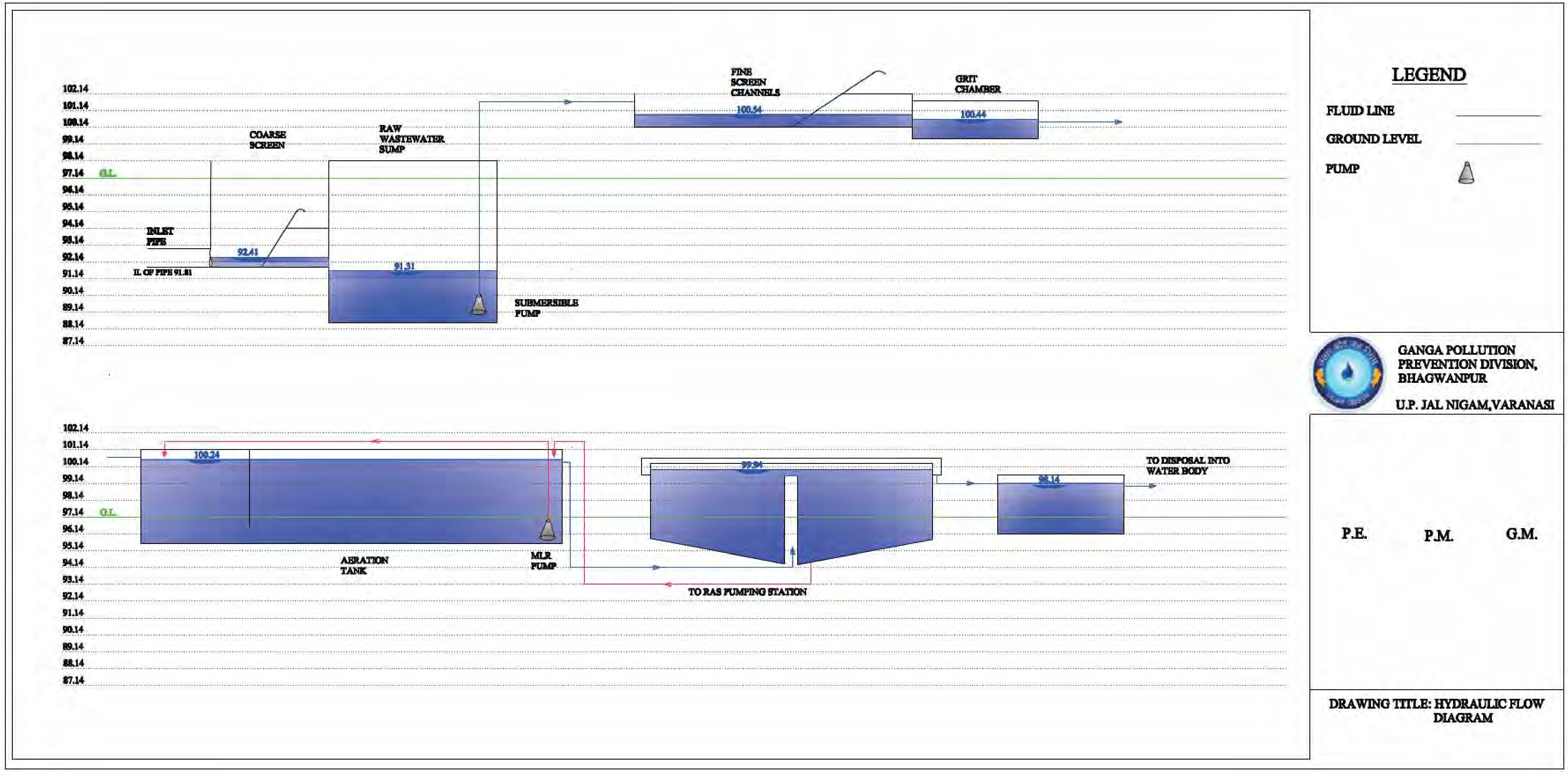
2) ID&T Case

- Plan of STP is same with the comprehensive case in the DPR.



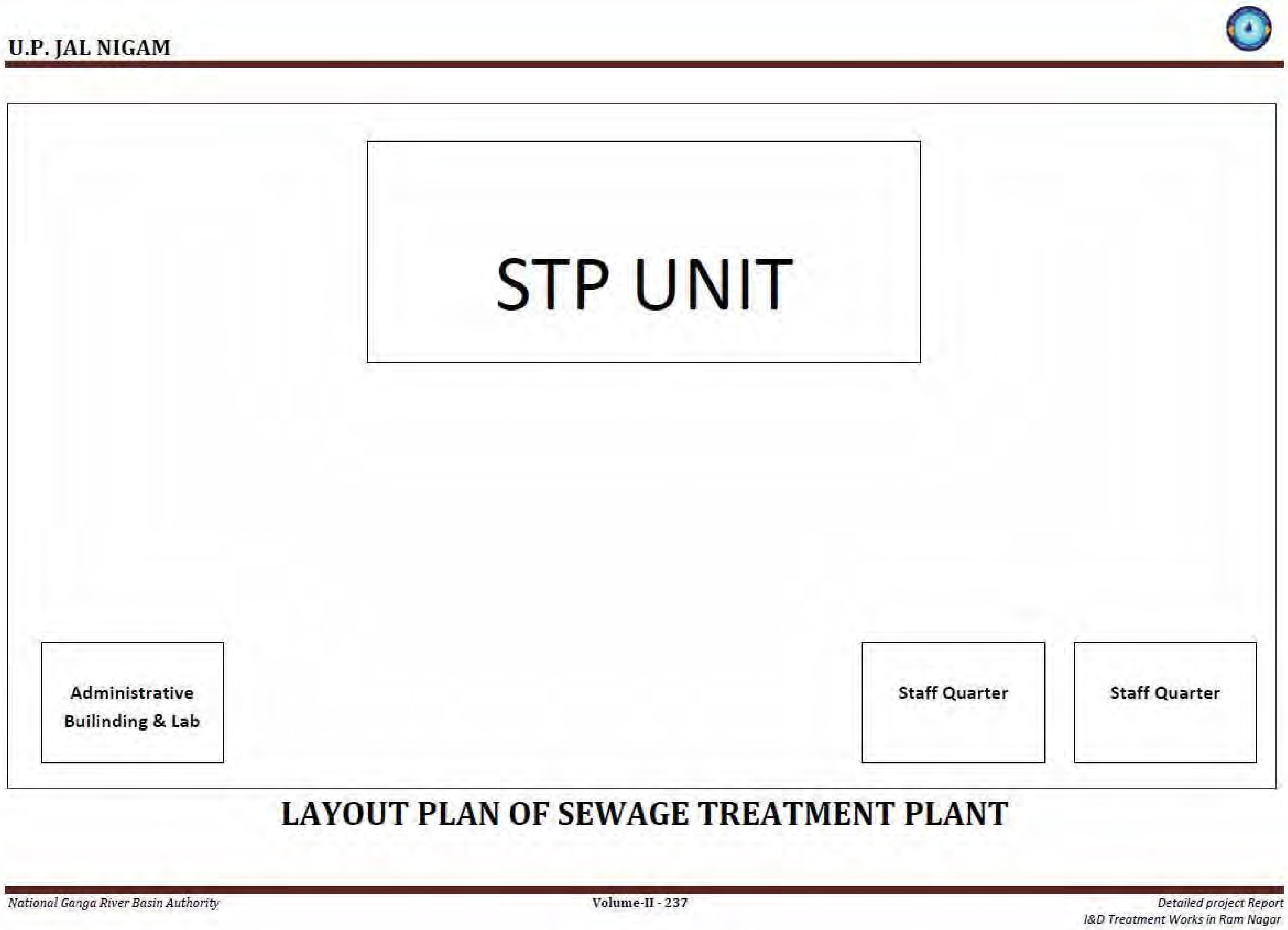
Source: Ramnagarr DPR (Comprehensive)

Figure 8.3.15 Layout of Proposed Ramnagar STP (Comprehensive)



Source: Ramnagar DPR (Comprehensive)

Figure 8.3.16 Flowsheet of Proposed Ramnagar STP (Comprehensive)



Source: Ramnagar DPR (ID&T)

Figure 8.3.17 Layout of Proposed Ramnagar STP (ID&T)

8.3.7 Chunar STP

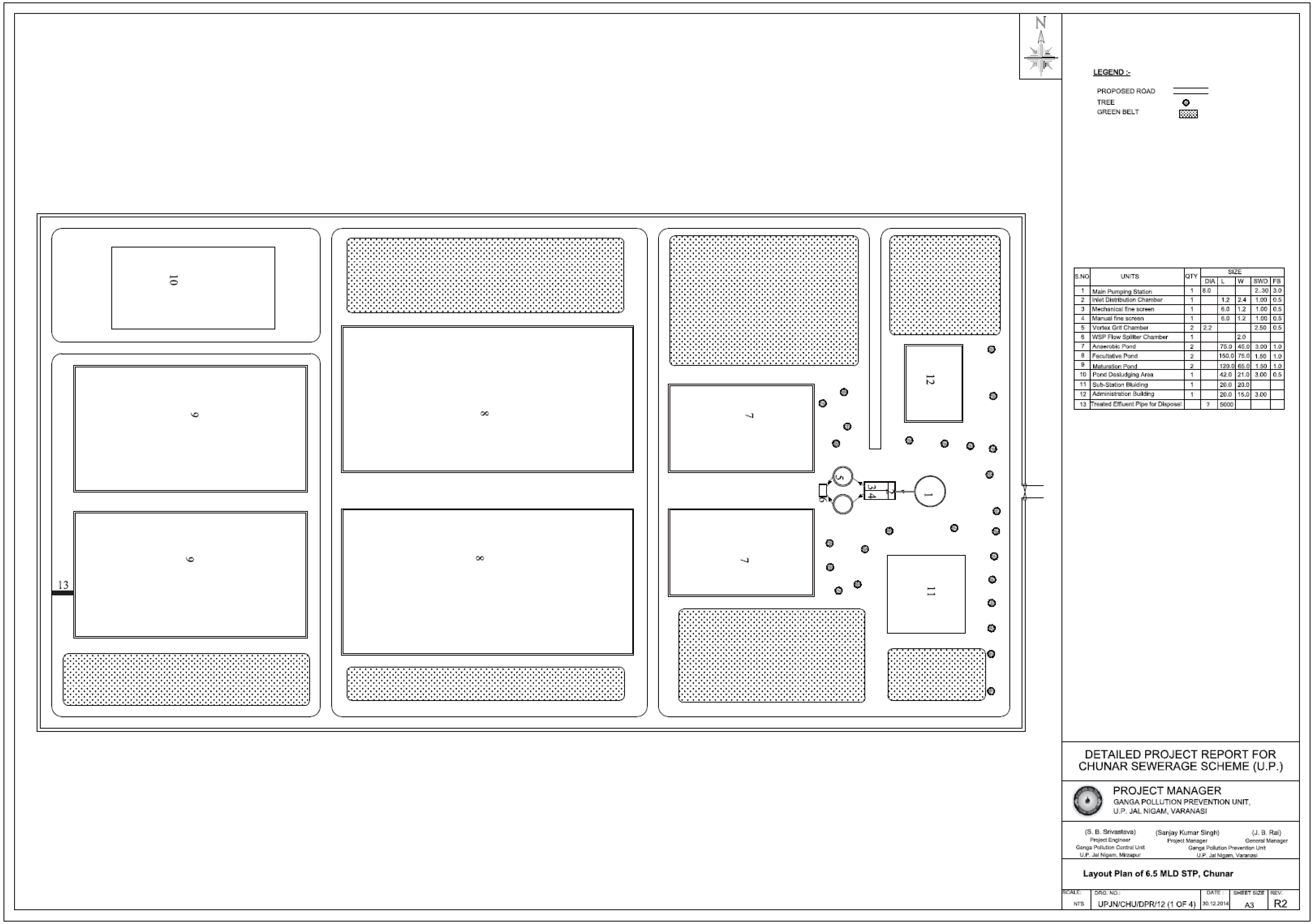
The following is an overview of the DPR.

1) Comprehensive Case

- New construction of 6.5MLD STP based on waste stabilization pond (WSP) is required.
- Installation of disinfection equipment and sludge treatment system is not written clearly.

2) ID&T Case

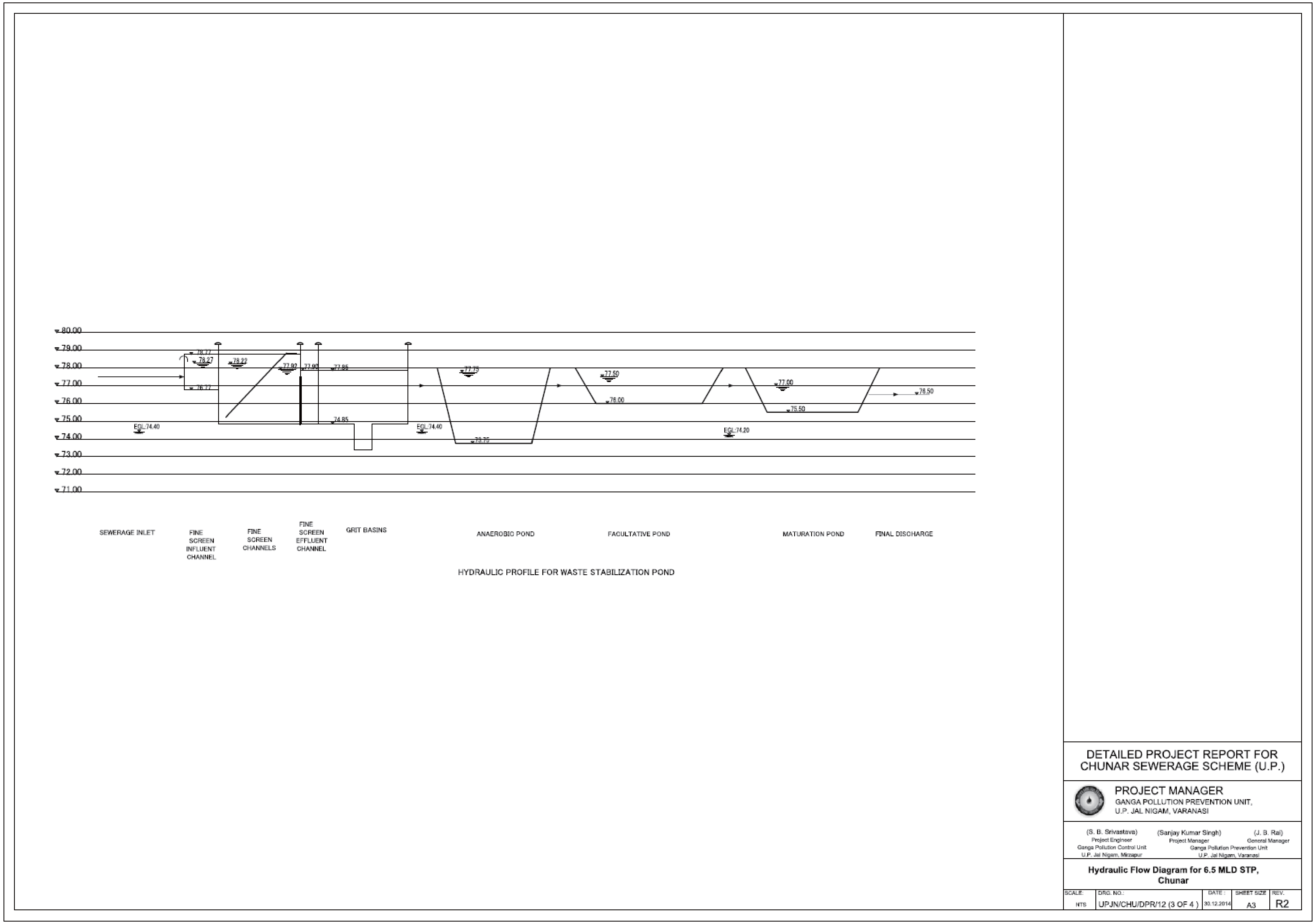
- New construction of 6.5MLD STP based on SBR is required.
- After water treatment process, Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener and centrifuge.



S.NO	UNITS	QTY	SIZE				
			DIA	L	W	SWD	FB
1	Main Pumping Station	1	8.0			2..30	3.0
2	Inlet Distribution Chamber	1		1.2	2.4	1.00	0.5
3	Mechanical fine screen	1		6.0	1.2	1.00	0.5
4	Manual fine screen	1		6.0	1.2	1.00	0.5
5	Vortex Grit Chamber	2	2.2			2.50	0.5
6	WSP Flow Splitter Chamber	1			2.0		
7	Anaerobic Pond	2		75.0	45.0	3.00	1.0
8	Facultative Pond	2		150.0	75.0	1.50	1.0
9	Maturation Pond	2		120.0	65.0	1.50	1.0
10	Pond Desludging Area	1		42.0	21.0	3.00	0.5
11	Sub-Station Bluiding	1		20.0	20.0		
12	Administration Building	1		20.0	15.0	3.00	
13	Treated Effluent Pipe for Disposal		?	5000			

Source: Chunar DPR (Comprehensive)

Figure 8.3.18 Layout of Proposed Chunar STP (Comprehensive)

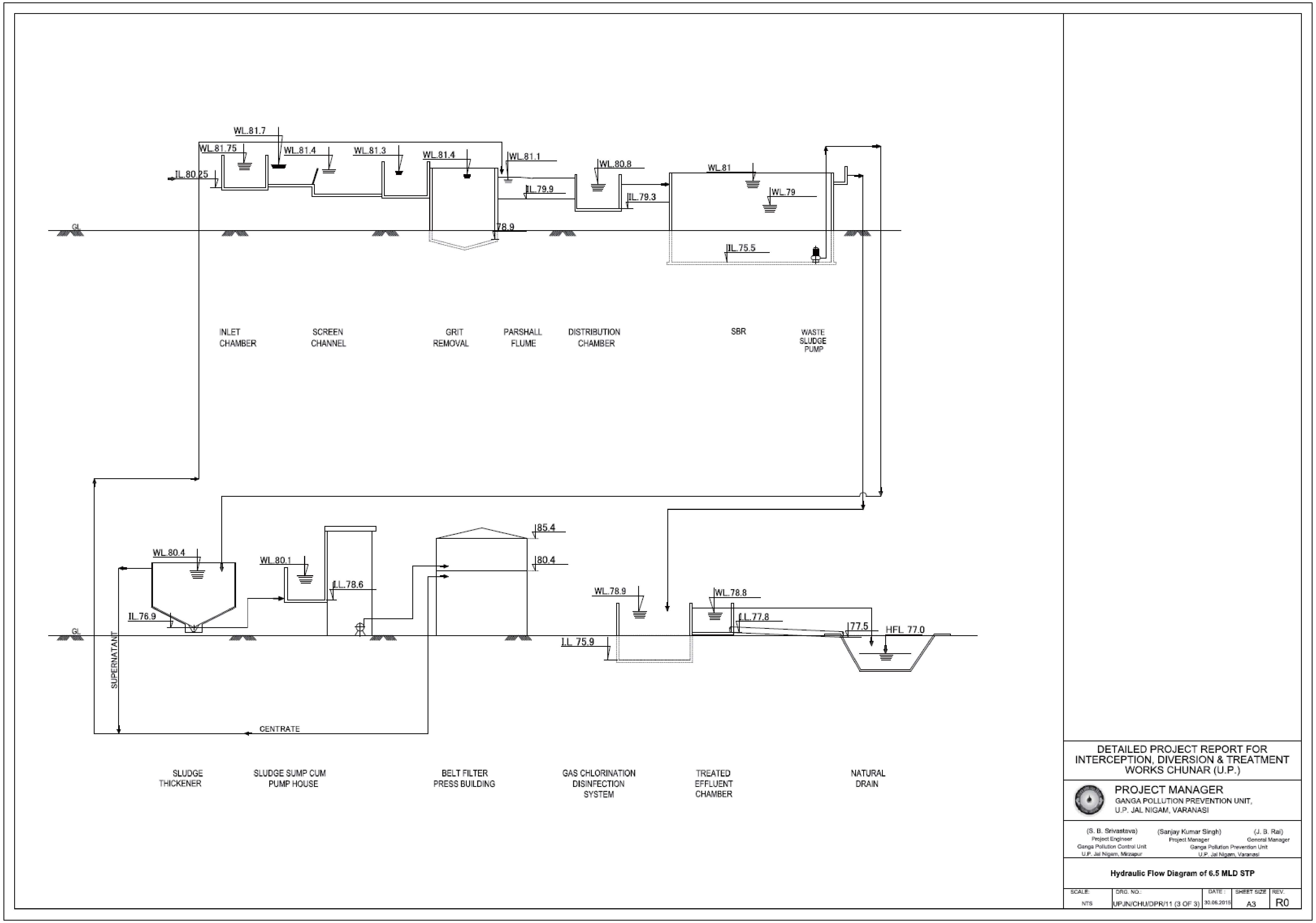


Source: Chunar DPR (Comprehensive)

Figure 8.3.19 Flowsheet of Proposed Chunar STP (Comprehensive)

Source: Chunar DPR (ID&T)

Figure 8.3.20 Layout of Proposed Chunar STP (ID&T)



Source: Chunar DPR (ID&T)

Figure 8.3.21 Flowsheet of Proposed Chunar STP (ID&T)

8.3.8 Saidpur STP

- DPR is not available yet as of March 2016.

8.3.9 Other Common Topics

- Each STP site location is indicated at figure at section 8.1.
- Effluent quality of BOD and SS from each STP is set in the range of 10-30 mg/l respectively.
- Comprehensive plan and ID&T plan is finalized separately.

8.3.10 Abstract of Proposed STP in Target Cities

Table 8.3.5 shows the list of proposed sewer works in target cities.

Table 8.3.5 Abstract of Proposed STP in Target Cities

<table>
<tr><th colspan="2" rowspan="2">STP</th><th rowspan="2">Target Year*</th><th colspan="2">Capacity of target STP (MLD)</th><th rowspan="2">Treatment Process</th></tr>
<tr><th>Existing</th><th>Target Year</th></tr>
<tr><td colspan="2">Dinapur**</td><td>2025</td><td>80</td><td>80</td><td>ASP +MBBR</td></tr>
<tr><td colspan="2">Bhagwanpur</td><td>2025</td><td>8</td><td>8</td><td>ASP</td></tr>
<tr><td colspan="2">Ramna</td><td>2035</td><td>-</td><td>50</td><td>CND</td></tr>
<tr><td rowspan="2">Mirzapur</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">14</td><td>32</td><td rowspan="2">UASB +SBR</td></tr>
<tr><td>ID&T</td><td>14</td></tr>
<tr><td rowspan="2">Vindhyachal</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">4</td><td rowspan="2">6</td><td rowspan="2">WSP+SBR</td></tr>
<tr><td>ID&T</td></tr>
<tr><td>Ghazipur</td><td>Comp.</td><td>2025</td><td>-</td><td>18</td><td>SBR</td></tr>
<tr><td rowspan="2">Ramnagar</td><td>Comp.</td><td>2050</td><td>-</td><td>13</td><td>CND</td></tr>
<tr><td>ID&T</td><td>2035</td><td>-</td><td>13</td><td>CND</td></tr>
<tr><td rowspan="2">Chunar</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">-</td><td rowspan="2">6.5</td><td>WSP</td></tr>
<tr><td>ID&T</td><td>SBR</td></tr>
</table>

Note: *Design year of capacity of target STP shown at DPR.

**New construction of 60MLD STP is under designing and construction by GAP-II another scheme.

CHAPTER 9 Preliminary Design of Sewerage Facilities

<Objective of the study>

The survey team has made some modifications of existing DPRs as alternative according to the necessity of revision of the plans.

<Methodologies

According to the description/rules in 9.1, verification of requirement of revision was confirmed for respective sewer plans, pumping stations and STPs. Given that different cities had different Design years of facilities as shown in Table 9.3.2 which were depicted from DPRs, the study was conducted by setting final target year for all the cities and towns as 2050 to confirm future allowance/room of the proposed sewage treatment plants by the unified comparison method among the subject cities and towns.

9.1 Verification of Existing DPRs Sewers

The verification of the existing DPRs and the modification of the designs if required were conducted in following manners:

(1). Verification of Sewer Planning Methodologies in Existing DPRs

With respect to sewer planning methodologies in existing DPRs, the items below were confirmed in order;

1) Descriptions on design methodologies and/or criteria for sewer networks including target year in existing DPRs,
2) Sewerage catchment areas and the boundaries from the sewerage maps including river crossings,
3) Sewerage system, namely separate/combined, or comprehensive/interception & diversion (I&D) in each target city in this project,
4) Locations and the scales of existing drains in target areas where the flows will be intercepted and the interception points in case of I&D. Those were confirmed carefully with route survey conducted during this study,
5) Locations of existing sewered areas and ongoing/planned sewerage works (Varanasi, Mirzapur),
6) STPs where the generated and collected sewage will be conveyed and the capacities,
7) Design population in districts and wards/colonies,
8) Allocation methods of population into flows of each drains to be intercepted in target year in case of I&D in comparison of ward/colony boundaries and drain alignments,
9) Methods of interceptions from existing drains based on proposed interception structures,
10) General ground levels in target areas and locations of intermediate pumping stations, sections of

rising mains from sewerage maps,

11) Areas where are difficult to connect to trunk lines or interceptors and the generated sewage are proposed to be treated with septic tanks due to the ground levels and scales,
12) Proposed trunk sewer sections and the widths, traffic conditions of the roads on grounds for excavation works,
13) Proposed sections (locations, lengths) of sewer installations with trenchless method and the reasons (river crossings/railway crossings/congested roads etc.).

The ways of planning confirmed from the points above are acceptable in terms of Indian standards (CPHEEO Manual and NMCG norms) and generally adopted ones in Japan and the other countries. Therefore planning methodology itself are not required to be changed in general.

However, in light of 2) and 5) above, District-III in Varanasi City had some issues and JICA Study Team proposed the following change of designs.

- Many sewers crossed Assi River without any proposal of trenchless installation that would be cause problem in construction stage. Since trenchless sections have issue of too deep sewer that makes difficult to connect to existing trunk sewer (Assi Interceptor) or alternate siphon makes difficult for O&M work, JICA Study Team concluded that the sewerage system should be remodelled without river crossings except for the upstream part of Assi River where the depth is not significant to be crossed by sewers.
- Assi Secondary Interceptor would be rerouted to inland route under GAP-II due to collapse of laid sewer beside River Ganga. However, it was not taken into account to the design. Therefore, the proposed sewerage system were revised with the rerouted Assi Secondary Interceptor.

In addition, in light of 11) above, there is no enough space for septic tank in congested District-I and also NMCG does not accept the utilization of septic tanks. Therefore, a small area near District-III was remodelled to connect to sewer in District-III rather than constructing the septic tank after discussion with UPJN. It was confirmed that the remodelling does not cause the change of STP capacities due to the small flow and allowance of the STP capacity. Since Interceptor system in Chunar also included some septic tanks, the sewer planning was revised in the city.

In light of 12) on road and traffic conditions, District-II had an issue for installation of trunk sewer. A continuous sections with heavy traffic on the ground was proposed to be installed with trenchless method in discussion and site visit with UPJN.

(2). Verification of Design Inflows and Flow Capacities of Sewers

1) Verification of Existing Design Standards in India

With respect to sewer design methodology in India, JICA Study Team verified “Chapter 3: Design and

Construction of Sewers" in "Manual on Sewerage and Sewage Treatment Systems, Part A: Engineering, Third Edition – Revised and Updated, MOUD & CPHEEO in collaboration with JICA, November 2013". The concepts of design are in general acceptable to be adopted for this project.

2) Verification of Design Parameters in DPRs in Comparison with Design Standard

The design parameters of sewers in main texts and flow calculation sheets of existing DPRs were verified in comparison with the aforementioned existing design standard in India. The example of verified parameters are as follows;

i. Inflow of domestic wastewater
ii. Groundwater infiltration
iii. Pipe material and Manning's coefficient of roughness of each material
iv. Slope, minimum and maximum flow velocities
v. Design depth of sewer (allowance)
vi. Minimum earth cover of sewer
vii. Size and interval of manholes

The parameters in DPRs followed the standard in general and it is acceptable.

(3) Verification of Sewer Capacities in DPRs

The capacities of proposed sewers in DPRs were verified with the design parameters verified as above in flow calculation sheets. The design invert and crown levels of sewers also were confirmed in balance with the levels of existing sewers and ones of ongoing works in Varanasi and Mirzapur.

JICA Study Team confirmed that there is no significant errors of setup and calculations itself in flow calculation sheets. Therefore, the flow calculation sheets were revised based on the revision of planning concepts in Varanasi District-I, II, III and Chunar without specific change of design parameters.

The more details of revised parts, locations and the methodologies in each target city are explained in sections for sewerage system in each city in Chapter 8 and 9.

9.1.1 General Concept

Table 9.1.1 shows the category of development method for each target city. Varanasi City has been and will be developed with comprehensive method as a large city more than 1 million population and Mirzapur and Ghazipur Cities should be developed with combination of ID&T method under implementation by NMCG as the urgent action and following sewer network development under implementation by MoUD as the cities more than 100,000 populations as of Census 2011. Chunar, Ramnagar and Saidpur Cities will be developed with ID&T method as the cities less than 100,000 populations. However, since it is difficult to intercept the wastewater from existing nallahs due to no road for interceptor in parallel with and close to Ganga River and also many large nalas with not only wastewater but also much groundwater in dry weather flow, the preparation of DPR ID&T for Ghazipur City has been facing the problem in UPJN and the initiation of the preparation is delayed.

Table 9.1.1 Category of Development Method for Target Cities in Accordance with MOUD Rule

City	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar	Saidpur
District	Varanasi	Mirzapur	Ghazipur	Varanasi	Mirzapur	Ghazipur
Population (Census2011)	1,435,113	234,170	121,020	49,087	37,227	24,338
Scale of City	More than 1 million	More than 1 lakh	More than 1 lakh	Less than 1 lakh	Less than 1 lakh	Less than 1 lakh
Development Method	Comp.	ID&T Sewer	(ID&T) Sewer	ID&T	ID&T	ID&T

Source: JICA Survey Team

9.1.2 Proposed Sewerage Work for Varanasi City District-I

All the project components for sewers are same with what was stated in sub-section 8.1.1 as comprehensive method.

The map showing the proposed sewerage system based on the DPR is shown in Figure 9.1.1 and abstract of proposed sewerage system is shown in Table 9.1.2.

9.1.3 Proposed Sewerage Work for Varanasi City District-II

Any significant issue was found in DPR Varanasi District-II after the confirmations such as matching of invert levels between proposed sewers and RTS which has been constructed in GAP-II and will be connected with the branch sewers under this project as shown in L-Section in Appendix 9.1.2. Therefore, all the project components for sewers are same with what was stated in sub-section 8.1.2 as comprehensive method.

Table 9.1.3 shows the proposed sewer works in the DPR. The map showing the proposed sewerage system is shown in Figure 9.1.2.

Table 9.1.2 Proposed Sewer Works in Varanasi District-I

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	193,294	840
RCC	250	9,862	309
RCC	300	4,808	0
RCC	350	2,010	18
RCC	400	2,069	268
RCC	450	1,609	30
RCC	500	2,081	99
RCC	600	1,638	192
RCC	700	84	30
RCC	800	317	90
RCC	900	0	0
Sub-total		**217,772**	**1,876**
Total		**219,648**	

(2) Manhole

Dia. (mm)	Nos.
900	10,898
1200	27
Total	**10,925**

(3) House Connection

Transfer of Exist. (nos.)	New Pipe (nos.)	New Chamber (nos.)
38,288	**9,804**	4,902

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
400	265	(30% of 883m)
600	218	(30% of 728m)
Total	**483**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
88

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
300	795
600	664
Total	**1,459**

Source: DPR Varanasi District-I compiled by JICA Survey Team

Table 9.1.3 Proposed Sewer Works in Varanasi District-II

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	236,690	332
RCC	250	11,062	0
RCC	300	6,018	269
RCC	350	3,788	145
RCC	400	4,132	499
RCC	450	2,427	311
RCC	500	2,875	540
RCC	600	1,366	368
RCC	700	1,924	90
RCC	800	570	439
RCC	900	1,244	918
Sub-total		**272,096**	**3,911**
Total		**276,007**	

(2) Manhole

Dia. (mm)	Nos.
900	12,983
1200	145
Total	**13,128**

(3) House Connection

Exist. (nos.)	New (nos.)	New Chamber (nos.)
79,836	**34,216**	17,108

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
450	256	(30% of 852m)
600	145	(30% of 484m)
900	309	(30% of 1,031m)
Total	**710**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
24

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
250	3,850
300	3,451
400	567
600	813
Total	**8,681**

Source: DPR Varanasi District-II compiled by JICA Survey Team

9.1.4 Proposed Sewerage Work for Varanasi City District-III

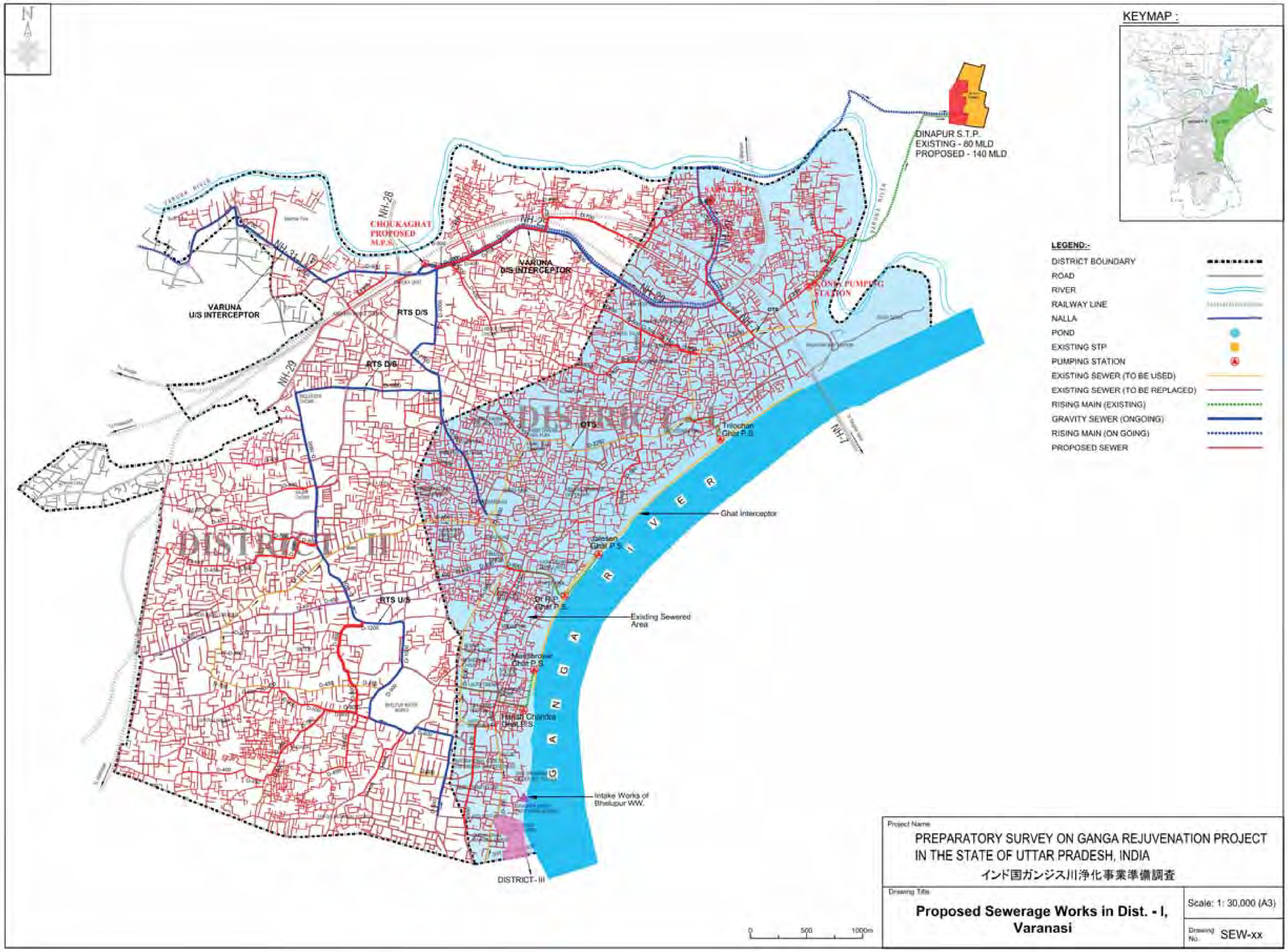
The project components for sewers which was stated in sub-section 8.1.3 with comprehensive method had the following significant issues:

1) Included many river crossings on Assi Nala alignment without any proposal of siphons under the river constructed by micro-tunnelling method. The alignment of sewers would interfere the flow of Assi Nala which may cause the flooding and/or accumulation of garbage.

2) The collaboration with latest plan in the nearby area of proposed route for Assi Secondary Interceptor of which the laid sewer was collapsed by land slide at bank of Ganga River and will be re-laid under GAP-II project was not found.

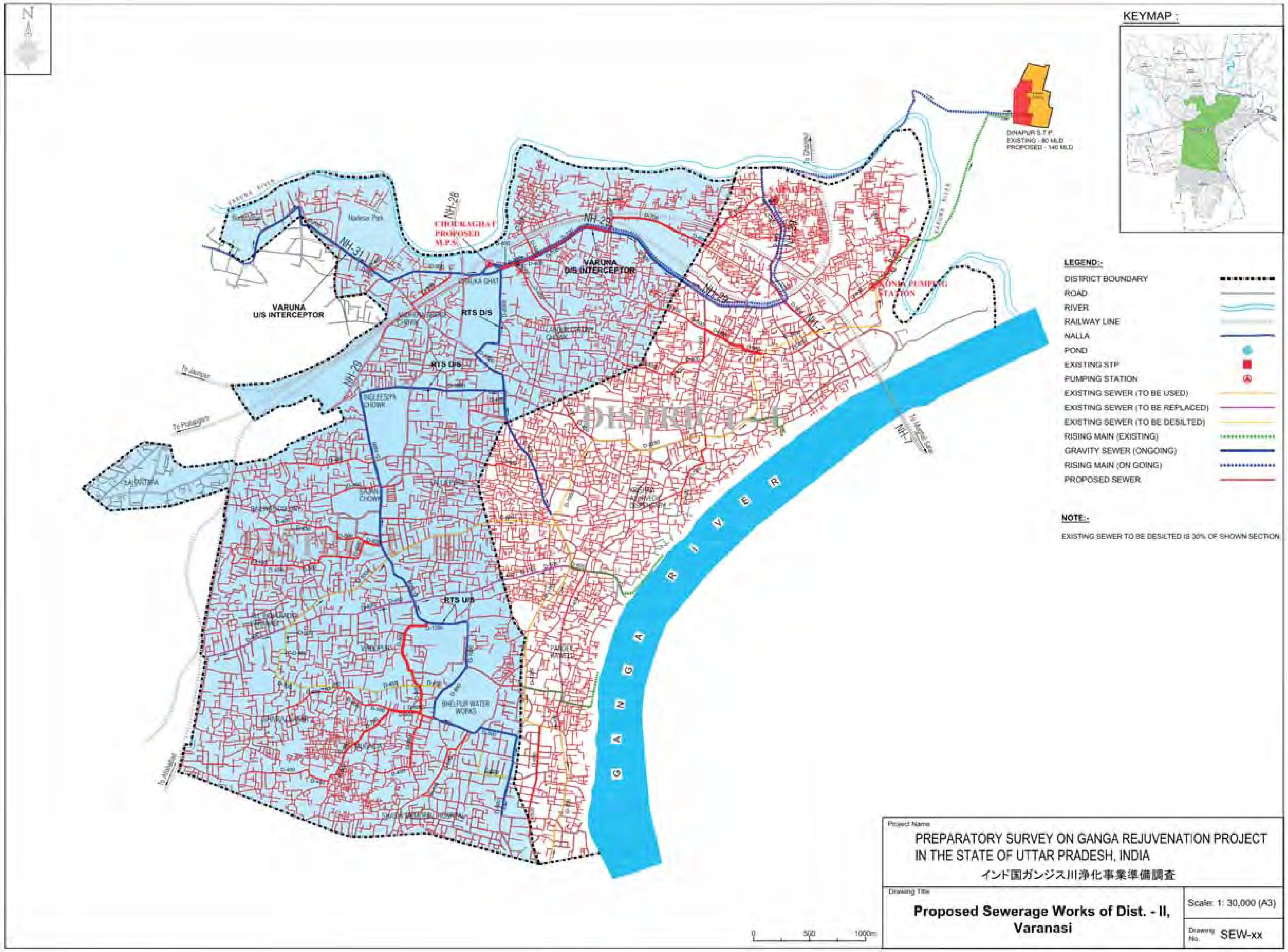
Therefore, JICA Survey Team proposed the remodelling of sewer network in nearby area of Assi Nala and proposed Assi Secondary Interceptor.

The map showing the proposed sewerage system is shown in Figure 9.1.3.



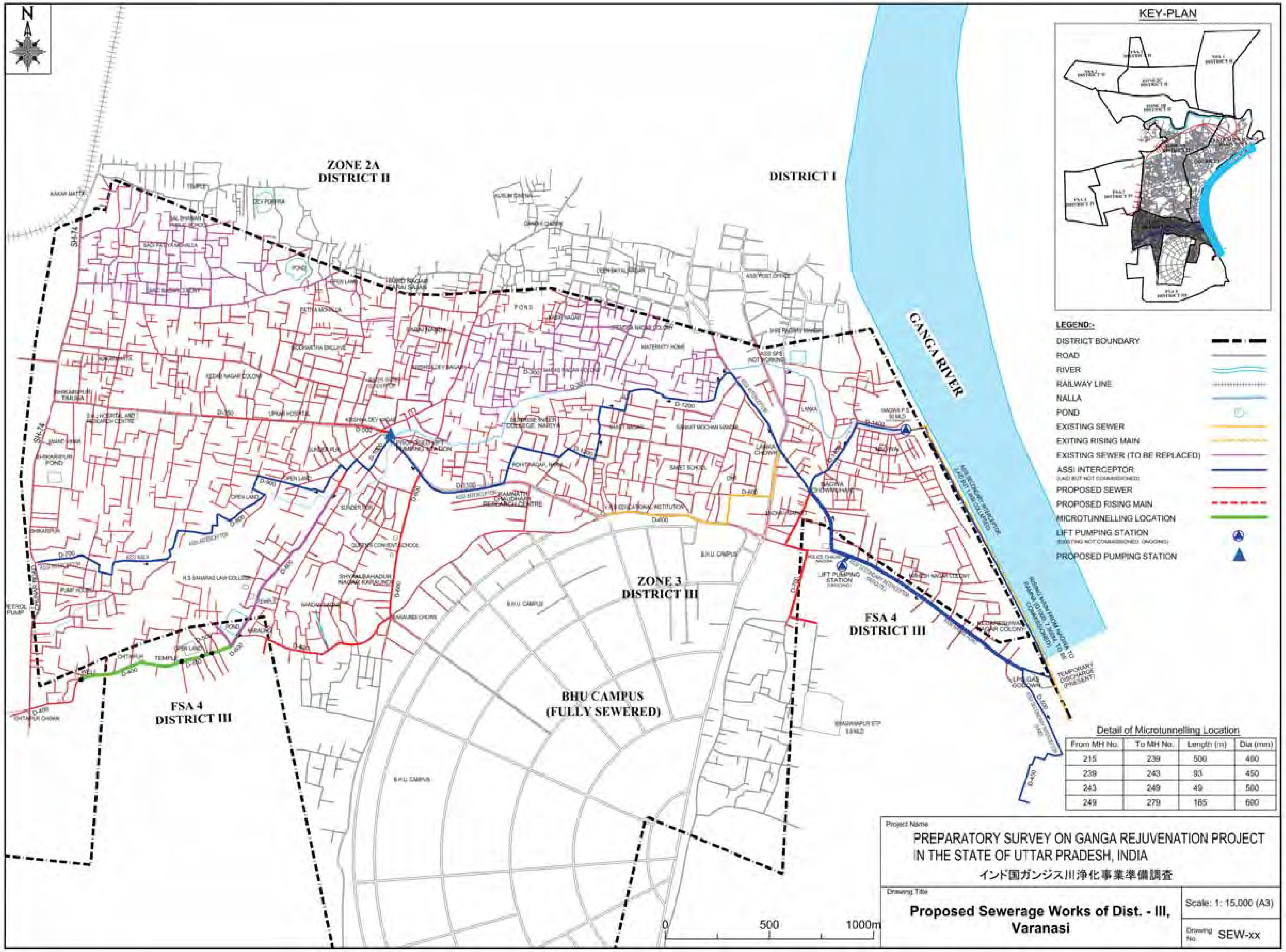
Source: DPR Varanasi District-I compiled by JICA Survey Team

Figure 9.1.1 Proposed Sewerage System in Varanasi City District-I



Source: DPR Varanasi District-II compiled by JICA Survey Team

Figure 9.1.2 Proposed Sewerage System in Varanasi City District-II



Detail of Microtunnelling Location

From MH No.	To MH No.	Length (m)	Dia (mm)
215	239	500	400
239	243	93	450
243	249	49	500
249	279	165	600

Source: JICA Survey Team

Figure 9.1.3 Proposed Sewerage System in Varanasi City District-III

9.1.5 Proposed Sewerage Work for Ramnagar City

The separate DPRs with comprehensive method and ID&T method were prepared for Ramnagar City. However, due to the scale of city with less than 100,000 population, only ID&T method will be adopted and sewer network to connect with interceptor will not be developed.

Since DPR ID&T for Ramnagar does not include the general sewerage map showing rising main route to STP, JICA Survey Team prepared the sewerage map in accordance with interview to UPJN on the base map of DPR Ramnagar comprehensive as shown in Figure 9.1.4.

The original DPR included the following issues from the review by JICA Survey Team.

1) The ground levels at interceptor alignment was not consistent with existing ones confirmed from route survey. However, the invert levels of drains of which the wastewater flows will be intercepted were almost correct. It lead to much less excavation depth than actually required ones in BOQ and cost.

2) The velocity of sewer did not exceed 0.8 m/sec which is required for combined sewer to flush the sands and silts in DPR's flow calculation even in ultimate year 2050.

3) An interception structure for Ram Bagh Drain as a largest drain to be intercepted was not estimated in BOQ for sewer works and it was not found in the BOQ for MPS beside Ram Bagh Drain.

Therefore, JICA Survey Team revised the flow calculation and BOQ based on accurate ground levels obtained from route survey. The proposed longitudinal profile (L-Section) for the interceptor designed from the revised flow calculation is shown in Appendix 9.1.3. In addition, JICA Survey Team revised the proposed interception structures as shown in Appendix 9.1.4 since the original drawing included many discrepancies from dimensions of interceptors in flow calculation sheet and BOQ.

Table 9.1.4 shows the BOQ of proposed sewer works. Although the excavation volume for interceptor and estimated number of interception structures are proposed to be increased due to aforementioned reasons, the dimensions in the table is consistent with original DPR.

Table 9.1.4 Proposed Sewer Works in Ramnagar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)
1) Gravity Sewer			Total
RCC	NP3	200	0
RCC	NP3	250	0
RCC	NP3	300	0
RCC	NP3	350	80
RCC	NP3	400	150
RCC	NP3	450	0
RCC	NP3	500	120
RCC	NP3	600	0
RCC	NP3	700	0
RCC	NP3	800	0
RCC	NP3	900	30
Sub-total			**380**
2) Rising Main			
DI	K9	400	**2,700**
Sub-total			**2,700**
Total			**3,080**

(2) Manhole

1200x900	0
1500x1500	10
Total	**10**

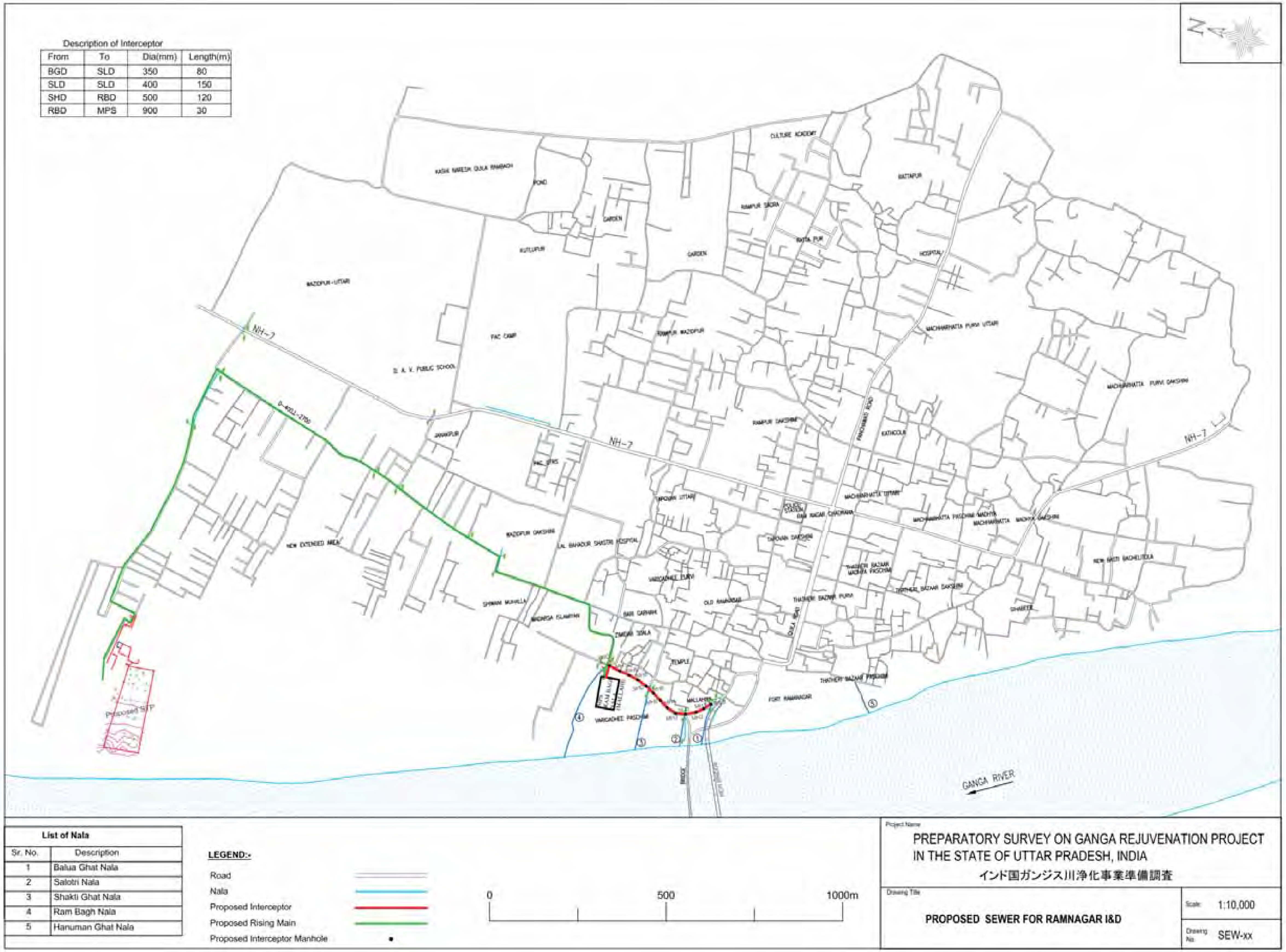
(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Ramnagar ID&T compiled by JICA Survey Team



Description of Interceptor

From	To	Dia(mm)	Length(m)
BGD	SLD	350	80
SLD	SLD	400	150
SHD	RBD	500	120
RBD	MPS	900	30

List of Nala

Sr. No.	Description
1	Balua Ghat Nala
2	Salotri Nala
3	Shakti Ghat Nala
4	Ram Bagh Nala
5	Hanuman Ghat Nala

Source: JICA Survey Team revised on DPR Ramnagar Comprehensive

Figure 9.1.4 Proposed Sewer Network in Ramnagar City (ID&T)

9.1.6 Proposed Sewerage Work for Mirzapur City

The separate DPRs with comprehensive method and ID&T method explained in Chapter 8 should be incorporated as Phase-I work for ID&T and Phase-II work for the successive sewer networks development to connect the branch sewers to interceptor without parallel lines except for rising mains as much as possible.

Figure 9.1.5 shows the proposed sewerage system for ID&T work (Phase-I) as urgent development and the longitudinal profile (L-Section) of proposed interceptor is shown in Appendix 9.1.x. Table 9.1.5 shows the abstract of ID&T work. The lengths of small diameters as connection pipes from interception structures to interceptor sewers would be revised due to the move of interception structures.

Figure 9.1.6 shows the integrated image of the works. For the easiness of future secondary sewer connection to interceptor, manholes in the road crossings should be constructed in Phase-I for future. To reduce the number of lift pumping stations on the secondary sewer alignments as much as possible for connecting to interceptor, the depth of interceptor should be enough deep considering the depth in end points of secondary sewers. (Local consultants of UPJN will revise DPR under that concept.)

Under this concept 10 pumping stations consisting of 1) existing four pumping stations for rehabilitation in Phase-1, 2) proposed four pumping stations in Phase-1, and 3) proposed two intermediate pumping stations in Phase-2 will be developed.

Table 9.1.5 Proposed Sewer Works in Mirzapur City (Phase-I: ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Interceptor				
RCC	NP3	200	750	0
RCC	NP3	250	400	0
RCC	NP3	300	800	0
RCC	NP3	350	0	0
RCC	NP3	400	555	0
RCC	NP3	450	550	0
RCC	NP3	500	1,659	0
RCC	NP3	600	2,211	0
RCC	NP3	700	0	0
RCC	NP3	800	210	0
RCC	NP3	900	1,700	0
RCC	NP3	1000	0	0
RCC	NP3	1200	0	0
Sub-total			**8,835**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	**370**	
DI	K9	250	-	
DI	K9	300	**3,550**	
DI	K9	350		
DI	K9	600	**80**	
DI	K9	700	**1,370**	
Sub-total			**5,370**	
3) Treated Effluent Reuse Line				
RCC	NP3	800	**7,000**	
Total			**21,205**	

(2) Manhole

Dia. (mm)	Nos.
1) Interceptor	
900	241
1200	65
Sub-total	306
900	38
Total	**344**

(3) Interception Structure (Nala Tapping Structure)

Zone	Nos.	
	New	Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

Source: JICA Survey Team revised from DPR Mirzapur ID&T

Table 9.1.6 Proposed Sewer Works in Mirzapur City (ID&T and Sewer Network)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length (Rm)				
			Open	Micro Tunneling	Replacement	Open	Micro Tunneling
			ID&T (NMCG)		Sewer Network (MoUD)		
1) Interceptor/Gravity Sewer							
RCC	NP3	200	750	0		217,181	110
RCC	NP3	250	400	0		3,814	0
RCC	NP3	300	800	0		9,141	25
RCC	NP3	350	0	0		1,716	0
RCC	NP3	400	555	0		4,219	30
RCC	NP3	450	550	0		1,275	25
RCC	NP3	500	1,659	0		1,908	0
RCC	NP3	600	2,211	0		586	20
RCC	NP3	700	0	0		1,899	0
RCC	NP3	800	210	0		1,199	0
RCC	NP3	900	1,700	0		970	20
RCC	NP3	1000	0	0		1,537	20
RCC	NP3	1200	0	0		0	30
					4,500		
Sub-total			**8,835**	**0**	**4,500**	**245,445**	**280**
2) Rising Main							
DI	K9	150	-	-	-	-	-
DI	K9	200	**370**	-	-	**356**	-
DI	K9	250	-	-	-	-	-
DI	K9	300	**3,550**	-	-	**36**	-
DI	K9	350	-	-	-	-	-
DI	K9	600	**50**	-	-	-	-
DI	K9	700	**1,370**	-	-	-	-
DI	K9	800	**30**				
Sub-total			**5,340**	**0**	-	**392**	-
3) Treated Effluent Reuse Line							
RCC	NP3	800	**7,000**	**0**	-	**0**	-
Total			**21,175**	**0**		**245,837**	**280**

(2) Manhole

Dia. (mm)	NMCG (Nos.)	MOUD (Nos.)
1) Interceptor		
900	241	10,210
1200	65	162
Sub-total	306	10,372
2) Treated Effluent Reuse Line		
900	38	0
Total	**344**	**10,372**

(3) Interception Structure (Nala Tapping Structure)

Zone	NMCG (Nos.)	
	New	Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

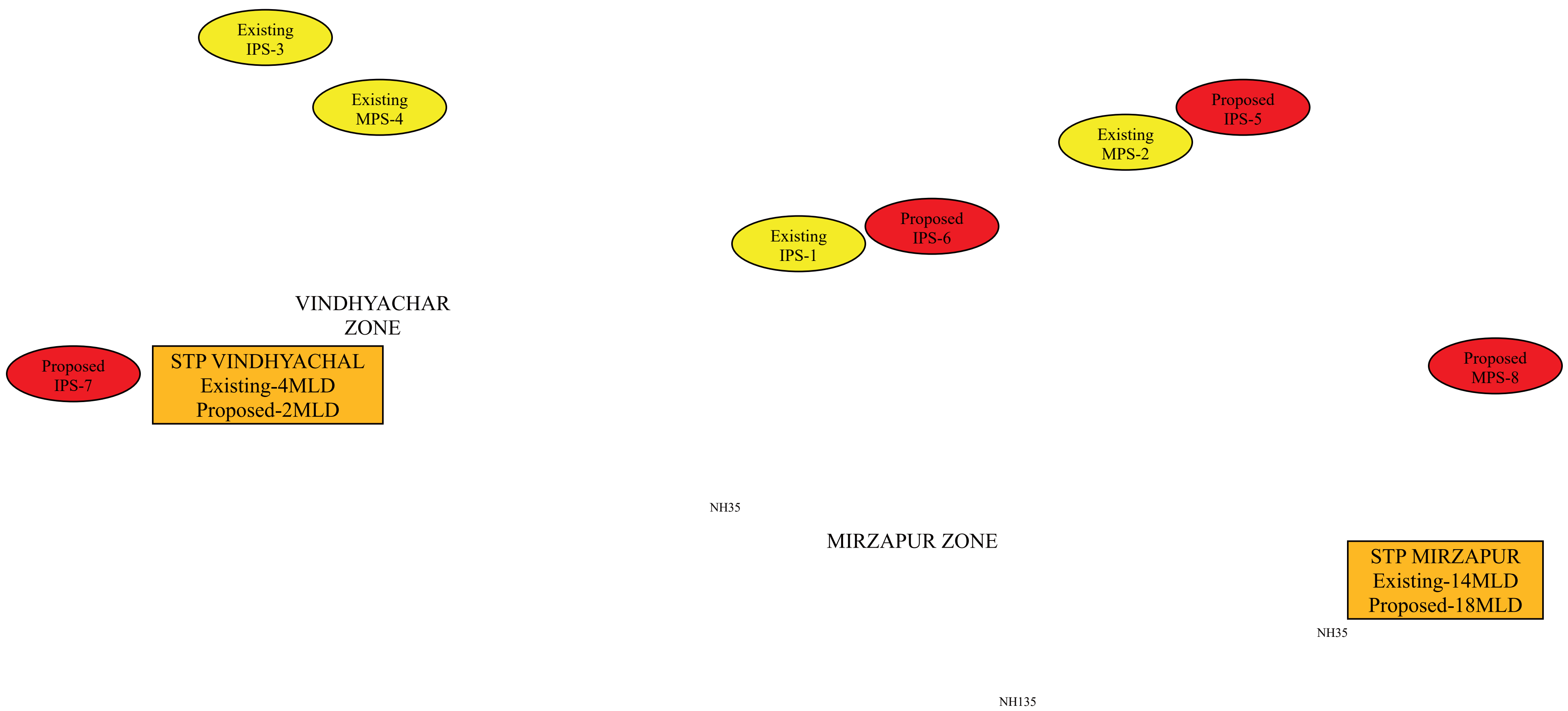
(4) House Connection (Nos.)

NMCG	MOUD
0	**5,726**

(5) Septic Tank Soak Pit (Nos.)

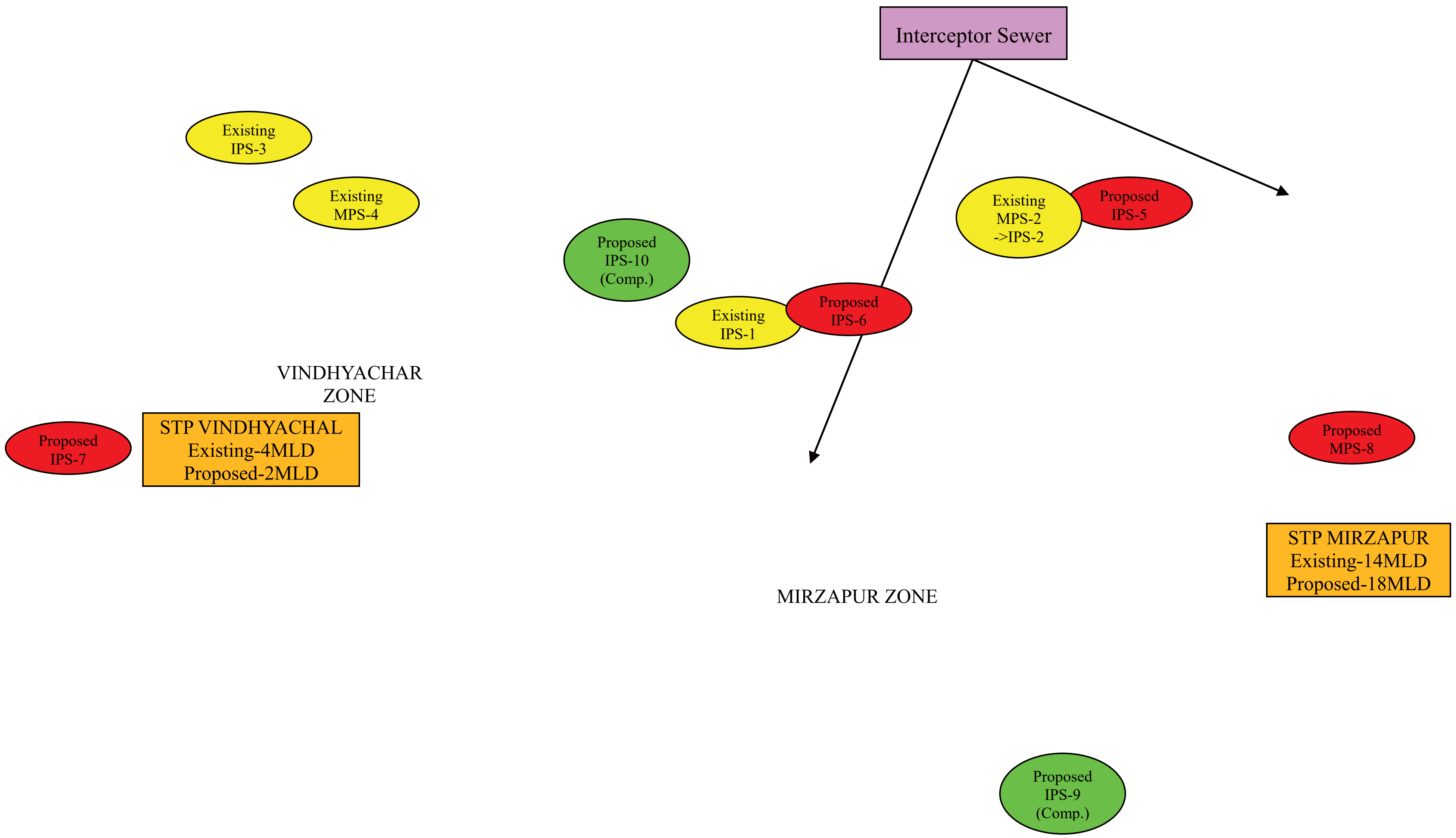
NMCG	MOUD
0	**8**

Source: JICA Survey Team revised from DPR Mirzapur Comprehensive and ID&T



Source: DPR Mirzapur ID&T revised by JICA Survey Team

Figure 9.1.5 Proposed Sewerage System in Mirzapur City ID&T (Phase-I)



Source: DPR Mirzapur Comprehensive and ID&T revised by JICA Survey Team

Figure 9.1.6 Proposed Sewerage System in Mirzapur City (Phase-I: ID&T and Phase-II: Sewer Network)

Table 9.1.7 General Specification of Pumping Stations in Proposed Sewerage Works in Mirzapur City (ID&T and Sewer Network)

1) NMCG (ID&T)

IPS

No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length	No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
Rehabilitation of Existing PS			Pump								Rising Main				Proposed			Pump								Rising Main		
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
Mirzapur															Mirzapur													
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700	1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**														
2	MPS-2 -> IPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370	2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**				Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal															Vindhyachal													
3	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250	3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**				Non-peak	50	2	1	1	12	50	1.2			
Sub-Total	3														Sub-Total	3												
Total	**6**																											

MPS

No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length	No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
Rehabilitation of Existing PS			Pump								Rising Main				Proposed			Pump								Rising Main		
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
Mirzapur															Mirzapur													
-	Existing MPS-2 in Kutchary should be renamed to IPS-2														1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	800	30
Vindhyachal																												
1	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100														
											Proposed	**DI-K9**	**300**	**30**														
Sub-total	1														Sub-Total	1												
Total	**2**																											

	8	

2) MOUD (Sewer Network)

IPS

No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length	No.	Name	Location	Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
Rehabilitation of Existing PS			Pump								Rising Main				Proposed			Pump								Rising Main		
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
															Mirzapur													
															1	IPS-7-> IPS-9	district jail Mirzapur	Peak	280	3	2	1	13	13	13	DI-K9	300	36
																		Non-peak	150	2	1	1	13	13	13			
															2	IPS-8-> IPS-10	lalah ghat	Peak	160	3	2	1	21	21	21	DI-K9	200	356
																		Non-peak	65	2	1	1	17	17	17			
Sub-Total	0														Sub-total	2												
Total	**2**																											

Source: DPR Mirzapur Comprehensive and ID&T revised by JICA Survey Team

9.1.7 Proposed Sewerage Work for Chunar City

The separate DPRs with comprehensive method and ID&T method were prepared for Chunar City. However, due to the scale of city with less than 100,000 population, only ID&T method will be adopted and sewer network to connect with interceptor will not be developed. Table 9.1.8 shows the BOQ of proposed sewer works and Figure 9.1.7 shows the sewerage map. Since the longitudinal profile (L-section) for interceptor has not been prepared for DPR, JICA Survey Team prepared the L-section as shown in Appendix 9.1.6.

Since NMCG commented for submitted DPR that 1) the use of septic tanks are not permitted, 2) the drains towards Jargo River also should be intercepted since the wastewater would inflow to Ganges River in future due to decrease of water use in nearby farm land, now DPR should be revised as follows;

1) The wastewater from septic tank areas should be collected into interceptor by lowering the interceptor depth or adding/moving the pump stations,

2) The drains towards Jargo River are to be intercepted with additional interceptor line.

Once the sewerage map will be finalized based on the actions above, the figures will be replaced.

Table 9.1.8 Proposed Sewer Works in Chunar City (ID&T) Tentative

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)	Length Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200		
RCC	NP3	250	700	
RCC	NP3	300		
RCC	NP3	350	250	
RCC	NP3	400		
RCC	NP3	450		
RCC	NP3	500		
RCC	NP3	600	1,550	
RCC	NP3	700	1,808	
Sub-total			**4,308**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	2,130	
DI	K9	250	-	
DI	K9	300	-	
DI	K9	350	30	
Sub-total			**2,160**	
3) Treated Effluent Reuse Line				
RCC	NP3	350	**3,695**	
Total			**10,163**	

(2) Manhole

Dia. (mm)	Nos.
900	86
1200	63
Total	**149**

(3) Interception Structure

Nos.
22

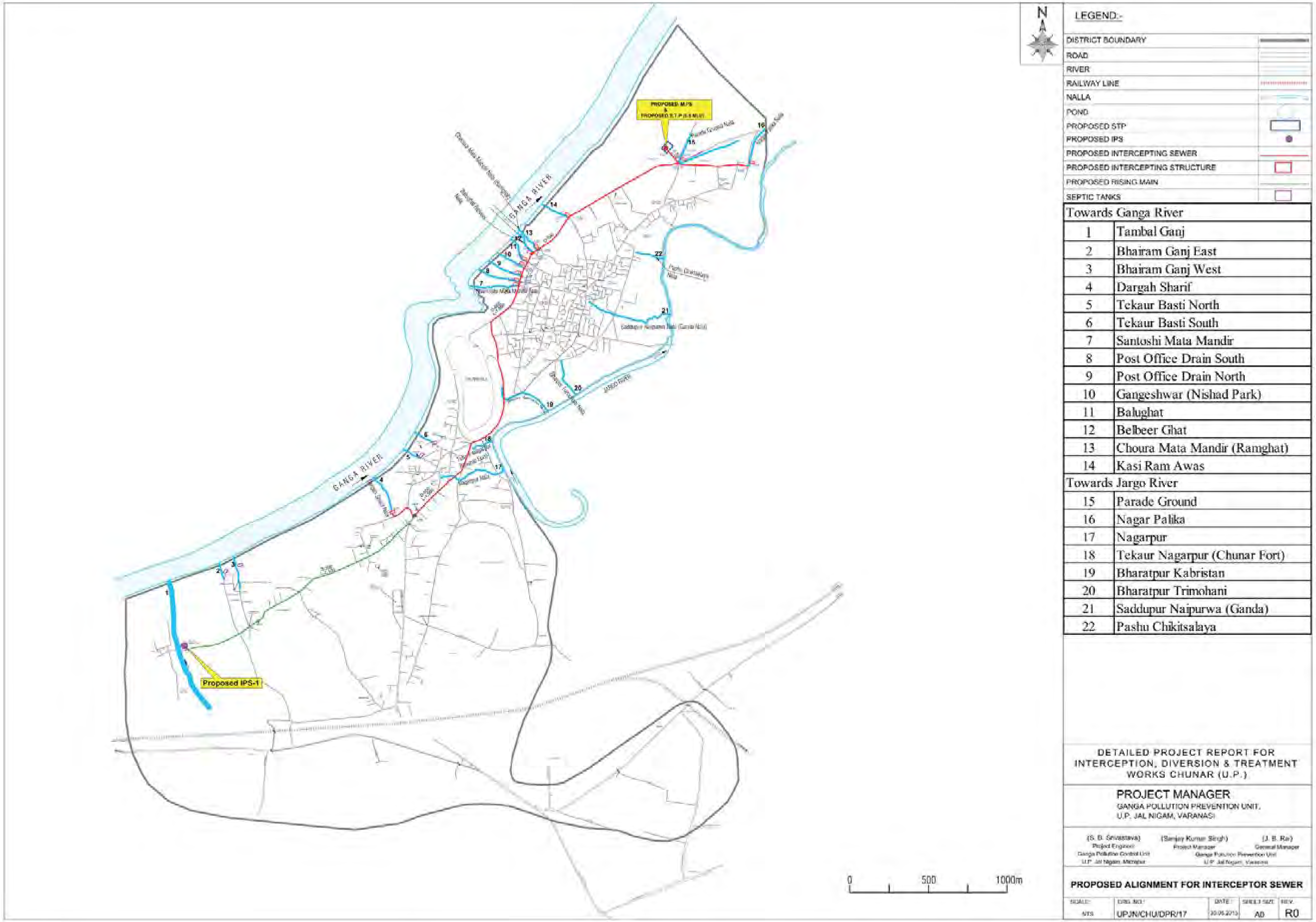
(4) Septic Tank Soak Pit

Nos.
0

(5) House Connection

Nos.
0

Source: DPR Chunar ID&T revised by JICA Survey Team



Source: DPR Chunar ID&T compiled by JICA Survey Team

Figure 9.1.7 Proposed Sewer Network in Chunar City (ID&T)

9.1.8 Proposed Sewerage Work for Ghazipur City

As a city where the population is more than 1 lakh Ghazipur City will be developed with the sewer networks. However, for urgent development of sewerage system UPJN has to prepare the DPR ID&T separate from the existing DPR comprehensive due to the instruction by NMCG., but UPJN still seeks for the development with only existing DPR comprehensive since interception of drains are difficult in this city which has large drains (rather those should be called as "rivers") and no good road for laying interceptor in parallel with Ganga River. In case UPJN would prepare DPR ID&T the JICA Survey Team would propose the necessary revisions for the DPR comprehensive and ID&T.

Due to the delay of starting the preparation of DPR Ghazipur ID&T by UPJN the JICA Survey Team prepared the image of interceptions from 13 existing drains as shown in **Figure 9.1.8**. The abstract of quantities are shown in Table 9.1.9. The intermediate pumping stations (IPS-1 and 2) are not necessary from the preliminary consideration of interceptor invert level but it is continued to be checked for matching with invert levels of future branch sewers to be connected.

Figure 9.1.9 shows the integrated image of 1) ID&T work as urgent measure and 2) future sewer network which will be developed with MoUD fund. The abstract of quantities is shown in Table 9.1.10. The quantities of future sewer network are under revision for deducting the overlapped sections between interceptor and future sewer network.

Table 9.1.9 Proposed Sewer Works in Ghazipur City (Phase-I: ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	350	770	0
RCC	NP3	400	1,661	0
RCC	NP3	450	0	0
RCC	NP3	500	0	0
RCC	NP3	600	1,018	0
RCC	NP3	700	1,360	0
RCC	NP3	800	1,414	0
RCC	NP3	900	967	0
RCC	NP3	1000	651	0
RCC	NP3	1100	494	0
Sub-total			**8,335**	**0**
2) Rising Main				
DI	K9	700	25	
Sub-total			**25**	**0**
Total			**8,360**	

MPS

(2) Manhole

Dia. (mm)	Nos.
900	118
1200	127
1500	39
Total	**284**

(3) Interception Structure

Nos.
13

Source: JICA Survey Team

Note: red color parts will be changed after further consideration

Table 9.1.10 Proposed Sewer Works in Ghazipur City (ID&T and Sewer Network)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length (Rm)				
			Open	Micro Tunneling	Open	Micro Tunneling	
			ID&T (NMCG)		Sewer Network (MoUD)		
1) Interceptor/Gravity Sewer							
RCC	NP3	200	0	0	57,974	0	
RCC	NP3	250	0	0	5,574	0	
RCC	NP3	300	0	0	3,664	0	
RCC	NP3	350	770	0	3,250	0	
RCC	NP3	400	1,661	0	1,604	0	
RCC	NP3	450	0	0	1,169	0	
RCC	NP3	500	0	0	2,742	0	
RCC	NP3	600	1,018	0	1,141	0	
RCC	NP3	700	1,360	0	525	0	
RCC	NP3	800	1,414	0	0	0	
RCC	NP3	900	967	0	2,415	0	
RCC	NP3	1000	651	0	264	0	
RCC	NP3	1200	494	0	188	0	
Sub-total			**8,335**	**0**	**80,510**	**0**	
2) Rising Main							
DI	K9	200	**-**	**-**	**250**	**-**	IPS-3
DI	K9	700	**25**	**-**			MPS
Sub-total			**25**	**0**	**250**	**-**	
Total			**8,360**	**0**	**80,760**	**0**	

(2) Manhole

Dia. (mm)	NMCG (Nos.)	MOUD (Nos.)
900	118	
1200	127	
1500	39	
Total	**284**	**1,721**

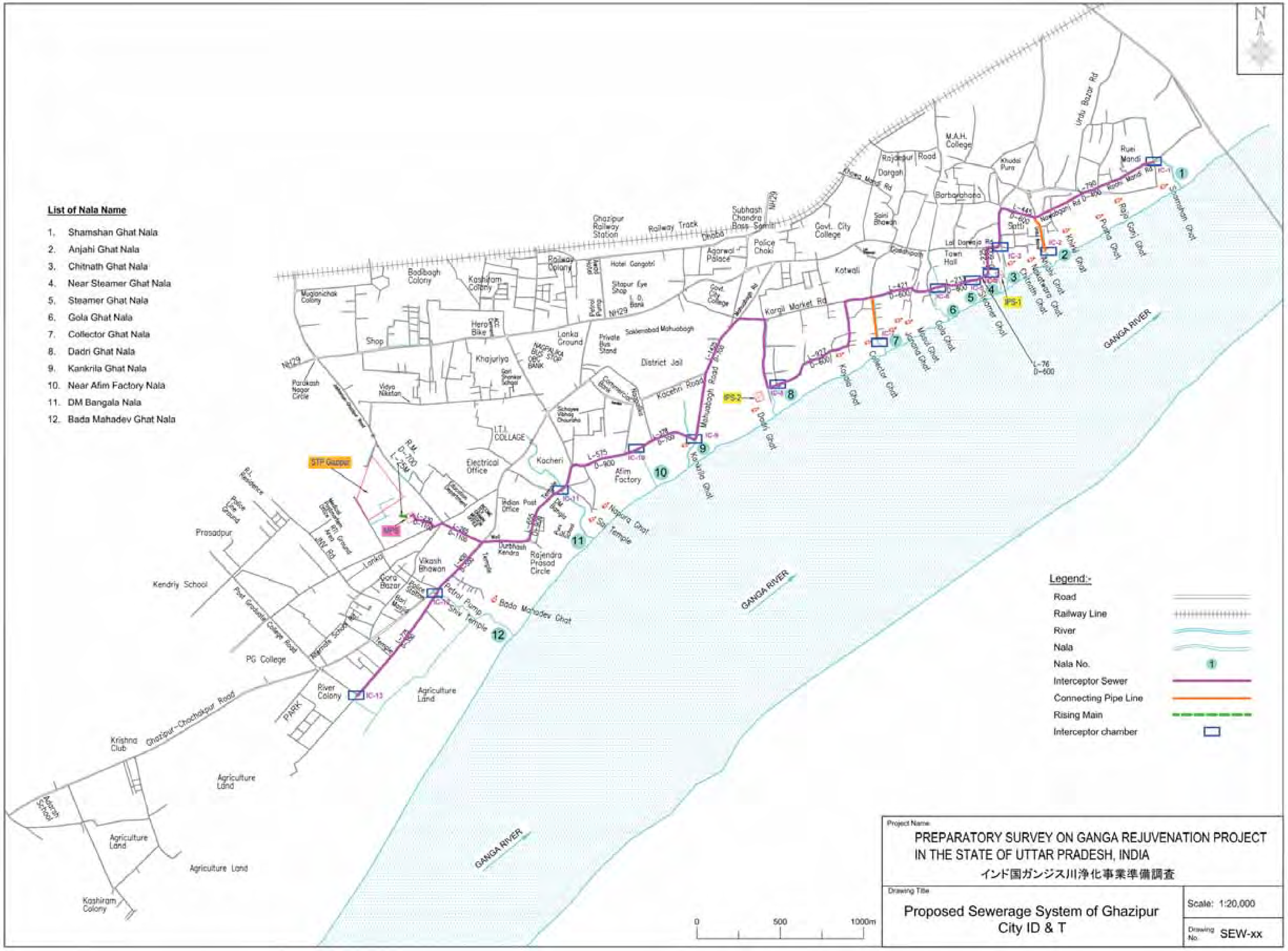
(3) Interception Structure (Nala Tapping Structure)

NMCG (Nos.)	MOUD (Nos.)
13	**0**

(4) House Connection (Nos.)

NMCG	MOUD
0	**3,900**

Source: JICA Survey Team, DPR Ghazipur Comprehensive
Note: red color parts will be changed after further consideration



Source: JICA Survey Team

Figure 9.1.8 Proposed Sewerage System in Ghazipur City ID&T

Source: JICA Survey Team based on DPR Ghazipur ID&T and Comprehensive

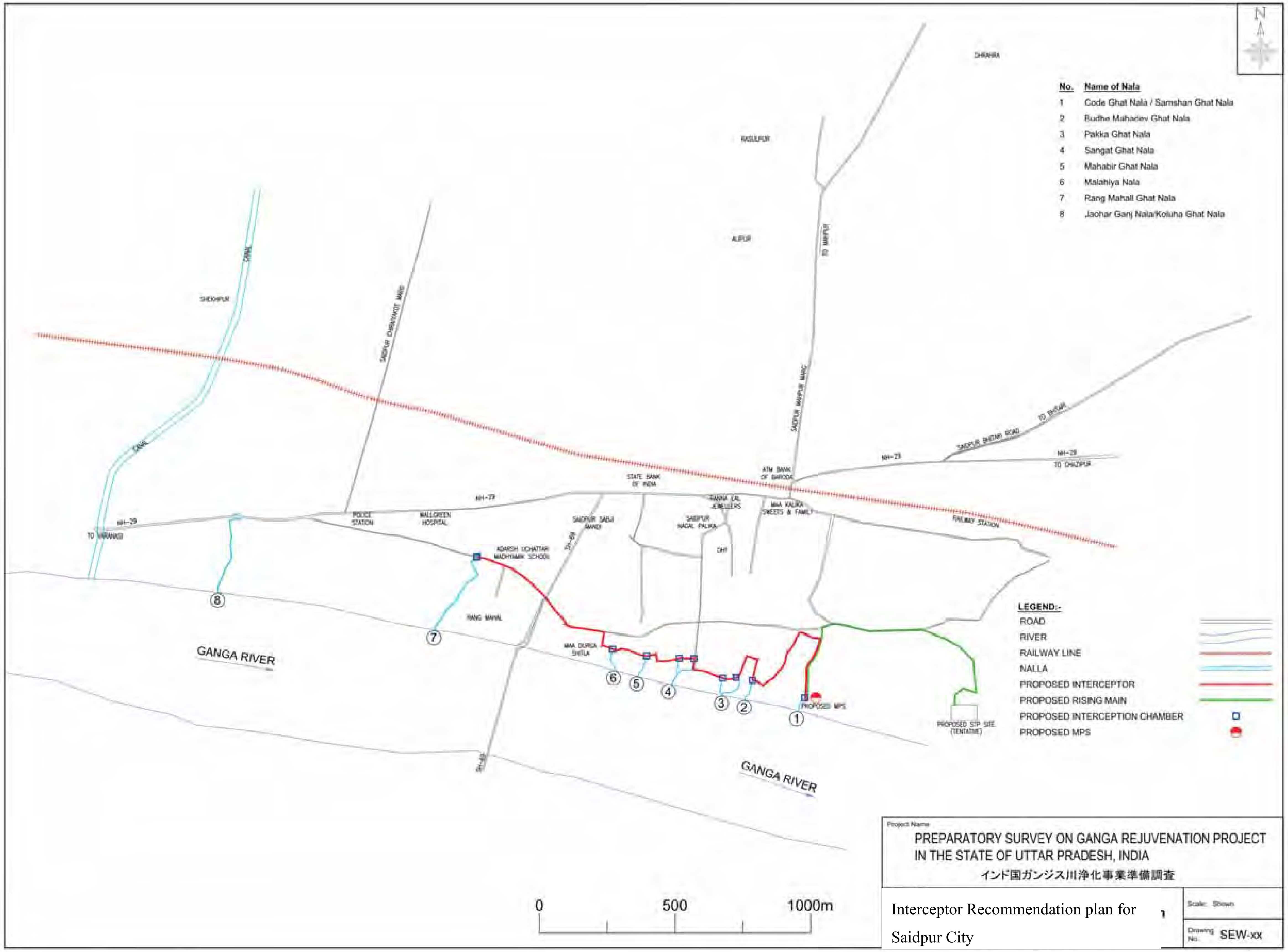
Figure 9.1.9 Proposed Sewerage System in Ghazipur City (Phase-I: ID&T and Phase-II: Sewer Network)

9.1.9 Proposed Sewerage Work for Saidpur City

DPR of ID&T was thought to be prepared by UPJN based on survey results of drains for interception. However, ID&T plan was not submitted and the land for the STP was not available at last. Based on the interview to UPJN, the possible route and tapping points under consideration are shown in **Figure 9.1.10**. This information will be useful when the land for the STP becomes available.

9.1.10 Abstract of Proposed Sewer Works for Target Cities

Table 9.1.11 shows the list of proposed sewer works (interceptor and/or sewer networks and rising mains) and number of pumping stations as urgent works which were revised from current DPRs by JICA Survey Team. Table 9.1.12 shows the list of future sewer works in target cities with combination of comprehensive and ID&T methods.



Source: JICA Survey Team based on Interview to UPJN

Figure 9.1.10 Interceptor Route in Saidpur City (Recommended Plan)

Table 9.1.11 Abstract of Proposed Sewer Works in Target Cities (Urgent Works):

No.			District	Varanasi								Mirzapur				Ghazipur			
			City/Town	Varanasi						Ramnagar		Mirzapur		Chunar		Ghazipur		Saidpur	
			Sewerage District	District-I		District-II		District-III		-		-		-		-		-	
			Development	Comprehensive		Comprehensive		Comprehensive		ID&T		ID&T		ID&T		ID&T		ID&T	
			Central Government	NMCG		NMCG		NMCG		NMCG		NMCG		NMCG		NMCG		NMCG	
	Item	Material	Dia. (mm)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																		
	1) Gravity	RCC	200	193,294	840	236,690	332	109,441	0	0	0	750	0	0	0	0	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	0	0	400	0	700	0	0	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	0	0	800	0	0	0	0	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	80	0	0	0	250	0	770	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	150	0	555	0	0	0	1,661	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	0	0	550	0	0	0	0	0		
		RCC	500	2,081	99	2,875	540	288	39	120	0	1,659	0	0	0	0	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	2,211	0	1,550	0	1,018	0		
		RCC	700	84	30	1,924	90	2,603	165	0	0	0	0	1,808	0	1,360	0		
		RCC	800	317	90	570	439	867	0	0	0	210	0			1,414	0		
		RCC	900	0	0	1,244	918	0	0	30	0	1,700	0			967	0		
		RCC	1000													651	0		
		RCC	1200													494	0		
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	380	0	8,835	0	4,308	0	8,335	0	1,235	0
			Total	219,648		276,007		120,342		380		8,835		4,308		8,335		1,235	
	2) Rising Main	DI	200					30				370		2,130				500	
		DI	300									3,550							
		DI	350											30					
		DI	400							2,700									
		DI	600									80							
		DI	700									1,370							
			Total	0	-	0	-	30	-	2,700	-	5,370	-	2,160	-	0	-	500	-
	3) Treated Effluent Reuse Line																		
		RCC	350	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-
		RCC	800	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-
			Total of pipe laying work	219,648		276,007		120,372		3,080		21,205		10,163		8,335		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159				279		86		118			
			1200	27		145		149				65		63		127			
			1500													39			
			1000x1500															29	
			1500x1500							10									
			Total	10,925	-	13,128	-	5,308	-	10	-	344	-	149	-	284	-	29	-
3	Interception Structure		Zone									Mirzapur	Vindhyachal						
	1) New		nos.	-	-	-	-	-	-	4	-	13	4	22	-	13	-	9	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	4	-	18	8	22	-	13	-	9	-
4	House Connection																		
	1) New		nos.	9,804	-	34,216	-	18,261	-	0	-	0	-	0	-	0	-	0	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	-	-	-	-	-	-
5	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) New		nos.	-	-	-	-	1	-	0	1	3	1	1	1	0	1	0	1
	2) Rehabilitation		nos.	-	-	-	-	-	-	-	-	2	2	-	-	-	-		
	Total		nos.	0		0		1		1		8		2		1		1	

Remarks: Saidpur was dropped due to Land issue for the STP

Source: JICA Survey Team based on DPRs and Proposals of Revisions for Target Cities

Table 9.1.12 Abstract of Proposed Sewer Works in Target Cities (ID&T and Sewer Networks):

No.			District	Varanasi								Mirzapur						Ghazipur					
			City/Town	Varanasi						Ramnagar		Mirzapur				Chunar		Ghazipur				Saidpur	
			Sewerage District	District-I		District-II		District-III		-		-				-		-				-	
			Development	Comprehensive		Comprehensive		Comprehensive		ID&T		ID&T		Sewer Network		ID&T		ID&T		Sewer Network		ID&T	
			Central Government	NMCG		NMCG		NMCG		NMCG		NMCG		MOUD		NMCG		NMCG		MOUD		NMCG	
	Item	Material	Dia. (mm)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																						
	1) Gravity	RCC	200	193,294	840	236,690	332	109,441	0	0	0	750	0	217,181	110	0	0	0	0	57,974	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	0	0	400	0	3,814	0	700	0	0	0	5,574	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	0	0	800	0	9,141	25	0	0	0	0	3,664	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	80	0	0	0	1,716	0	250	0	770	0	3,250	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	150	0	555	0	4,219	30	0	0	1,661	0	1,604	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	0	0	550	0	1,275	25	0	0	0	0	1,169	0		
		RCC	500	2,081	99	2,875	540	288	39	120	0	1,659	0	1,908	0	0	0	0	0	2,742	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	2,211	0	586	20	1,550	0	1,018	0	1,141	0		
		RCC	700	84	30	1,924	90	2,603	165	0	0	0	0	1,899	0	1,808	0	1,360	0	525	0		
		RCC	800	317	90	570	439	867	0	0	0	210	0	1,199	0			1,414	0	0	0		
		RCC	900	0	0	1,244	918	0	0	30	0	1,700	0	970	20			967	0	2,415	0		
		RCC	1000											1,537	20			651	0	264	0		
		RCC	1200											0	30			494	0	188	0		
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	380	0	8,835	0	245,445	280	4,308	0	8,335	0	80,510	0	1,235	0
			Total	219,648		276,007		120,342		380		8,835		245,725		4,308		8,335		80,510		1,235	
	2) Rising Main	DI	200					30				370		356		2,130				250			
		CI	200																			500	
		DI	300									3,550		36									
		DI	350													30				1,440			
		DI	400							2,700													
		DI	600									80											
		DI	700									1,370								25			
			Total	0	-	0	-	30	-	2,700	-	5,370	-	392	-	2,160	-	0	-	1,715		500	-
	3) Treated Effluent Reuse Line																						
		RCC	350	-	-	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-	-	-
		RCC	800	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-	-	-	-	-
	Total of pipe laying work			219,648		276,007		120,372		3,080		21,205		246,117		10,163		8,335		82,225		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159				279		10,210		86		118					
			1200	27		145		149				65		162		63		127					
			1500															39					
			1000x1500																			29	
			1500x1500							10													
			Total	10,925	-	13,128	-	5,308	-	10	-	344	-	10,372	-	149	-	284	-	1,721	-	29	-
3	Interception Structure		Zone									Mirzapur	Vindhyachal	Mirzapur	Vindhyachal								
	1) New		nos.	-	-	-	-	-	-	4	-	13	4	-	-	22	-	13	-	-	-	9	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	4	-	18	8	-	-	22	-	13	-	-	-	9	-
4	House Connection																						
	1) New		nos.	9,804	-	34,216	-	18,261	-	0	-	0	-	28,629	-	0	-	0	-	3,900	-	0	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Septic tank soak pit		nos.	-	-	-	-	-	-	-	-	-		8		0	-	-	-	-	-	-	-
6	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) New		nos.	-	-	-	-	1	-	0	1	3	1	2	-	1	1	0	1	1	0	0	1
	2) Rehabilitation		nos.	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-		
	Total		nos.	0		0		1		1		8		2		2		1		1		1	

Remarks: Saidpur was dropped due to land issue for the STP

Source: JICA Survey Team based on DPRs and Proposals of Revisions for Target Cities

9.1.11 Permission for Road Cutting

The outline of obtaining permissions for road cuttings for laying of pipes can be categorized into permission by (1) PWD and (2) ULBs according to interviews to concerned agencies such as NHAI Varanasi Office, PWD, UPJN and construction supervision consultant for GAP-II project.

(1) Permission by Public Works Department (PWD)

PWD handles the permission for road cuttings on the following roads;

1) National highway (NH)

2) State highway (SH)

3) Major district road (MDR)

4) Other district road (ODR)

5) Village road (VR): roads connecting to villages (not minor roads in villages)

6) Major municipal road

In many cases in city areas the managements of national highways are transferred from National Highway Authority of India (NHAI) to PWD NH Divisions. Therefore, permissions for all the road cutting works on national highways are to be obtained from PWD NH Division and ones on the other major roads above are to be obtained from PWD office. The steps from application to permission proceeds as follows in general;

1. Application document with drawings are prepared by contractor and submitted to UPJN. In special or urgent case UPJN alone prepares the document.
2. UPJN submits the documents to PWD local office (Varanasi, Mirzapur, Ghazipur). The copies are also sent to urban local body (ULB) office.
3. PWD local office checks the existing utilities such as water supply pipelines, electric cables, and communication cables and any event to use the road which is planned during construction period in the section. If there is not a significant issue requiring adjustment between concerned departments on such as power supply and communication, the permission document will be issued quickly by PWD office alone. PWD NH Division sends the information to NHAI also in case of national highway.
4. If there is any issue, the administration authority such as District Magistrate (DM) as district level, or Divisional Commissioner as division level, or Principal Secretary of PWD as state level hold the meeting between concerned organizations (only government organizations such as Jal Kal and departments of power, communication) and adjust the schedule.
5. After such a meeting "No Objection Certificate (NOC)" is issued from the administration authority who held the meeting to PWD office.
6. PWD office issues the permission document. The required period is normally 1 to 2 months

but it depends on situation of each road and scale of cutting work. The period might be longer as 6 months in case of national highway and insufficient information in attached drawings to application and meanwhile, the period might be rather shortened to several days in the urgent and relatively minor road case according to UPJN.

Table 9.1.13 shows the list of pipe laying on highways which may take long time for obtaining permissions of road cutting. The ID&T works in Mirzapur, Chunar, and Ghazipur are stated as "N/A" but since some sections of the interceptors will be installed under major municipal roads it does not mean all the permission for pipe installation works will be obtained from only ULBs (NPP, NP).

Dia. 900 mm pipe in NH29 in Varanasi District-II would be a biggest issue among all the locations. There have been ongoing work for rising mains under GAP-II in the same road but since the pipe laying in this case is deeper and requires more width for cutting, the permission matter should be taken care enough and the application to PWD should be submitted early enough during the detailed design stage after checking of existing public utilities on the alignment.

Table 9.1.13 Pipe Laying on Major Roads in Target Cities

Project	Development	Major Road	Largest Pipe	Application
Varanasi Dist-I	Comp.	NH7, NH29 Luxa Road Bhadani Road	500mm 500mm 450mm	PWD Varanasi (NH Division) PWD Varanasi
Varanasi Dist-II	Comp.	NH29 Rathyatra Mahmurganj Road	900mm 450mm	PWD Varanasi (NH Division) PWD Varanasi
Varanasi Dist-III	Comp.	SH74 University Road	200mm 600mm	PWD Varanasi
Ramnagar	ID&T	NH7	N/A	PWD Varanasi (NH Division)
Mirzapur	ID&T	NH35, NH135, SH5	N/A	N/A
	Comp.	NH35, NH135 SH5	300mm 400mm	PWD Mirzapur (NH Division) PWD Mirzapur
Chunar	ID&T	NH35	N/A	N/A
Ghazipur	ID&T	NH29 Mahuabagh Road Ghazipur – Chochakpur Road	N/A To be confirmed ditto	N/A PWD Ghazipur
	Comp.	NH29 Kacehri Road	500mm 500mm	PWD Ghazipur (NH Division) PWD Ghazipur
Saidpur	ID&T	NH29 SH69 MDR166E	To be confirmed N/A N/A	(PWD Ghazipur NH Division) N/A N/A

Note:
Comp.: comprehensive, NH: national highway, SH: state highway, N/A: no plan of installing pipe
Source: JICA Survey Team

(2) Permission by Urban Local Bodies (ULBs)

The permissions for road cutting works on all the municipal roads except for roads maintained by PWD are to be obtained from ULB offices. The period for permission is in general less than the case of major roads handled by PWD.

(3) Reference

1) The road cutting length in one application should be 1 to 5 km and the applicant cannot submit for many sections at the same time. The case for 5 km application as maximum length is only the case if the road is not congested.

2) Basically PWD, not contractor for pipe laying work, recovers the pavement on the major roads mentioned above. The exception is only the less important road among the roads handled by PWD. UPJN will pay for the cost called "cutting/road maintenance charges" within the state governments.

3) The documents to be attached to application document are;

a) Longitudinal section of pipe laying work

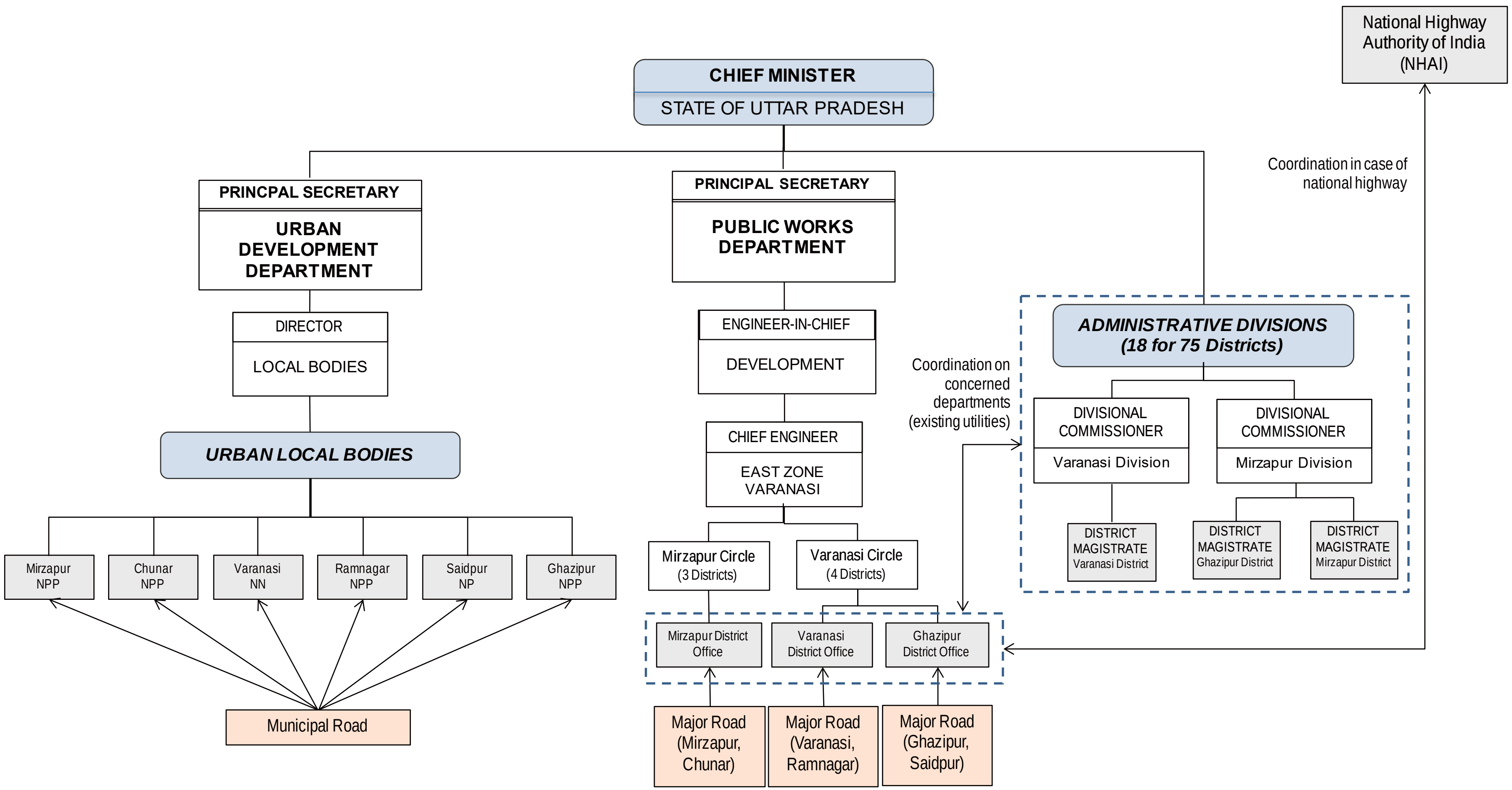
b) Cross section of the work

c) Brief specification

d) Key map of the project

e) Project brief

The concerned government agencies for road cutting permission explained in 1) and 2) above are shown in **Figure 9.1.11**.



Source: JICA Survey Team

Figure 9.1.11 Concerned Government Agency for Road Cutting Permission

9.2 Intermediate Pumping Stations

9.2.1 Varanasi City District-I

No pumping station is proposed for Varanasi City District-I.

9.2.2 Varanasi City District-II

No pumping station is proposed for Varanasi City District-II.

9.2.3 Varanasi City District-III

One lift pumping station (LPS) were proposed near Sarai Nandan beside Assi Interceptor in DPR. The required dimension is shown in following table. The plan and section for the proposed interceptor is shown in Appendix 9.2.1.

Since the sewerage design in District-III is under revision from original DPR, the design of this pumping station such as depth would be revised further.

Table 9.2.1 Proposed Dimension for LPS near Sarai Nandan in Varanasi District-III

No.	LPS (New)													
	Location	Flow (MLD)		Pumps								Rising Main		
		2035	2050	Total	Duty	Standby	Capacity (m3/hr)	Total Capacity (Duty) (m3/hr)	Total Capacity (Duty) (MLD)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	near Sarai Nandan (MH No. 1295)	3.92	6.45	6	4	2	100	400	9.6	15	10	DI	200	30

Source: DPR Varanasi District-III

9.2.4 Ramnagar City

1) General

A master pumping station (MPS) was proposed by UPJN in DPR Ramnagar ID&T as the design period is shown in **Table 9.2.2** and the general specification is shown in **Table 9.2.3**. The design ground level is TP 74.50m which was determined from high water level of Ganga River 73.90m + 0.45m allowance as per CPHEEO manual.

Since many discrepancies from BOQ in DPR were found in layout drawing, JICA Survey Team has revised the civil structures and buildings to match the contents between drawing and BOQ. The general layout is shown in Appendix 9.2.2.

Table 9.2.2 Design Period for MPS at Ram Bagh Drain, Mallahi in Ramnagar City

No.	Item	Design Period
1	Civil Structure (Wet Well, Screen Chamber etc.)	30 years (2050)
2	E&M (Pumps etc.)	15 years (2035)

Source: DPR Ramnagar ID&T

Table 9.2.3 General Specification of Proposed Pumping Stations in Ramnagar City (ID&T)

No.	PS	Location	PS Capacity (MLD)		Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
			Average	Peak			Nos.	Duty	Standby						
1	MPS	Ram Bagh Nala, Mallahi	**13**	29.25	Peak	Submersible non clog	3	2	1	7.84	55	180	DI-K9	400	2,700
					Non-peak	Submersible non clog	2	1	1	3.94	55	100			

Source: JICA Survey Team confirmed from DPR Ramnagar ID&T

2) Civil Work

The dimensions of civil works are listed in the following table. The dimensions of some structures were adjusted from figures in original DPR (such as H6.9m in inlet chamber) based on the actual layout and revised interceptor design which was revised based on topo survey result of ground and drain levels. Since original heights of civil structures seemed to have some extra free board compared to the required water depths, the heights were reduced.

Table 9.2.4 Dimension of Civil Works for MPS Mallahi in Ramnagar

No.	Structure	Dimension	Water Depth	Note
A	Civil			
1	Inlet Chamber	W4.0m x L3.0m x H5.15m	1.02m	Height reduced based on revised interceptor design
2	Mechanical Screen Channel	W1.1m x L7.0m x H5.15m x 2 nos.	0.55m	Width and length adjusted from DPR
3	Manual Screen Channel	W1.1m x L7.0m x H5.15m	0.55m	Width and length adjusted from DPR
4	Silt Catching Basin	W1.8m x L9.7m x H5.15m x 2 nos.	0.55m	Width adjusted from DPR
5	Wet Well	Internal Dia. 7.5m x H8.65m	1.75m	Height reduced based on inlet chamber level
B	Building			
1	Pump House	W8.5m x L6.0m x H6.0m	-	Width adjusted from DPR
2	HT Room/Metering Room	W12.0m x L6.0m x H6.0m	-	As per DPR
3	LT Room	W6.0m x L6.0m x H6.0m	-	As per DPR
4	Staff Quarter	W8.5m x L5.7m x H6.0m	-	As per DPR

Source: JICA Survey Team

9.2.5 Mirzapur City

1) Phase-I: ID&T Work

a) IPS

Two existing IPS will be rehabilitated and three new IPS will be constructed as shown in following tables. The plans and sections for IPS-5 to 7 after the revisions for matching with flow calculations and BOQs are shown in Appendixes 9.2.3 to 9.2.5.

Table 9.2.5 General Specification of Rehabilitated IPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**
Vindhyachal														
2	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**

Table 9.2.6 General Specification of New IPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal													
3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	50	2	1	1	12	50	1.2			

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-8 in Mirzapur Zone. The general specifications of the MPSs are listed in the following tables. The plan and sections for new MPS-8 is shown in Appendix 9.2.6.

Table 9.2.7 General Specification of Rehabilitated MPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity (Duty)		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	MPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal														
2	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100
											Proposed	**DI-K9**	**300**	**30**

Table 9.2.8 General Specification of New MPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (m3/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	600	30

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

2) Phase-II: Sewer Network

Two additional IPS will be constructed for development of sewer network as shown in following table.

Table 9.2.9 General Specification of New IPS in Mirzapur City (Sewer Network)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos. Total	Duty	Standby	Head (m)	Total Capacity (cum/hr)	(MLD)	Material	Dia. (mm)	Length (m)
Mirzapur													
1	IPS-7-> IPS-9	district jail Mirzapur	Peak	280	3	2	1	13	13	13	DI-K9	300	36
			Non-peak	150	2	1	1	13	13	13			
2	IPS-8-> IPS-10	lalah ghat	Peak	160	3	2	1	21	21	21	DI-K9	200	356
			Non-peak	65	2	1	1	17	17	17			

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

9.2.6 Chunar City

IPS-1 and MPS were proposed in DPR Chunar ID&T as listed in the following table. JICA Survey Team is reviewing the design. The layout of proposed MPS are shown in Appendixes 9.2.7. Since the discrepancies in depth and water levels from flow calculation and BOQ were found those figures were corrected. However, such as pump head would be revised further since the sewerage design for Chunar are under revision.

Table 9.2.10 General Specification of Proposed Pumping Stations in Chunar City (ID&T)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Tambal Ganj	Peak	Submersible	3	2	1	105	23	DI-K9	200	2,130
			Non-peak	Submersible	2	1	1	45	19			
					5	3	2					
2	MPS	Near STP	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar ID&T

9.2.7 Ghazipur City

Comprehensive plan was submitted and UPJN is still preparing the DPR for Ghazipur ID&T. JICA Survey Team reviewed comprehensive plan and the design of master pumping station (MPS) in STP site and any other IPSs.

9.2.8 Saidpur City

UPJN has been preparing the DPR for Saidpur ID&T. However, since STP site was not secured in the period of DPR review, Saidpur was dropped from the review work.

9.3 . STPs

9.3.1 Considerations in STP plan

1) Outline

In India, when finalizing a sewer DPR, the engineer mainly refers to “Guidelines for Preparation of Project Reports” by the National River Conservation Plan and the National Ganga River Basin Authority” (MoEF, NRCD, 2010) and “Manual on Sewerage and Sewage Treatment Systems” (MoUD, CPHEEO, JICA, 2013). However strict application has not been made, so the ideas on about individual items, have been left to the discretion of each engineer (UPJN and consultants in the case of these plans) and approver (NGRBA in the case of these plans).

Based on these manuals and other DPR etc., the survey team reviewed STP plans of each DPR. Main considerations are shown in **Table 9.3.1.**

Table 9.3.1 Main considerations in STP plan

1) Design condition	a) design year
	b) design population
	c) design sewage flow
	d) design influent sewage quality
	e) design effluent water quantity
	f) site boundary on map
	g) design ground level (GL) and design effluent water level
	h) other condition
2) Design concept	a) sewage treatment process
	b) disinfection process
	c) sludge treatment process
	d) sludge disposal
	e) necessity of spare machine
3) Design output	a) spec table of main structure and equipment
	b) design calculation sheets
	c) layout plan drawing
	d) hydraulic calculation sheets
	e) hydraulic flow diagram
	f) construction schedule
	g) matching at another components (Between comprehensive and ID&T, pipe planning)

Source: JICA Survey Team

2) Design Year

The description of the design year for the whole DPRs is certain, but in the actual STP construction plan, they were set as shown in **Table 9.3.2**. It is mostly set at approximately 10 to 20 years after the current year (2016). Since the design year setting depends on the construction plan of each local governments, it will be different from each other respectively. The subsequent year will be added in the future if necessary, and it is desirable to refer to a future planned site. Survey Team conducted future projection uniformly for setting the year as 2020, 2030, 2035, 2040, 2050 as presented. Given that different cities had different Design years of facilities as shown in Table 9.3.2 which were depicted from DPRs, the study was conducted by setting final target year for all the cities and towns as 2050 to confirm future allowance/room of the proposed sewage treatment plants by the unified comparison method among the subject cities and towns.

Table 9.3.2 Design Year of Proposed STP

STP		Design Year	Current Year	Term (years)	Remarks
Dinapur		2030	2016	14	
Bhagwanpur		2030		14	
Ramna		2035		19	
Mirzapur	Comp.	2030		14	
	ID&T				
Vindhyachal	Comp.	2030		14	
	ID&T				
Ghazipur	Comp.	2025		9	
Ramnagar	Comp.	2050		34	
	ID&T	2035		19	Detail plan is not shown.
Chunar	Comp.	2030		14	
	ID&T				

Source: JICA Survey Team

3) Design Population

As identified in **Chapter 7**, there is no problem in the design population.

4) Design Sewage Flow

As the design sewage flow, both average and maximum flows are required. As identified in **Chapter 7**, the average design flow has no problem. And in the CPHEEO manual, the design maximum flow is set by multiplying the peak factor in **Table 9.3.3**. Basically, the design maximum flow is applied to an inlet chamber to primary and secondary clarifiers.

Table 9.3.3 Peak Factor for Contributory Population

Contributory Population	Peak Factor
Up to 20,000	3.00
Above 20,001 to 50,000	2.50
Above 50,001 to 750,000	2.25
Above 750,001	2.00

Source: CPHEEO manual, 2013

5) Design Influent Sewage Quality

At the existing STP, records of actual influent sewage value can be of some help for the design. In this survey, as shown in **Chapter 6**, the water quality survey was conducted for design as well as for confirmation of the current status.

6) Design Effluent Water Quality

The transition in recent years of effluent quality regulation values is shown in the following. In 2016, there has been a movement of further strengthening of regulations. And DPRs were finalized before the amendment announcement, thus most current design values for DPRs is not consistent with them. DPR review was made in consideration of these new standards in the work. **Table 9.3.4** indicates the transition and the new standard as of June 2016.

Table 9.3.4 History of Effluent Standards from STP in India

Water Quality Item		NGRBA Guidelines (2010)	CPHEEO Manual (2013)	**CPCB New Standards (27th April 2016)**
		Effluent Standards for discharge into water bodies	Recommended Guidelines for Treated Sewage	**Parameters Limit Not Authorized**
pH	-	5.5-9.0	-	**6.5-9.0**
BOD_5	mg/l	20	Less than 10	**Not more than 10**
COD	mg/l	-	-	**Not more than 50**
TSS	mg/l	30	Less than 10	**Not more than 10**
NH_4-N	mg/l	-	-	**Not more than 5**
T-N	mg/l	-	Less than 10	**Not more than 10**
T-P	mg/l	-	Less than 2	**Less than 2**
Faecal Coliforms	MPN/100mL	Desirable– 1,000 Permissible– 10,000	Less than 230	**Less than 230**

Source: JICA Survey Team

This report basically accepts the new effluent discharged standards for sewage treatment plant in the draft notification gazetted on November 24, 2015.

Compared with the old 2013 CPHEEO manual, the new standard is definitely exhaustive. However the values are almost same as the 2013 standard. UPJN got the notification of the new water quality standard on 27th April 2016 from CPCB.

Since all the existing STPs were constructed according to the old standards, the effluent from them is not compliant with the new standards. They must be reconstructed following the new standards after their lives. However, new construction shall be conducted prior to remodelling/reconstruction of the old facilities in terms of securing the treatment capacity during the construction work, difficulties of reconstruction work within the existing plant yard and budget issue for the construction work. After the operation of new facilities, old facilities can be reconstructed

7) Site Boundary on Map

It is easy to grasp the site boundary of existing STPs. On the other hand, it is hard for New STPs in the drawings of DPRs. In this survey, our team surveyed boundaries of all proposed sites (See appendix). Based on these results, the layout plan should be prepared inside the confirmed site boundary.

8) Design Ground Level (GL) and Design Effluent Water Level

As results of ground elevation survey, the actual GL ware rather different in those of some DPRs. And around Varanasi, large-scale flood occurs in 1978 and 2013. Hence, the planned GL and planned effluent water level should be set on the basis of these past water levels.

2016/1/25 UP IRRIGATION

IRRIGATION DEPARTMENT, UTTAR PRADESH

Login for Departmental Users Instruction for Flood Entry

The water level in major rivers of Uttar Pradesh Date: 01/25/2016

date 25/01/2016 Click To Change Date Reaching Danger Level Above Danger Level

Departmental CWC Both Reservoir

serial number	River	Gauge Site	District	The maximum water level (m 0)	Year	Danger levels (m 0)	date	time	Water level (m 0)	Rain (m 0 m 0)	Trend
1	Nalar	Mrora	Pauri	556.00	1993	556.60	01/25/2016	-NA-	0.00	0.00	-NA-
2	Ganges	Haridwar	Haridwar	296.23	1978	294.00	01/25/2016	-NA-	0.00	0.00	-NA-
3	Ganges	Narsura D 0 S 0	Bulandshahr	180.01	1998	178.42	01/25/2016	-NA-	0.00	0.00	-NA-
4	Ganges	Fatehgarh	Frukabad	138.06	1972	137.60	01/25/2016	-NA-	0.00	0.00	-NA-
5	Ganges	Gumta	Kannauj	126.24	1998	125.97	01/25/2016	-NA-	0.00	0.00	-NA-
6	Ganges	Ankingat	Kanpur	124.30	1978	124.00	01/25/2016	-NA-	0.00	0.00	-NA-
7	Ganges	Kanpur	Kanpur	113.46	1967	114.00	01/25/2016	-NA-	0.00	0.00	-NA-
8	Ganges	Dimu	Rae	99.84	1973	99.36	01/25/2016	-NA-	0.00	0.00	-NA-
9	Ganges	Phaphamau	Allahabad	87.98	1978	84.73	01/25/2016	-NA-	0.00	0.00	-NA-
10	Ganges	Chhag	Allahabad	88.03	1978	84.73	01/25/2016	-NA-	0.00	0.00	-NA-
11	Ganges	Mirzapur	Mirzapur	80.34	1978	77.72	01/25/2016	-NA-	0.00	0.00	-NA-
12	Ganges	Varanasi	Varanasi	73.90	1978	71.26	01/25/2016	-NA-	0.00	0.00	-NA-
13	Ganges	Gazipur	Gazipur	65.22	1978	63.10	01/25/2016	-NA-	0.00	0.00	-NA-
14	Ganges	Ballya	Ballya								
15	Ramganga	Kalagdr	Bijnor								
16	Ramganga	Muradabd	Moradabad								
17	Ramganga	Bareilly	Bareilly								
18	Ramganga	Dabri	Shahjahanpur								

Figure 9.3.1 Maximum Water Level in Major Rivers

Source: JICA Survey Team

9) Other Condition

a) Soil

In the case of soft ground, pile foundation or ground improvement is required. These costs should be included in the estimation.

b) Material

Compliance with the Indian Standard (IS) or the British Standard (BS) is required.

c) Mechanical Model

On the basis of the manufacturer catalogues and adopt performance, mechanical model should be chosen.

d) Noise and Odour Regulation

See Chapter 11.

e) Architectural Standard

Compliance with the National Building Code of India 2005 (NBC 2005) is required. In addition, additional equipment such as lighting, firefighting equipment, hand washing etc. are required mainly at the administration building. These costs should be included in the estimation.

f) Temporary Works

If the excavation depth is deep or the groundwater level is high, unlined excavation may wreak ground collapse. Hence, appropriate temporary works are required.

g) Entrance Road

If an existing road is narrow as an approach road to STP, construction vehicles may not go through. In that case, the road widening is required.

h) Site Maintenance and Ancillary Works

In spite of no direct effect on plant performance, hall road, boundary wall and planting work are required as parts of civil works. These costs should be included in the estimation.

i) Monitoring System

The selection of resident monitoring or remote monitoring is required. In addition, the necessity of a SCADA system should be considered.

10) Sewage Treatment Process

The sewage treatment process mentioned in this report is proposed by the consultants and does not represent at this stage an actual or presumed endorsement, preference, or acceptance by JICA.

a) Performance in India

In India, when selecting a sewage treatment process, the engineer mainly refers to foregoing references and "Compendium of Sewage Treatment Technologies" (NRCD, 2009). According to this, the outline of the existing STPs in India is described below.

- 32 STPs (728 MLD treatment capacity) were constructed and II existing STPs (151MLD treatment capacity) were renovated under the Ganga Action Plan Phase I (GAP-I). Activated sludge process (ASP) and its modifications were the most preferred technology accounting for almost 62% of the total capacity.

- 26 STPs (722 MLD treatment capacity) were set up under the Yamuna Action Plan, Phase-I (YAP-I). Upflow Anaerobic Sludge Blanket (UASB) process was the most preferred treatment technology, accounting for 83 percent of the total installed treatment capacity.

- Concurrently with YAP, 30 STPs having a treatment capacity of 2325 MLD were added in Delhi under the river conservation programme of the Government of NCT Delhi. Most of these STPs are based on the ASP technology or its minor variants. A big STP (182 MLD capacity) has been constructed at Rithala using the BIOFOR-F technology.

In addition to the technological options discussed above, several other technologies have been used with success in various parts of India. These include the Sequential Batch Reactor (SBR) technology and its minor modification which has been employed in several STPs in western and southern India. Another technological option is the Moving Biological Bed Reactor (MBBR), which is very similar to the FAB* system. Further in many places in western and southern India, the UASB process has been used in conjunction with the FAL and Final Polishing Unit (FPU) or in combination with the ASP to provide higher quality treatment.

*fluidized aerated bed

Source: Compendium of Sewage Treatment Technologies (NRCD, 2009)

b) Candidates considered with new standards

As mentioned above, the effluent quality regulations is strengthened. However, planned effluent water quality in these existing STPs are higher than the value shown at 2016 CPCB standard. Therefore, when adopting these processing methods, not only to ensure the HRT, but it is necessary to ensure that has sufficient treating capacity by process calculation.

On the other hand, STPs in Japan that is achieved the effluent quality standards of India are described below.

Table 9.3.5 STPs in Japan achieved the effluent quality standards of India (2013)

Sewage Process Method	Nos.	Actual Elimination Rate		
		BOD	SS	T-N
Oxidation Ditch	140	98.6%	97.6%	83.1%
Activated Sludge Process	127	98.5%	98.0%	84.1%
Step Flow Multistage Nitrification Denitrification	13	97.1%	96.8%	84.5%
Sequencing Batch Reactor	11	98.6%	98.4%	86.5%
Anaerobic Aerobic Activated Sludge Process	10	98.8%	95.2%	82.8%
Extended Aeration Method	8	98.2%	99.0%	88.1%
Advanced Oxidation Ditch	7	99.1%	98.9%	91.5%
Circulated Nitrification / Denitrification Process	6	99.0%	99.1%	89.4%
Anaerobic Anoxic Oxic Process	6	98.7%	98.9%	80.8%

Note: Based on “Statistics of Sewerage in Japan 2013” (JSWA, 2015), process which past adopted records are more than 5 nos. are made up.

Source: JICA Survey Team

Based on these facts, the candidates which will be satisfied with the standards are shown below.

- Sequencing Batch Reactor (SBR)
- Activated Sludge Process (ASP)
- Oxidation Ditch Process (OD)
- Anaerobic Aerobic Process (AO)
- Circulated Nitrification / Denitrification Process (CND)
- Anaerobic Anoxic Oxic Process (A2O)
- Membrane Biological Reactor (MBR)

c) Sequencing Batch Reactor (SBR)

The sequencing batch reactor (SBR) is a type of activate sludge treatment system which treats wastewater by aeration and sedimentation in a single tank. The detention time of each process can be adjusted flexibly in this process.

Since the anaerobic, anoxic and oxic conditions can be also flexibly controlled, nitrogen and phosphorus removal corresponding to loading variation is possible according to the operation condition.

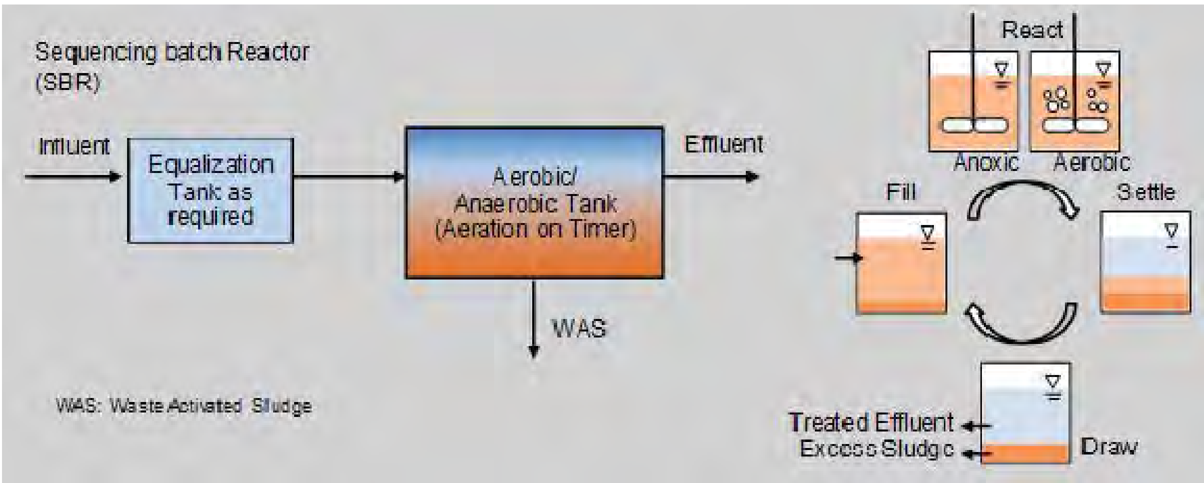


Figure 9.3.2 Process Flow of SBR

Source: JICA Survey Team

It should be noted that an advanced type which is a kind of SBR, has been attracting attention in recent India. It performs multi-processes in a single reactor like SBR, and has a proprietary technology for automatic control by DO monitoring, a blower and a decanter etc. This allows for shorter cycle times as well as the omission of a separate denitrification cycle. Hence, no mixers for denitrification are necessary.

d) Activated Sludge Process (ASP)

This is the most conventional process for wastewater treatment worldwide. As shown in Figure, at first the raw wastewater flows into the primary sedimentation tank for removal of suspended solids. Dissolved organic pollutant is then removed by biological oxidation under aerated condition. Supernatant from final sedimentation tank is discharged as final effluent after chlorination process.

Effluent quality, especially BOD, is low enough in this process, while nitrogen and phosphorus removal is unexpected. Skilled engineers are required for operation and maintenance to avoid troubles (e.g. Sludge bulking, Biological foam).

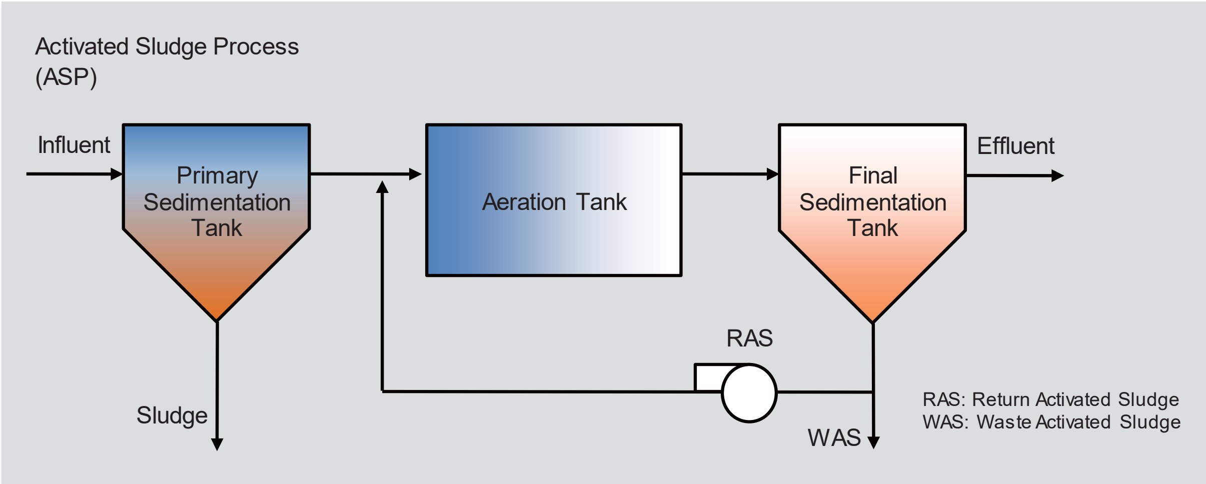


Figure 9.3.3 Process Flow of ASP

Source: JICA Survey Team

e) Oxidation Ditch Process (OD)

Oxidation ditch is one form of an extended aeration system having certain special features like an endless oval ditch for the aeration tank with rotors/aerators. The channel can be earthen with lined sloping sides and lined floor or it may be built in concrete or brick with vertical walls. Sewage is aerated by a surface rotor/aerators placed along the channel. The rotor/aerators not only aerate the sewage but also provide a horizontal velocity to the mixed liquor preventing the sludge from settling in the ditch.

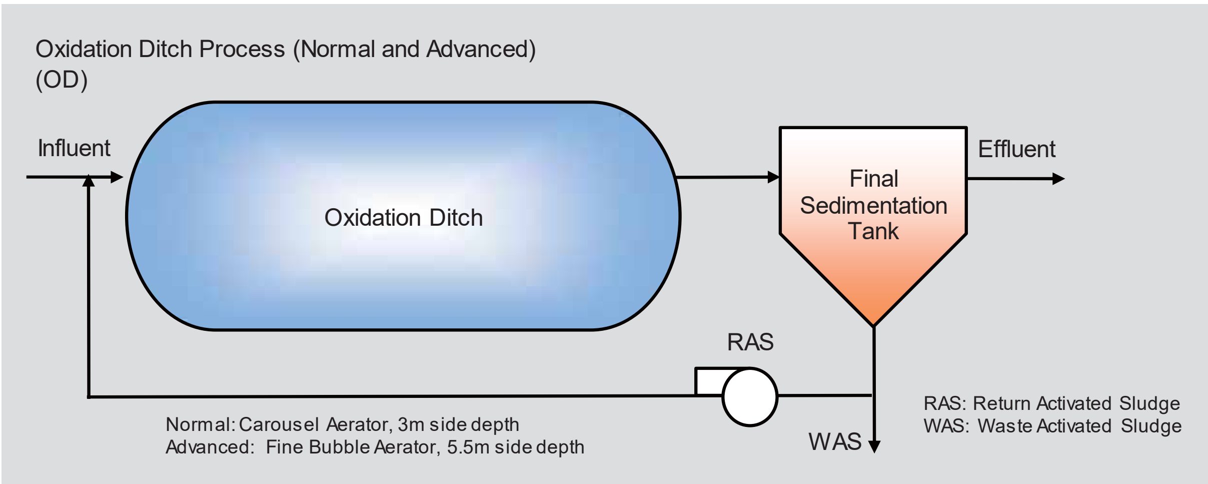


Figure 9.3.4 Process Flow of OD

Source: JICA Survey Team

f) Anaerobic Aerobic Process (AO)

This process is similar to ASP. By dividing an aeration tank into the anaerobic zone and aerobic zones with a wall, it is possible to remove phosphorus effectively.

Organic substrates are supplied from incoming sewage into the anaerobic zone and the return sludge comes into contact with the carbon source only in the anaerobic zone. The faster uptake of organic substrates in the anaerobic zone is the key for bacteria to win in the microbial selection in the enhanced biological phosphorus removal process.

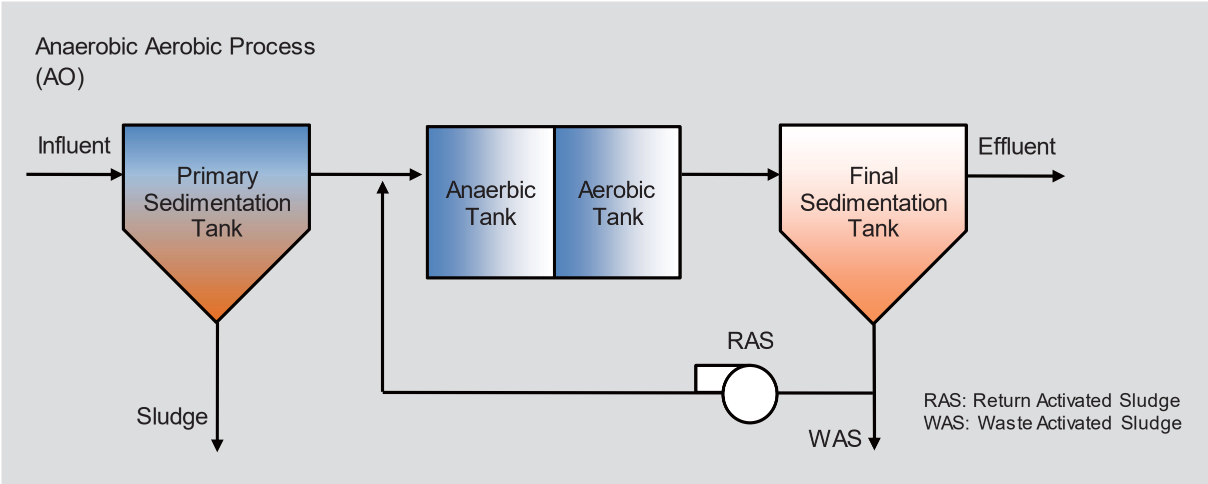


Figure 9.3.5 Process Flow of AO

Source: JICA Survey Team

g) Circulated Nitrification / Denitrification Process (CND)

Single-stage systems are those in which nutrient removal is achieved in a single basin and clarifier. The removal of nitrogen is achieved by combined nitrification (under aerobic conditions) and denitrification (under anoxic conditions). A single-stage system using one anoxic zone can achieve 65 to 70% removal efficiency of T-N for normal influent.

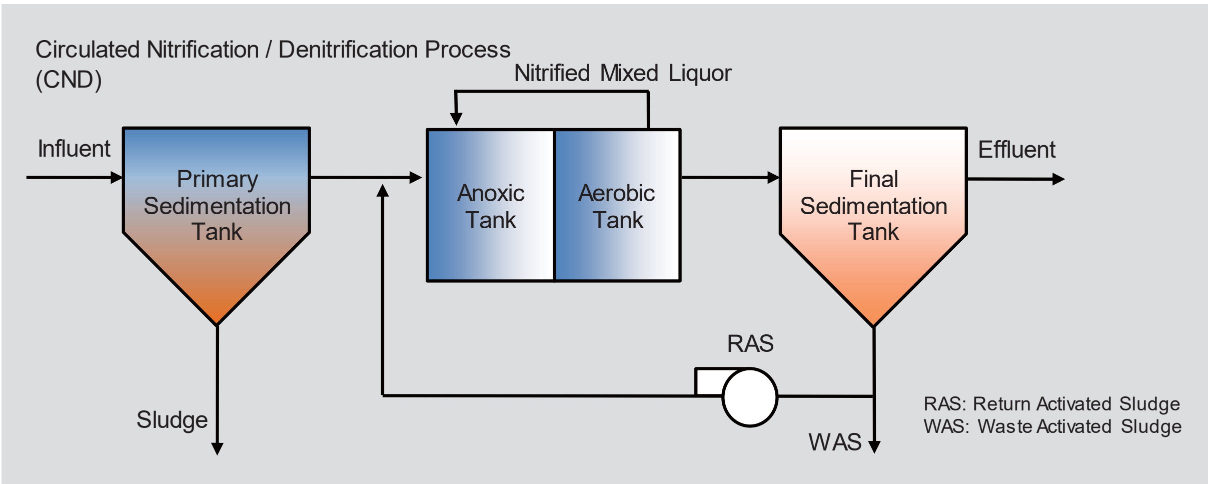


Figure 9.3.6 Process Flow of CND

Source: JICA Survey Team

h) Anaerobic Anoxic Oxic Process (A2O)

In this process, sludge is returned to a reactor in a series of anaerobic, anoxic and oxic tanks, with circulation from oxic tank to anoxic tank as shown in **Figure 9.3.7**. This enables simultaneous removal of nitrogen and phosphorus as an advanced wastewater treatment.

Compared to ASP, since the anaerobic tank and anoxic tank are needed for this system, it needs the construction area wider.

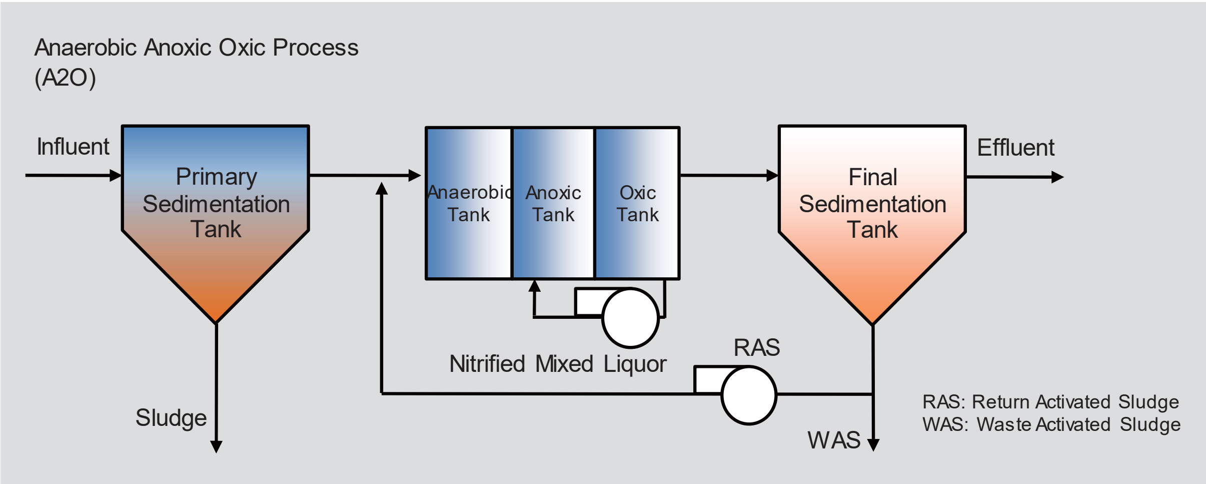


Figure 9.3.7 Process Flow of A2O

Source: JICA Survey Team

i) Membrane Biological Reactor (MBR)

MBR is an activated sludge process similar to ASP. The difference is in the method of separation of liquid and solid. In the MBR process, the bio-solids are separated by membranes.

MBR does not require final sedimentation tanks and the reactor tank volume can be smaller than that of ASP due to high MLSS concentration. Disinfection is not needed because coliform is removed by the membrane. However, the flow equalization tanks are usually equipped because the flux of membrane is not so flexible to flow variation. When the site is small, MBR has advantages.

Much air supply is required to protect the fouling on the membrane surface which causes the high power cost. Chemical cost for periodical cleaning of membrane and membrane replacement cost is necessary. O&M cost for MBR is higher than that of ASP.

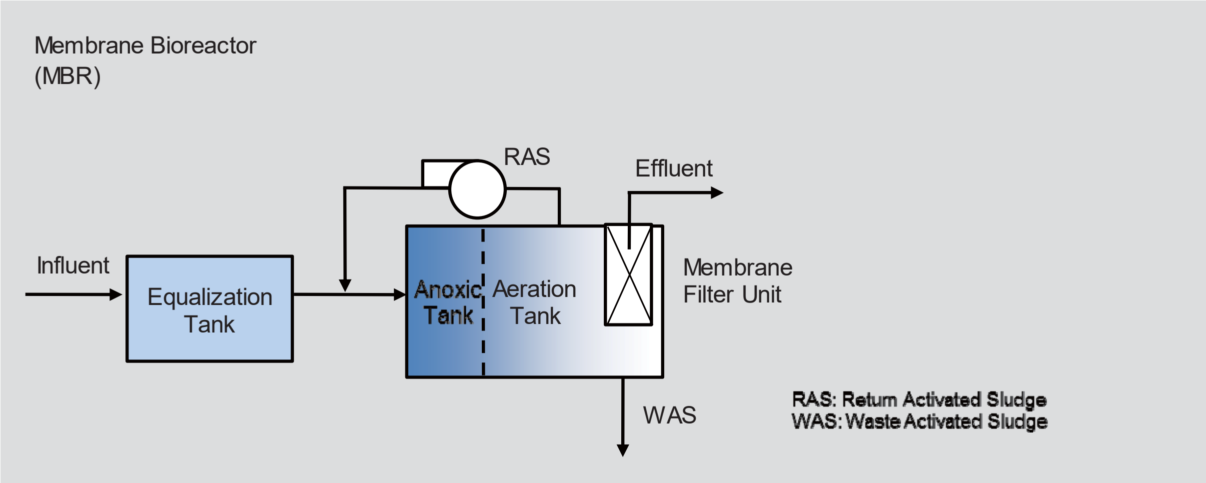


Figure 9.3.8 Process Flow of MBR

Source: JICA Survey Team

j) Comparison of Sewage Treatment Processes

The comparison of sewage treatment processes is shown in **Table 9.3.6**. Circulated Nitrification / Denitrification Process (CND), advanced type SBR and Moving Bed Biofilm Reactor (MBBR) are selected as appropriate processes. Since similar type of the CND is selected in Ramna and Ramnagar DPRs, it seems easy for accepting the new standard for the two STPs. Advanced type SBR has been accepted as the DPR process in the past, (DPR for Pune, in 2014) It is considered to be appropriate for the new standard as well.

At all existing STPs (Dinapur, Bhagwanpur, Mirzapur, Vindhyachal), the upgrading to CND process or advanced type SBR will be needed in the future. Dinapur STP will employ MBBR for replacing existing old trickling filters for keeping good water quality till the life of the lanes come. The MBBR will be removed at the same time when the life for the treatment lane comes.

k) Phosphorus removal

The new standard of T-P concentration of effluent is 2 mg/l as stipulated in **Table 9.3.4**. As shown in **Table 6.1.5**, T-P concentration in the raw sewage of Bhagwanpur STP and Dinapur STP were 3.00 mg/l 2.28mg/l.

Since all the processes listed above are capable of removing approximately 50% of T-P, the effluent quality will be compliant with the new standard.

Table 9.3.6 Comparison of Sewage Treatment Processes

Item	Process incapable of Nitrogen removal				Process for Nitrogen removal					
Name	Sequencing Batch Reactor	Activated Sludge Process	Oxidation Ditch Process	Anaerobic Aerobic Process	Advanced Oxidation Ditch Process	Sequencing Batch Reactor	Circulation Type Nitrification Denitrification Process	Moving Bed Biofilm Reactor	Anaerobic Anoxic Aerobic Process	Membrane Bioreactor
	SBR	ASP	OD	AO	Advanced OD	Advanced type SBR	CND	MBBR	A2O	MBR
DPR		Bhagwanpur (Existing)				Chunar	Ramnagar	Dinapur		
						Vindhyachal (Extension)	Ramna			
						Mirzapur (Extension)				
						Ghazipur				
Nitrogen removal	N/A	N/A	N/A	N/A	5	5	5	5	5	5
Treated Water Quality	3	3	3	3	4	4	4	4	4	5
Lot for Treatment Process	3	3	2	3	3	3	3	3	3	3
CAPEX	3	3	3	3	3	3	3	3	2	2
Easiness of Maintenance	3	3	4	3	3	3	3	4	2	2
OPEX	3	3	3	3	4	3	3	3	3	3
Past Record in India	4	3	2	1	1	4	4	2	1	1
Total	(19)	(18)	(17)	(16)	23	25	25	24	20	21
Adoption	N/A	N/A	N/A	N/A	Better	Best	Best	Better	Fair	Fair

Legend 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A (Not Applicable)

Source: JICA Survey Team

11) Disinfection Process

As methods of disinfection for Faecal Coliforms, mainly one of the 3 methods is used in STP from Chlorination, Ozone disinfection, and UV disinfection. Especially in India, Chlorination is the most common method.

As long as the detention time in the chlorination tank is secured as 30 minutes, the effluent standard for Coli will be kept in the range of the standard as stipulated in the design manual,

12) Sludge Treatment Process

By purifying sewage, since sludge is generated around the solid matter, it must also consider the processing method. For example, the sludge generated in the primary and secondary clarifiers is termed raw sludge, the moisture content is about 99%, thus must be concentrated. The method of concentration consists of sludge thickening and mechanical dewatering. Further, also in the means of power generation by biogas, sludge reduction by sludge digestion is efficient.

13) Sludge Disposal

As the sludge disposal process in the urban area in Japan, dewatered sludge is often treated furthermore for volume reduction to landfill or re-use by incineration. But this time target STPs are located near farmland, thus green farmland reduction of dewatered sludge is realizable.

14) Necessity of Spare Machine

In view of the trouble or maintenance, pumps, blowers and dewatering machines are desirable to have spare units.

15) Spec Table of Main Structure and Equipment

For major facilities, it should be organized in a list and subjected to a check of other organized content.

16) Design Calculation Sheets

The STP consists of two big fields, that is, “civil engineering and architecture” and “mechanical and electrical engineering”. About former, the part about hydraulic design and water tank capacity should be determined by calculation sheets. About latter, specifications should be determined by calculation or manufacturer catalogue, etc.

17) Layout Plan Drawing

Major facilities have to be layout inside boundaries without interference to other structures. In addition, expansion after the design year should be considered. In other words, consideration of allocation of sewage flow and tank is required.

18) Hydraulic Calculation Sheets

19) Hydraulic Flow Diagram

From an inlet chamber to a discharge point, confirmation of flow down without hydraulic problems is required. All target STPs, at first pump-up in or before STP, then ensure the height meters above ground. After that, it has a natural flow to the discharge point.

20) Construction schedule

Any of the DPRs, there is no description of the specific construction process. Without construction time schedule, estimation of annual estimated cost and procurement planning are supposed to be difficult.

Also, defining operation start point and confirming excess process capacity from the inflow sewage amount, should be required.by using a staircase graph, such as shown in the figure below.

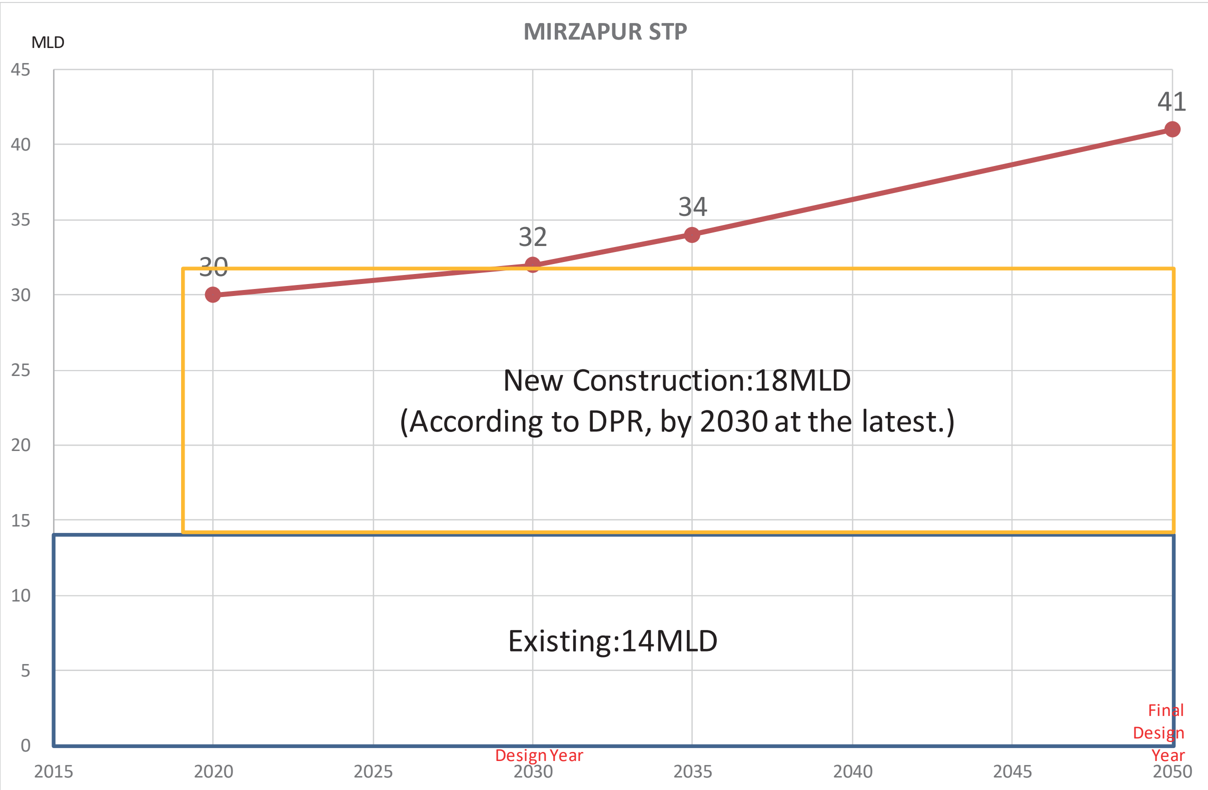


Figure 9.3.9 Construction plan of Mirzapur STP based on DPR

Source: JICA Survey Team

Note: About 3 STPs (Dinapur, Bhagwanpur and Ramna) in Varanasi City, not graphed for no year transition flow plan in DPR.

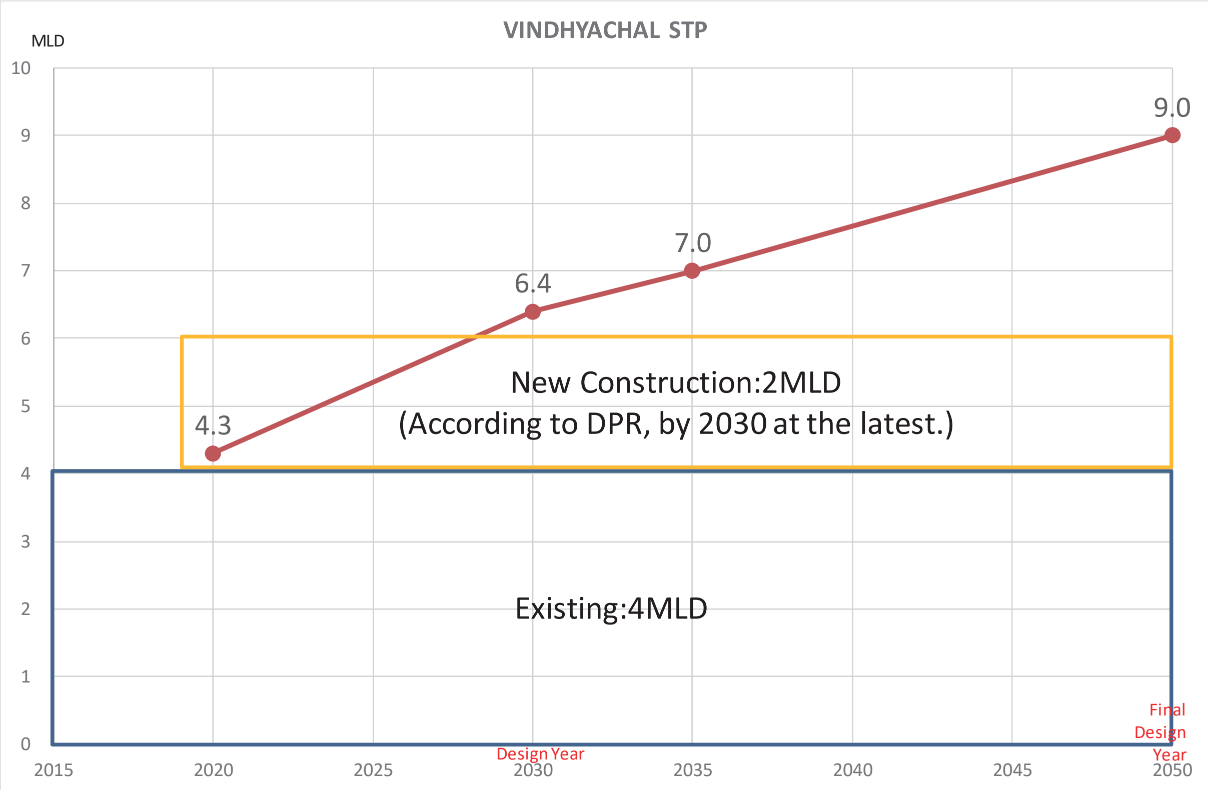


Figure 9.3.10 Construction plan of Vindhyachal STP based on DPR

Source: JICA Survey Team

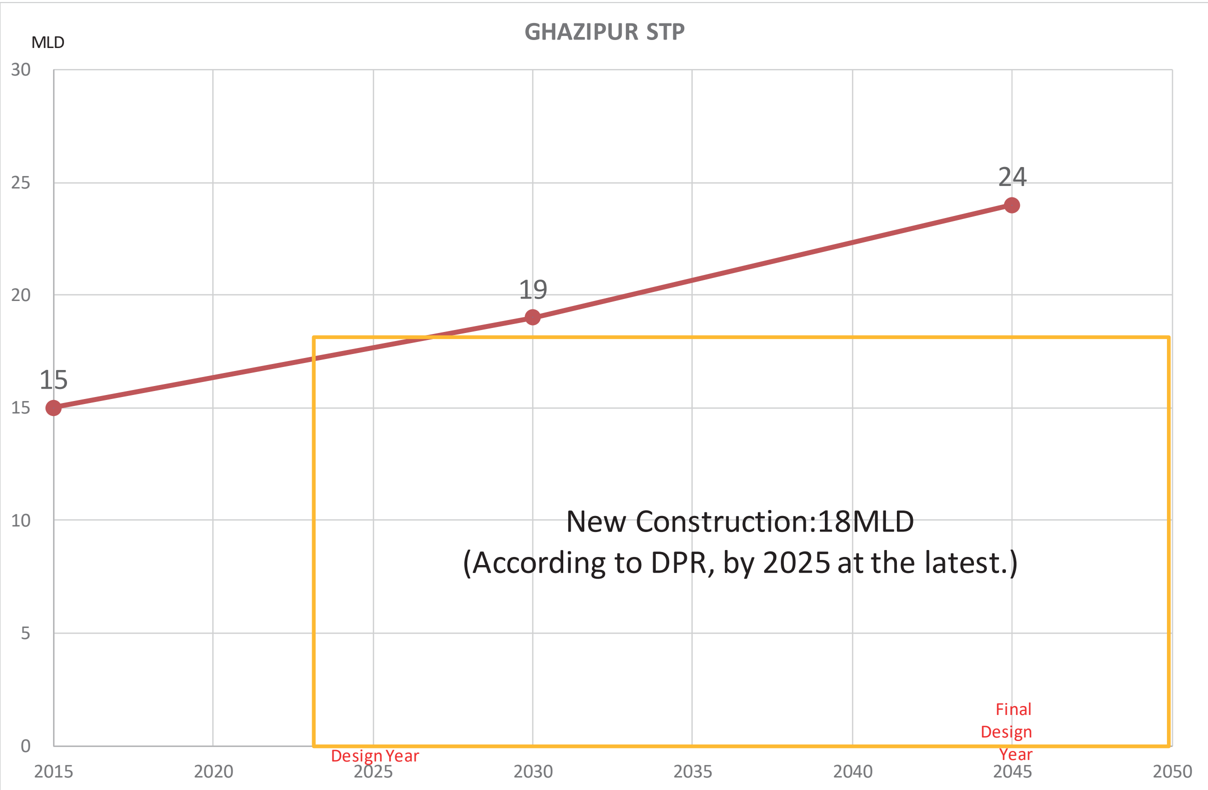


Figure 9.3.11 Construction plan of Ghazipur STP based on DPR

Source: JICA Survey Team

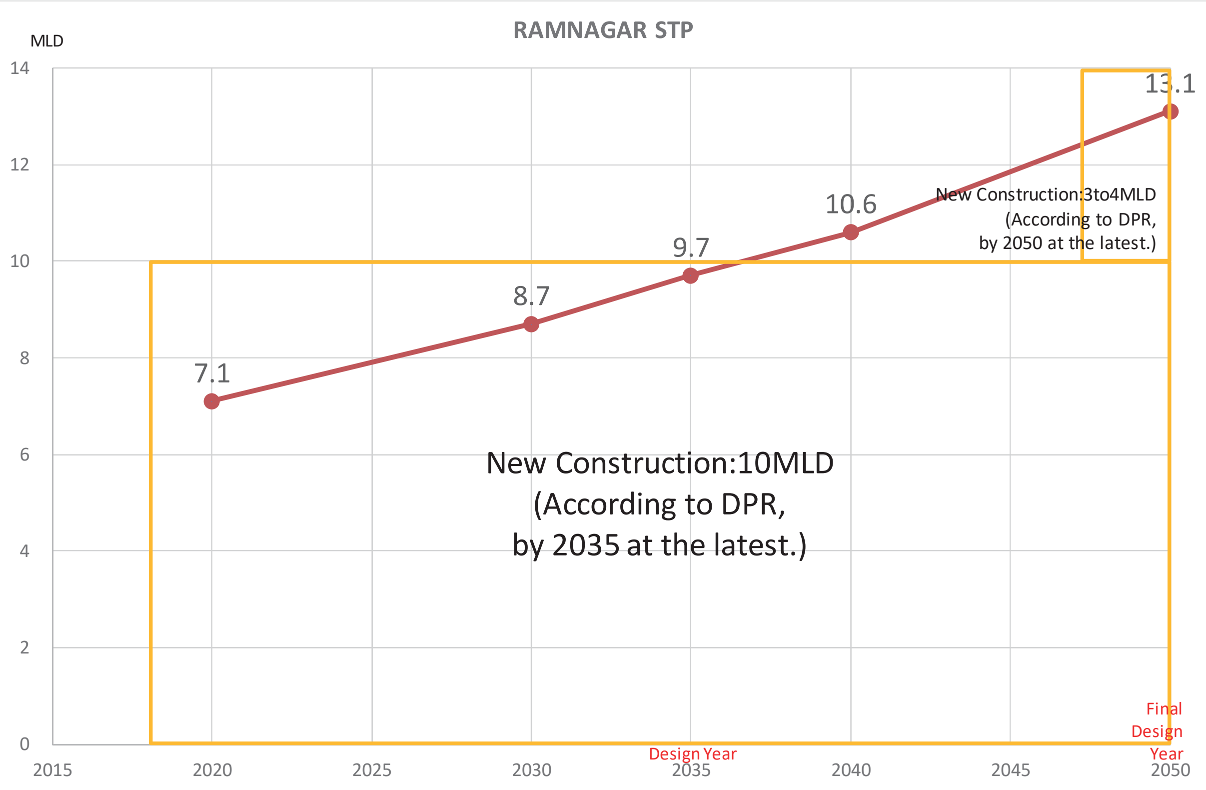


Figure 9.3.12 Construction plan of Ramnagar STP based on DPR

Source: JICA Survey Team

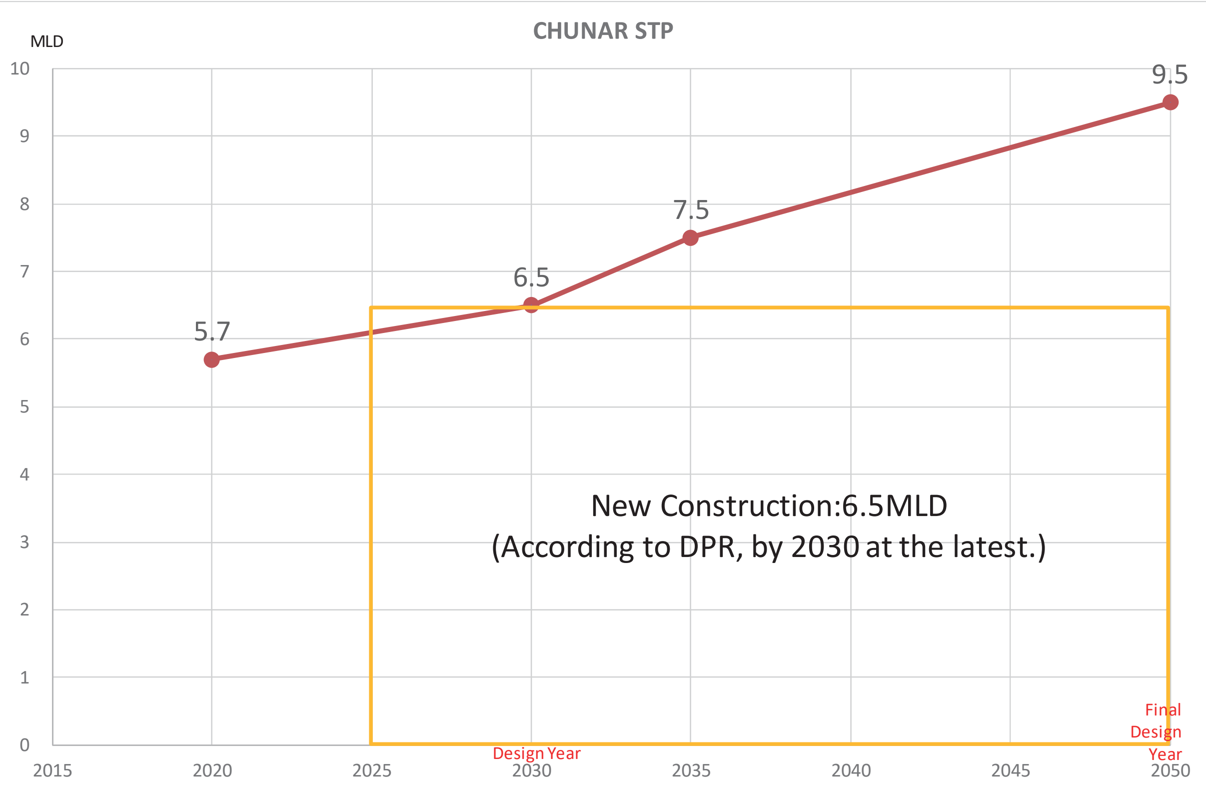


Figure 9.3.13 Construction plan of Chunar STP based on DPR

Source: JICA Survey Team

21) Matching at Another Components (Between comprehensive and ID&T, pipe planning)

In case of project implementation on two stages of ID&T and comprehensive plan, project components shall be properly arranged between the both plans.

9.3.2 Dinapur STP

(1) Consideration of biological treatment process

1) Point to review

As mentioned in 5.2.2, the existing STP is proposed upgrade. At the DPR, many demolitions of existing structures are planned for a reason that biological reactors need larger footprint for meeting the new effluent standards, which have changed to more strict water quality and added nitrogen and phosphorus. However, those existing structures made of reinforced concrete are not as old as being demolished, which are commissioned in 1994, and most of them can be used sufficiently by rehabilitation, therefore, they should be utilized as many as possible not to waste assets. To review the mentioned above, the DPR plan, Single-stage CND, is compared to two alternative plans, Moving Bed Biofilm Reactor (MBBR) and Double-stage CND by Step Feed, by JICA Survey team.

2) Description of DPR's plan and alternatives

a) Single-stage CND plan (DPR)

As shown on Figure 9.3.6, CND comprises anoxic tanks, aerobic tanks, and final clarifiers. Nitrogen can be removed by circulating mixed-liquor from aerobic tank, where organic/ ammonium nitrogen are oxidized by nitrification, to anoxic tank, where denitrification occurs by utilizing BOD of influent wastewater for carbon source; this method is termed MLE technology. As advantage of Single-CND, it is the simplest system and the least equipment in the three plans. However, as disadvantage, the largest footprint is required, which causes much demolition and renewal of the existing facilities, not only liquid treatment facilities but also some sludge treatment facilities. Furthermore, the side water depth, 7.5m, is higher than generally reactor, which makes maintenance of diffusers difficult.

b) MBBR plan (Alternative 1)

The schematic process diagram and layout plan of MBBR plan are shown in Figure 9.3.15, Figure 9.3.16 respectively.

This plan accomplishes to reduce volume by putting biofilm carriers into aerobic tank, where more nitrifiers are kept in it. As advantage of this plan, three existing aerobic tanks can be utilized with modification of water depth from 3.75m to 4.5m; because the freeboard has enough room, it is possible by raising outlet weir level. Existing trickling filter basins are demolished as other plans, and three anoxic tanks added there. As disadvantage, the most electrical power consumes because biofilm carriers need high DO concentration to keep nitrification in it.

c) Double-stage CND plan (Alternative 2)
The schematic Process diagram and layout plan of Double-stage CND plan are shown in
Figure 9.3.**17**, Figure 9.3.18 respectively.

In this plan, the facility has three series of biological reactor, which comprises two sets of anoxic/ aerobic tanks each series. In Double-stage CND, influent wastewater dividedly flows to the two anoxic tanks, which makes MLSS concentration in first anoxic/aerobic tanks higher than that in second anoxic/aerobic tanks; namely first anoxic/ aerobic tanks can keep more bacteria that work for wastewater treatment. Therefore, entire volume of reactor can be more compact than Single-stage CND, if MLSS concentration at inlet of secondary clarifier is same value. As other advantage of this process, circulation rate of nitrified mixed-liquor can be less than Single-stage CND, because the mixed-liquor nitrified at first aerobic can be removed at second anoxic tank without circulation.

Figure 9.3.14 Layout plan of Dinapur STP (DPR plan)

Source: DPR

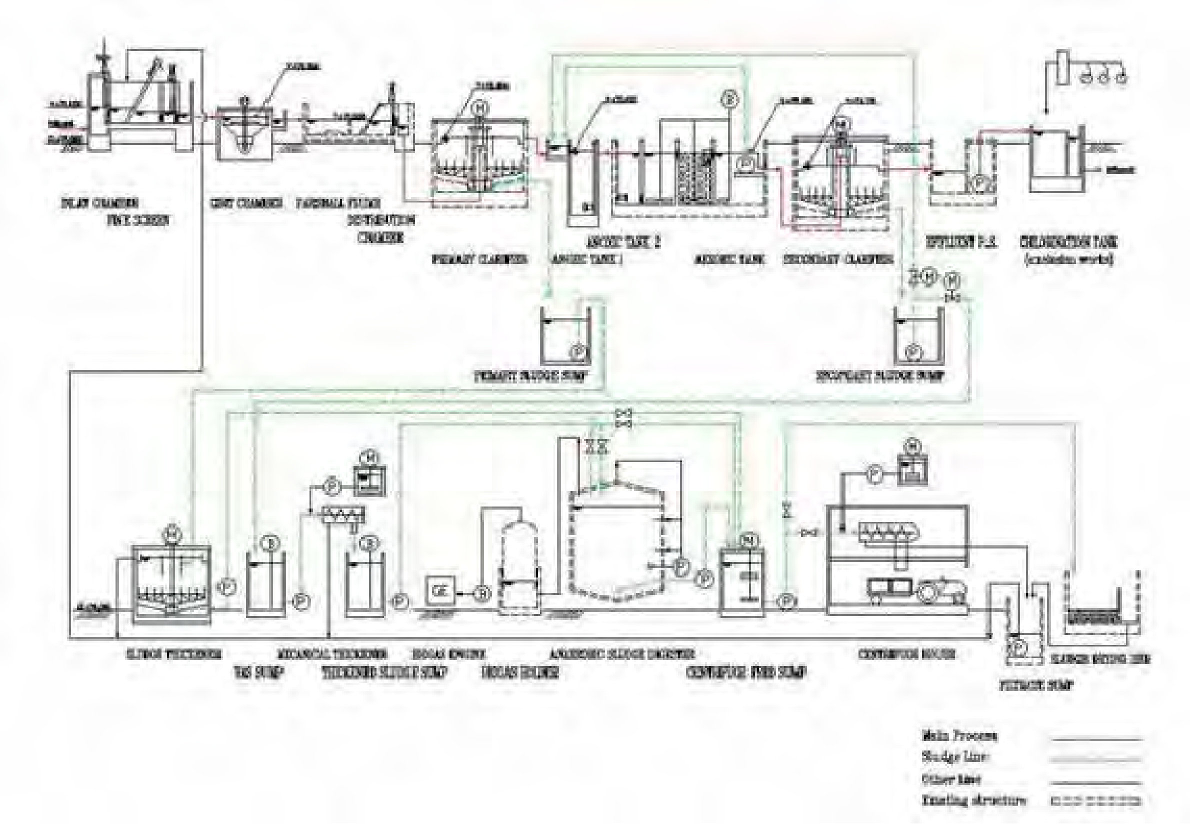


Figure 9.3.15 Schematic Process diagram of Dinapur STP (Alternative 1)

Source: JICA Survey Team

Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	$5.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	####^{W}	####^{L}	####^{SWD}
06	Distribution Chamber	1	####^{W}	####^{L}	####^{SWD}
07	Primary Clarifier	3	$31.2^{Dia.}$		3.5^{SWD}
08	Anoxic Tank 1	3	20.0^{W}	15.0^{L}	5.5^{SWD}
09	Anoxic Tank 2	3	20.0^{W}	19.5^{L}	4.5^{SWD}
10	Aerobic Tank	3	20.0^{W}	40.0^{L}	4.5^{SWD}
11	Secondary Clarifier	3	$40.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	$11.5^{Dia.}$		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	$29.0^{Dia.}$		7.0^{SWD}
19	Biogas Holder	2	$21.0^{Dia.}$		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	####^{W}	####^{L}	####^{H}
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	####^{H}
23	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	####^{H}
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	16.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	####^{H}
30	Power House	1	29.5^{W}	31.6^{L}	####^{H}
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	####^{H}
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Figure 9.3.16 Layout plan of Dinapur STP (Alternative 1)

Team

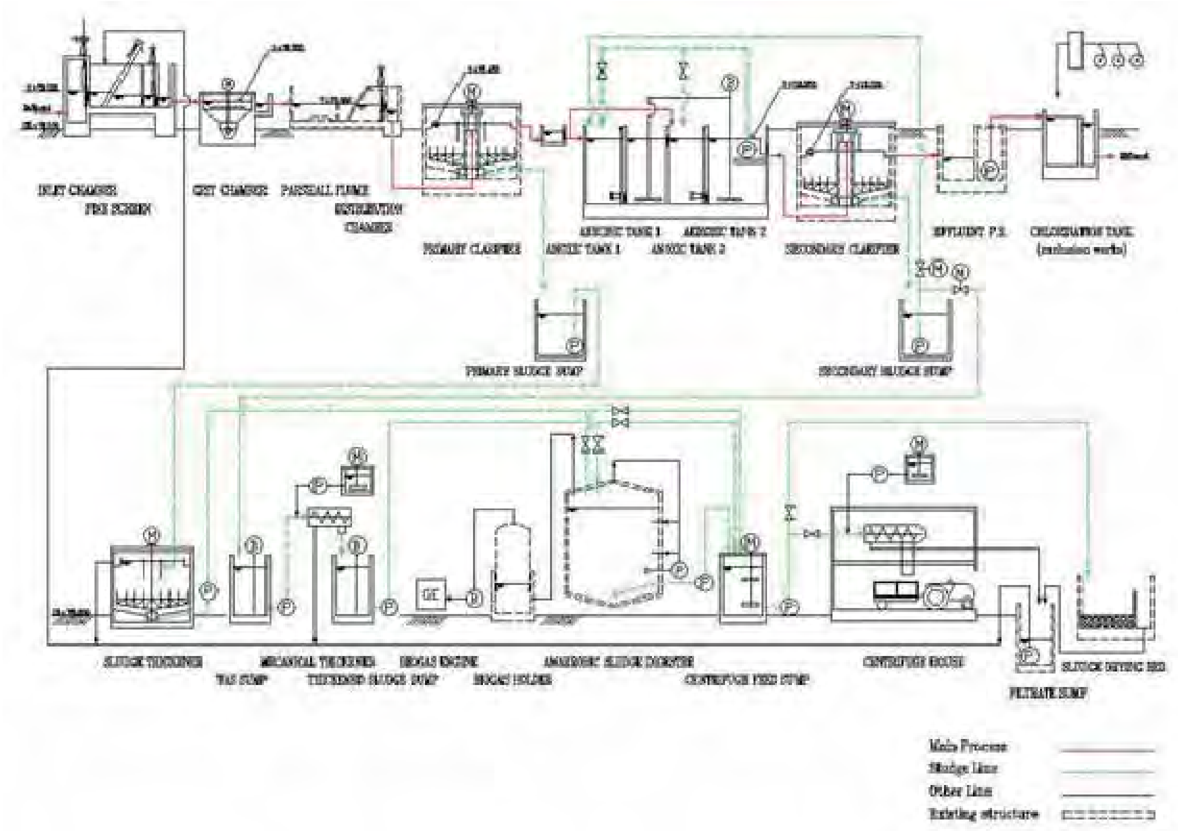


Figure 9.3.17 Schematic Process diagram of Dinapur STP (Alternative 2)

Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	5.0^{Dia}		3.0^{SWD}
05	Parshall Flume	1	****^{W}	****^{L}	****^{SWD}
06	Distribution Chamber	1	****^{W}	****^{L}	****^{SDW}
07	Primary Clarifier	3	31.2^{Dia}		3.5^{SWD}
08	Anoxic Tank 1,2	6	23.0^{W}	17.0^{L}	5.5^{SWD}
09					
10	Aerobic Tank 1,2	6	23.0^{W}	25.0^{L}	5.5^{SWD}
11	Secondary Clarifier	3	40.0^{Dia}		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	11.5^{Dia}		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	29.0^{Dia}		7.0^{SWD}
19	Biogas Holder	2	21.0^{Dia}		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	****^{W}	****^{L}	****^{H}
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	****^{H}
23	Air Blower Room	1	12.0^{W}	37.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	****^{H}
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	10.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	****^{H}
30	Power House	1	29.5^{W}	31.6^{L}	****^{H}
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	****^{H}
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Figure 9.3.18 Layout plan of Dinapur STP (Alternative 2)

Source: JICA Survey Team

3) Assumption of design

The following values should be calculated for design of biological reactors to remove nitrogen:

- Required volume to secure nitrification in aerobic tank,
- Required volume for denitrification in anoxic tank,
- Circulation rate of nitrified mixed-liquor to achieve desired nitrogen removal performance.

If the above values are appropriate, BOD removal performance also will be achieved. Since those values does not mentioned in the DPR, they are calculated by JICA Survey team, which are referred to "Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION", METCALF & EDDY/AECOM. Design condition for the calculation is shown in Table 9.3.7, which bases on the DPR, however some design values are arranged by JICA survey Team. And the result is shown in Table 9.3.8.

Table 9.3.7 Design Condition for Dinapur STP

Item	Design Value			Remarks
Flow Rate	80,000m3/d			
Temperature	20 ℃			
MLSS	3,000mg/l			at effluent of final reactor
Water quality	Influent	After Primary Clarifier	Effluent	
BOD	250mg/l	175mg/l	10mg/l	reduction 30% at Primary
COD	450mg/l	315mg/l	50mg/l	reduction 30% at Primary
TSS	400mg/l	160mg/l	10mg/l	reduction 60% at Primary
VSS	280mg/l	112mg/l	-	
T-N	50mg/l	45mg/l	10mg/l	reduction 10% at Primary
NH4-N	37mg/l	33.3mg/l	2mg/l	reduction 10% at Primary

Source: JICA Survey Team

Table 9.3.8 Comparison of Dinapur STP plans

Plan		DPR plan	Alternative 1	Alternative 2
Process		Single-stage CND	MBBR	Double-stage CND
Number of Series		2	3	3
Anoxic tank	Volume (m3/series)	6,799	3,371	4,268
	HRT	4h	3.03h	3.84h
Aerobic tank	Volume (m3/series)	10,722	3,560	6,267
	HRT	6.4h	3.2h	5.64h
Return Activated Sludge		60%	60%	60%
Internal Recycle		244%	214%	60%
Required Air (m3/d)		544,776	859,863	544,965

Source: JICA Survey Team

4) Comparison of plans

The demolished structures and rebuilt structures are shown in Table 9.3.9. and the comparison table is shown in Table 9.3.10.

Table 9.3.9 Demolished structures and rebuilt structure (Dinapur STP)

Plan	DPR plan	Alternative 1	Alternative 2
Process	Single-stage CND	MBBR	Double-stage CND
Demolished Facilities	1. Tricking Filters (Dia.22.5m x 3nos.) 2. Primary Clarifier (Dia.31.2m x 2nos.) 3. Aeration tank (4.500m3 x 2nos.) 4. Secondary Clarifier (Dia.40m x 2nos.) 5. RAS Pump House 6. Sludge Digester (4,600m3 x 3nos.) 7. Biogas holder (3,000m3 x 2nos.) 8. Engine House 9. Work Shop	1. Tricking Filters (Dia.22.5m x 3nos.) 2. RAS Pump House	1. Tricking Filters (Dia.22.5m x 3nos.) 2. Aeration tank (4.500m3 x 2nos.) 3. RAS Pump House 4. Work Shop
Rebuilt Facilities	1. Primary Clarifier (Dia.39m x 2nos.) 2. Aeration tank (17.500m3 x 2nos.) 3. Secondary Clarifier (Dia.46m x 2nos.) 4. RAS Pump House 5. Sludge Thickener (Dia.11.5m x 2nos.) 6. Sludge Digester (6,400m3 x 2nos.) 7. Biogas holder (2,700m3 x 2nos.) 8. Engine House 9. Air Blower Room 10. Mechanical Thickener 11. Centrifuge Building 12. Electrical Building	1.RAS Pump House 2. Sludge Thickener (Dia.11.5m x 2nos.) 3. Air Blower Room 4. Mechanical Thickener 5. Centrifuge Building 6. Electrical Building	1. Aeration tank (10.600m3 x 3nos.) 2. RAS Pump House 3. Sludge Thickener (Dia.11.5m x 2nos.) 4. Air Blower Room 5. Mechanical Thickener 6. Centrifuge Building 7. Electrical Building

Source: JICA Survey Team

Table 9.3.10 Comparison table of Dinapur STP plans

Plan	DPR plan	Alternative 1	Alternative 2
Process	Single-stage CND	MBBR	Double-stage CND
Treated water quality	4 x 2	4 x 2	4 x 2
	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.
Capital expense	2 x 2	5 x 2	4 x 2
	Most of existing facilities, including sludge treatment facilities are scrapped and renewed.	Aerobic tanks need remodelling. Existing Primary/Secondary Clarifiers can be used.	Aerobic/anoxic tanks need renewal. Existing Primary/Secondary Clarifiers can be used.
Operational expense	4 x 2	3 x 2	5 x 2
	The simplest system. The least electrical power.	Much electrical power is needed due to large Air Blower.	Electrical power of circulation is the least.
Easiness of maintenance	4 x 1	3 x 1	5 x 1
	The system is most simple and number of equipment is least in the three plans. Due to deep reactors, maintenance of diffusers are not easy.	In addition to normal biological treatment, knowledge peculiar to this system is necessary to operate.	Flexible operation is possible against variation of raw water characteristics.
Past record in India	4 x 1	3 x 1	5 x 1
Total	28	30	36

Evaluation Score: 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)
Importance Level: 2:High, 1:Moderate

Source: JICA Survey Team

As a result of the above comparison, Second-stage CND plan is proposed.

(2) Proposed plan (Double-stage CND)

Design parameters for proposed STP are shown in Table 9.3.11.

The minimum water temperature is set to 20 degrees, which is changed from the DPR. To secure 20 days of duration time in Sludge Digesters, thickening for secondary sludge is separated from primary sludge and mechanical thickener is introduced for it, which is also different from the DPR.

Table 9.3.11 Design Parameters for Proposed Dinapur STP

	Facility	Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	at peak flow
2	**Grit Chamber**		Vortex type	
(1)	Surface Load	m^3/m^2/day	4500	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	m^3/m^2/day	35	
4.	**Aerobic Tank 1,2**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	Final aerobic tank
(3)	SRT	day	4.9	
(4)	HRT	hour	5.64	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	60	
5.	**Anoxic Tank 1,2**			
(1)	HRT	hour	3.84	
(2)	Flow split ratio		First 0.5 : Second 0.5	
6.	**Secondary Clarifier**			
(1)	Surface Load	m^3/m^2/day	25	
7.	**Chlorination Tank**		Not in scope of project	
8.	**Gravity Thickener**			
(1)	Sludge loading	kg/m2・day	120	
(2)	Thickened sludge	%	5	Primary sludge
9.	**Mechanical Thickener**			
(1)	Thickened sludge	%	5	Secondary sludge
10.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
11.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	16.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

Description of the proposed STP is as follows.

1) Headworks

The headworks facility comprises one Inlet Chamber, three Fine Screen channels, two Grit Chambers, one

Parshall Flume, and one Distribution Chamber. Parshall Flume and Distribution Chamber are used existing structure, but the others are renewed.

Manually operated gates before Fine Screen channels are installed for maintenance of the screens. The Fine Screens are “Step screen” type whose openings are 6mm; one of three is for standby.

Because the space for installation is narrow, Grit Chambers are adopted “Vortex” type, which can be compact and high efficient separation.

2) Primary Clarifier

Three existing Primary Clarifiers, Column-supported circular type, continue to be used after rehabilitation, whose surface loading rate is capable. Primary sludge is withdrawn by Primary Sludge Pumps, which are installed in Primary Sludge Sump and transferred to Gravity Thickener.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)

The biological treatment facility is three series of Double-stage CND that comprise first Anoxic Tank, first Aerobic Tank, second Anoxic Tank, second Aerobic Tank, and Secondary Clarifier each. In this process, organic matter (BOD, COD), SS, and nitrogen are removed by MLE technology, which can achieved to the new standards that CPCB have notified except Faecal Coliforms.

Wastewater from Primary Clarifier flows to first Anoxic Tank and second Anoxic Tank dividedly, whose BOD is utilized for carbon source of denitrification where nitrified mixed-liquor comes from aerobic tank or Secondary Clarifier. Because the step feeding of wastewater increases MLSS/biomass concentration in first Anoxic/Aerobic Tank, the volume can be less than Single-stage CND. At the assumption of design, MLSS concentration in first Anoxic/Aerobic Tank is 3,844mg/l while that is 3,000mg/l in second Anoxic/Aerobic Tank, therefore, approximately 10% of the total volume can be reduced from Single-stage CND.

Each Anoxic tank has a volume of 2,134 m3, HRT 1.92 hours, where a submersible mixer is installed for stirring, which is reasonable price and no need of base and support structure at upper portion.

Each Aerobic Tank has a volume of 3,138m3, HRT 2.82 hours, where fine bubble diffusers are installed, whose oxygen transfer rate is required to be more efficient than 30.5%.

Nitrified mixed-liquor is transferred from the pit following second Aerobic Tank to first Anoxic Tank by circulation pumps that are submersible type equipped with a screw impeller. As a result of calculation regarding nitrogen removal, the capacity of circulation pumps is required to be more than 60% of internal recycle ratio.

Three existing Secondary Clarifiers, Column-supported circular type, continue to be used after rehabilitation, whose surface loading rate is capable. Secondary sludge is withdrawn by PAS Pumps, which are installed in Secondary Sludge Sump, and the sludge is transferred to first Anoxic Tank or WAS Sump, which is selected by the motorized valves.

4) Effluent Pumping station

Following Secondary Clarifier, treated water flows to Effluent Pumping Station and is pumped up to Chlorination Tank by Effluent Pumps. The facility is existing and continues to be used, however Effluent Pumps and the rerated piping are renewed.

5) Chlorination facility

This facility is not in scope of project.

6) Sludge treatment facilities

The sludge treatment process comprises thickening, anaerobic digestion, and sludge dewatering.

According to the DPR, primary sludge and secondary sludge went to Sludge thickeners, where they were combined. However, securing the HRT required in the existing Anaerobic Sludge Digesters is difficult, therefore, sludge thickening process is separated into primary sludge and secondary sludge, and then mechanical thickeners are taken for the secondary sludge, which can reduce volume of the sludge.

Three existing Anaerobic Sludge Digesters continue to be used after rehabilitation, but the mixers are required to be upgraded for high sludge concentration. The existing Biogas Holders are also capable, which can continue to be used. Following digesters, digested sludge are transferred to centrifugal facility, which consists of three centrifuges with a capacity of 25m3/h, three sludge feed pumps, a belt conveyer, two polyelectrolyte dosing system. Some existing Sludge Drying Beds remain as a backup of centrifuge facility.

Table 9.3.12 Facility List of Proposed Dinapur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**Basins & Tanks**					
1	Inlet Chamber	1	5.5	4.5	2.5	0.5
2	Main Screen Channel	3	1.5	7.5	1.3	0.5
3	Bypass Screen Channel	1	1.5	7.5	1.5	0.5
4	Grit Chamber	2	5.0	-	3.0	0.5
5	Parshall Flume	1	***	***	***	***
6	Distribution Chamber	1	***	***	***	***
7	Primary clarifier	3	31.2	-	3.5	0.5
8	Anoxic Tank 1,2	6	23.0	17.0	5.5	0.5
9	Aerobic Tank 1,2	6	23.0	25.0	5.5	0.5
10	Secondary Clarifier	3	40.0	-	3.5	0.5
11	Chlorine Contact tank (not in scope of project)	1	***	***	***	***
12	Primary Sludge Sump	3	3.0	4.0	4.0	0.5
13	Secondary Sludge Sump	3	3.0	4.0	4.0	0.5
14	Sludge Thickener	2	11.5	-	4.0	0.5
15	WAS Sump	2	6.0	6.5	4.0	0.5
16	Thickened Sludge Sump	1	6.0	6.5	4.0	0.5
17	Anaerobic Sludge Digester	3	29.0	-	7.0	1.5
18	Biogas Holder	2	21.0	-	8.7	0.5
19	Centrifuge Sludge Sump	2	6.0	6.0	3.5	0.5
20	Sludge Drying Bed	***	***	***	***	***
B	**Buildings**					
1	Filtrate Sump House	1	12.7	13.0	***	
2	Air Blower Room	1	12.0	25.0	6.0	
3	Treated Effluent Pump House	1	12.7	13.0	***	
4	Chlorination building (not in scope of project)	1	***	***	***	
5	Thickened Sludge Pump House	1	6.0	6.0	4.0	
6	Mechanical Thickener Building	1	10.0	15.0	8.0	
7	Centrifuge Building	1	15.0	30.0	10.0	
8	Control Room for Digester	1	4.2	4.3	***	
9	Power House	1	29.5	31.6	***	
10	Biogas Flare	2				
11	Administration Building & LAB	1	12.6	25.2	***	
12	Electrical Builging	1	15.0	20.0	8.0	

Source: JICA Survey Team

Table 9.3.13 Equipment List of Proposed Dinapur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 1.0(m)×Height :1.5(m)	-	4
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.50 (m)×SWD :1.30 (m) ×Open Space:6(mm)	2.20	2W+1S
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.50 (m)×SWD:1.30 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :9.0 (m)	1.50	1W
5. Grit Chamber	Vortex Type SS304	Dia. :5.00 (m)	11.0	2W
6. Primary Clarifier	Column-supported Circular Clarifier MS+ Epoxy	Dia. 31.2(m)×Height :3.5(m)	2.20	3W
7. Primary Sludge Pumps	Submersible, non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:50(m^3/h)×Total Head:10.0 (m)	5.5	3W+3S
8. Mixers for Anoxic Tank	Submersible SS304	Width :23.0 (m)×Length :17.0(m)×SWD :5.5(m)	5.0	12W
9. Diffusers	Fine Bubble Membrane	SOR:586 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	3W
10. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :250 (mm)× Air Flow :3800(m^3/h) ×Pressure: 65 (K Pa)	110.0	6W+3S
11. Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :300 (mm)×Discharge:670(m3/h)×Total Head:5.0 (m)	22.0	3W+3S
12. RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :300 (mm)×Discharge:670(m^3/h)×Total Head:5.0 (m)	22.0	3W+3S
13. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	6
14. Secondary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 40.0(m)×Height :3.5(m)	2.2	3W
15. Treated Effluent Pumps	Horizontal Centrifugal Cast Iron	Dia. :500 (mm)×Discharge:1670(m^3/h)×Total Head:12.0 (m)	130.0	4W+2S
16. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 11.5(m)×Height :4.0(m)	0.4	2W
17. Gravity Thickened Sludge Pumps	Progress Cavity Cast Iron / SS304	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:20.0 (m)	15.0	2W+1S
18. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :125 (mm)× Air Flow :600(m^3/h) ×Pressure: 40 (K Pa)	15.0	1W+1S
19. Mechanical Thickener	Rotary Drum	Capacity :50(m^3/h)	2.6	2W+1S

Items	Specification		kW	Pcs/Units
20. Mechanical Thickener Feed Pumps	Progress Cavity Cast Iron / SS304	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:20.0 (m)	15.0	2W+1S
21. Mixer for digester		Dia.:29 (m)×SWD :7(m)×Tank Volume:4622 (m3)	30.0	3W
22. Biogas power generator		Output:600(kW)	-	2W+1S
23. Desulfurization equipment		Capacity :360(m3/h)	-	2W
24. Biogas Holder	Floating Type	Dia.:21 (m)×SWD :8.7(m)×Tank Volume:6027 (m3)	-	2W
25. Biogas Flare		Capacity :360(m3/h)		2W
26. Mixer for Centrifuge Feed Sump	Vertical Shaft SS304	Width :6.0 (m)×Length :6.0(m)×SWD :3.5(m)	22.0	2W
27. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :25 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
28. Centrifuge	Solids Bowl Type SS304	Capacity :25 (m3/h)	44.5	2W+1S
29. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :25 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
30. Crane for Centrifuge	Single-girder overhead	Capacity:5.0 (ton)×Lift:6.0 (m)	17.1	1W
31. Polyelectrolyte Dosing System		Width :2.5 (m)×Length :2.5(m)×SWD :2.5(m)	3.7	2W
32. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:40 (mm)×Discharge :0.9 (m3/h)×Total Head:20.0 (m)	0.75	2W+1S
33. Polyelectrolyte Dosing Pump For Thickener	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.45 (m3/h)×Total Head:20.0 (m)	0.4	2W+1S
34. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:150 (mm)×Discharge :150(m^3/h)×Total Head:15.0 (m)	15.0	2W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 33kV, VCB HV outgoing feeder panels, IP52, 33kV, VCB Power transformers: outdoor use, 33/0.415-0.24 kV,1500 kVA			1pc 2pcs 2pcs
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 4000A, LV feeder panels: IP52, 600V, ABSs with 100 A, MCCBs Auto power factor correction panels MCC for Raw sludge pump set			2pcs 6pcs 2pcs 1pc

Items	Specification	kW	Pcs/Units
	MCCs for Liquid process Air blower starter panels with VFD MCCs for Solid process		1pc 4pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meter in inlet chamber Level meters of pre and post screens Level meter in primary sludge sump Primary sludge flow meters Air blow flow meters Air blow pressure meters MLR (Mixed Liquor Recycle) flow meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Residual chlorine analyzer Effluent flow meter Level meter in WAS (Waste Activated Sludge)sump WAS (Waste Activated Sludge) flow meters Thickened sludge flow meter Level meter in thickened sludge sump Level meters in polyelectrolyte solution tank for mechanical thickener Polymer dosing flow meters Level meters in digester Digested sludge flow meters Temperature meters in digester Level meter in centrifuge feed sump Centrifuge feed flow meters Level meter in polyelectrolyte solution tank for centrifuge Polymer dosing flow meters for centrifuge Generated biogas flow meter Generated biogas pressure meter Filtrate flow meter		1pc 1pc 6pcs 1pc 1pc 3pcs 3pcs 3pcs 3pcs 6pcs 3pcs 1pc 1pc 1pc 1pc 1pc 1pc 2pcs 3pcs 3pcs 1pc 9pcs 1pc 3pcs 2pcs 3pcs 1pc 1pc 1pc
4. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.3 Bhagwanpur STP

(1) Consideration of biological treatment process

1) Point to review

At the DPR, the existing biological treatment facilities are not utilized entirely. Like as Dinapur STP, the DPR plan, SBR process, is compared to an alternative plan, Single-stage CND, by JICA Survey team.

2) Description of DPR's plan and alternative plan

a) SBR plan (DPR):

As mentioned at Item 9.3.1 c), SBR-process is carried out in a single tank, where cyclic actions are repeated: fill, aeration, reaction, settling, and decanting. To remove nitrogen, either putting anoxic reaction time in a cycle, or making an anoxic zone in a reactor is required.

In case of the former method, anoxic reaction time should be set in a fill action or before aeration, because anoxic reaction requires BOD as carbon source. Hence some nitrate generated at the aeration is decanted without denitrification. Therefore, a volume of SBR basin should be more than the capacity not to exceed the regulated amount of T-N when decanting.

In case of the latter method, an anoxic zone should be equipped with at inlet portion of a SBR basin, so that denitrification can occur during fill and aeration/ reaction actions by circulation; therefore, that may allow omission of anoxic reaction time in a cycle and reducing volume of the reactor. Besides, the anoxic zone can be used as a selector, which can increase growth of floc-forming bacteria and can suppress growth of filamentous bacteria. Consequently, the latter method has some advantages over the former method, however, it may be more expensive because of the patented technology, which is called C-Tech.

The design calculation by JICA Survey team has been done in the former method. As a result of the calculation, the required HRT of SBR basins is 24 hours, which is equal to the amount of calculation by the manufacture that are attached in Annexure of the DPR, while the amount proposed in the body of the DPR is 17.34 hours. As this design HRT of SBR basins, 24 hours are taken. However, the values of raw water quality referred to the DPR for design are higher than the actual values reported from the existing STP, therefore, the values of raw water characteristics should be reconsidered at the final detailed design.

The schematic process diagram and layout plan of SBR plan are shown in Figure 9.3.19, Figure 9.3.20 respectively.

b) Single-stage CND plan (Alternative 1):

As shown on Figure 9.3.6, CND comprises anoxic tanks, aerobic tanks, and final clarifiers. At this plan, two existing primary/ secondary clarifiers continue to be reused after rehabilitation and also two existing aeration tanks are utilized as anoxic tanks with improvement. Although the two series of existing biological treatment are a conventional ASP without nitrogen removal, these can be upgraded to single-stage CND by adding new aerobic tanks, if wastewater flowrate is half of the present design flowrate. For another half of design flowrate, additional a series of biological treatment facility is built newly: a primary clarifier, an anoxic tank, an aerobic tank, and a secondary clarifier.

The schematic process diagram and layout plan of Single-stage CND are shown in Figure 9.3.21, Figure 9.3.22 respectively.

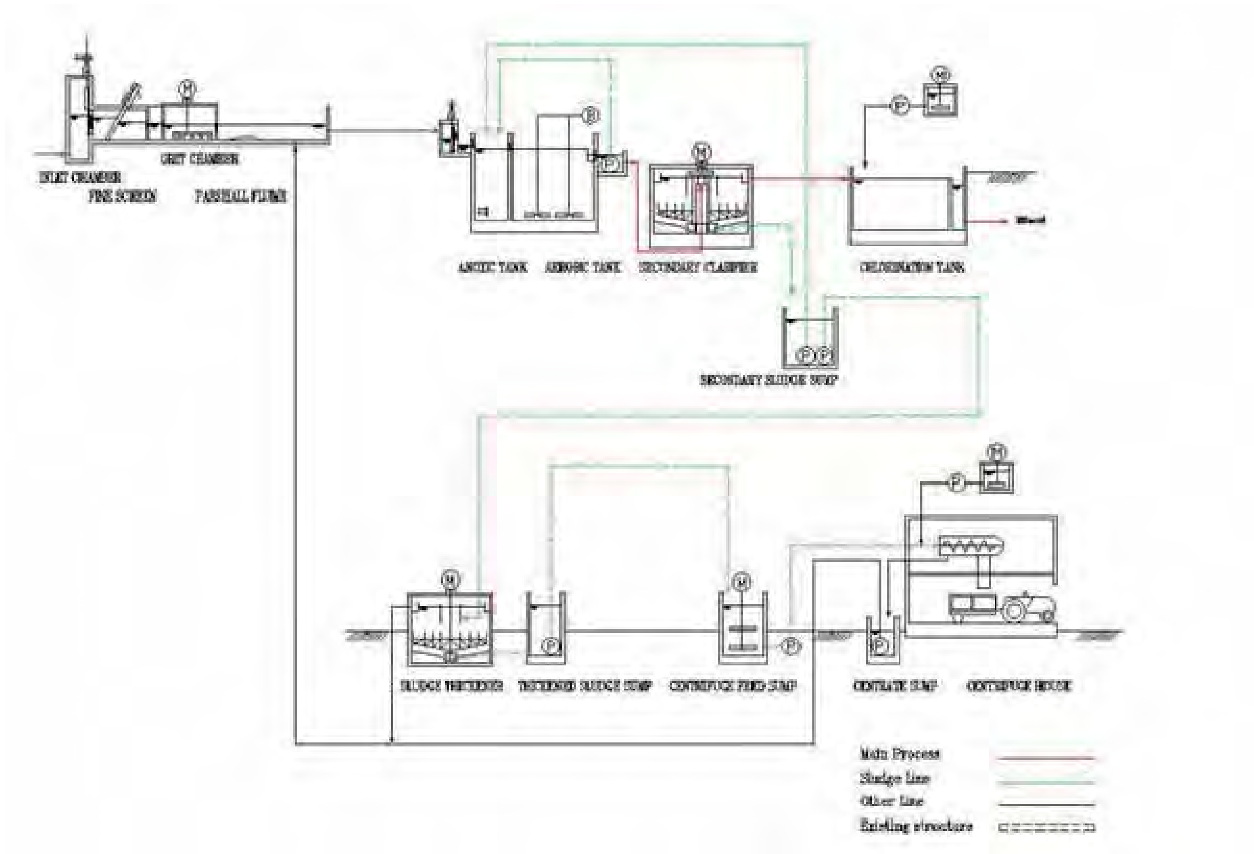
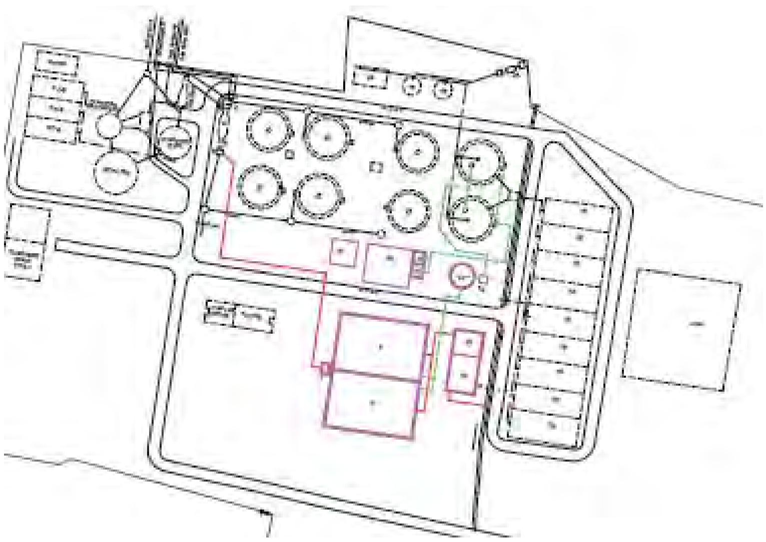


Figure 9.3.19 Schematic Process diagram of Bhagwanpur STP (SBR plan)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	****^{H}
02	Main Screen Channel	1	****^{W}	****^{L}	****^{H}
03	Bypass Screen Channel	1	****^{W}	****^{L}	****^{H}
04	Grit Chamber	1	****^{W}	****^{L}	****^{H}
05	Parshall Flume	1	0.35^{W}	****^{L}	****^{SWD}
06	Distribution Chamber 1	1	****^{W}	****^{L}	****^{SDW}
07	Distribution Chamber 2	1	****^{W}	****^{L}	****^{SDW}
08	SBR	2	22.0^{W}	34.0^{L}	5.5^{SDW}
12	Chlorine Contact Tank	1	****$^{Dia.}$	****^{L}	****^{SWD}
13	Sludge Thickener	1	$9.5^{Dia.}$		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	$18.0^{Dia.}$		9.8^{SWD}
16	Biogas Holder	3	$7.5^{Dia.}$		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	****^{H}
19	Filtrate Sump	1	****^{W}	****^{L}	****^{H}
20	Primary Sludge Pump House	1	****^{W}	****^{L}	****^{H}
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	****^{W}	****^{L}	****^{H}
23	Chlorination Building	1	****^{W}	****^{L}	****^{H}
24	Engine Room	1	8.5^{W}	15.0^{L}	****^{H}
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Figure 9.3.20 Layout plan of Bhagwanpur STP (SBR plan)

Source: JICA Survey Team

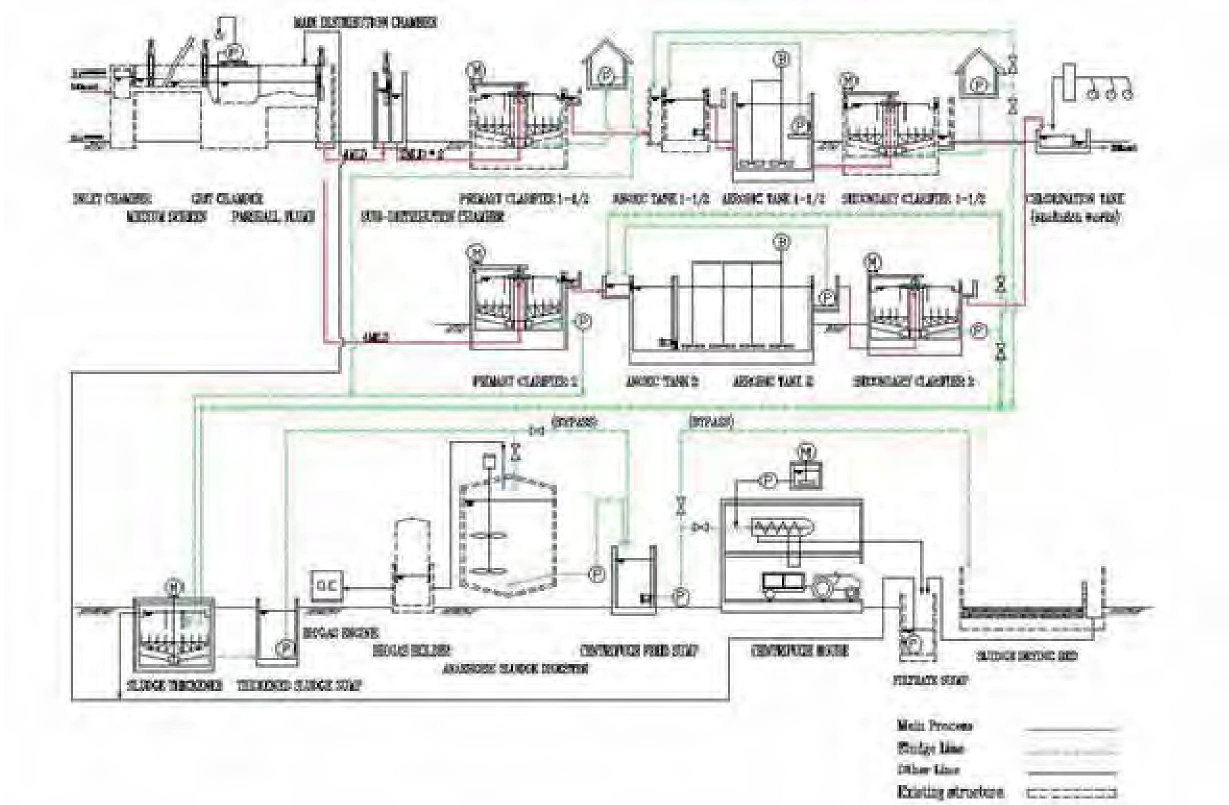
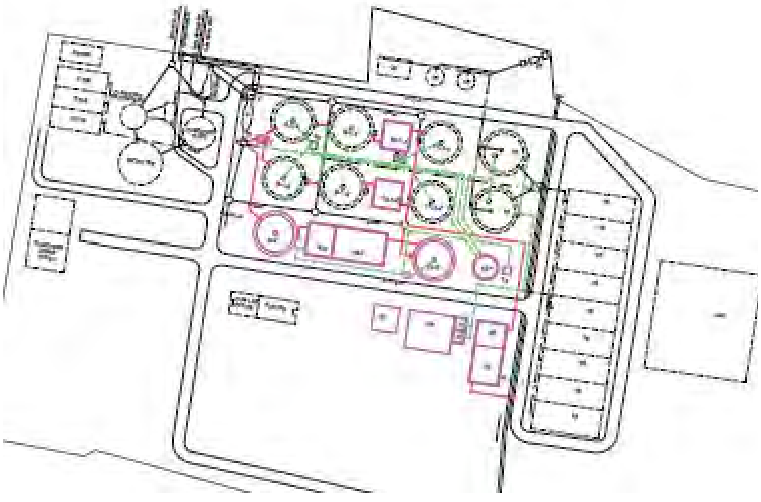


Figure 9.3.21 Schematic Process diagram of Bhagwanpur STP (Single-stage CND plan, Alternative)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	••••^{H}
02	Main Screen Channel	1	••••^{W}	••••^{L}	••••^{H}
03	Bypass Screen Channel	1	••••^{W}	••••^{L}	••••^{H}
04	Grit Chamber	1	••••^{W}	••••^{L}	••••^{H}
05	Parshall Flume	1	0.25^{W}	••••^{L}	••••^{SWD}
06	Main Distribution Chamber	1	••••^{W}	••••^{L}	••••^{SDW}
07	Sub-distribution Chamber	1	••••^{W}	••••^{L}	••••^{SDW}
08-1	Primary Clarifier 1-1/2	2	14.6^{Dia}		3.5^{SWD}
08-2	Primary Clarifier 2	1	14.6^{Dia}		3.5^{SWD}
09-1	Anoxic Tank 1-1/2	2	15.6^{Dia}		3.5^{SWD}
09-2	Anoxic Tank 2	1	12.0^{W}	10.5^{L}	5.5^{SWD}
10-1	Aerobic Tank 1-1/2	2	9.5^{W}	10.5^{L}	5.5^{SWD}
10-2	Aerobic Tank 2	1	12.0^{W}	16.5^{L}	5.5^{SWD}
11-1	Secondary Clarifier 1-1/2	2	16.0^{Dia}		3.5^{SWD}
11-2	Secondary Clarifier 2	1	16.0^{Dia}		3.5^{SWD}
12	Chlorine Contact Tank	1	••••^{W}	••••^{L}	••••^{H}
13	Sludge Thickener	1	9.5^{Dia}		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	18.0^{Dia}		9.8^{SWD}
16	Biogas Holder	2	7.5^{Dia}		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	••••^{H}
19	Filtrate Sump	1	••••^{W}	••••^{L}	••••^{H}
20	Primary Sludge Pump House	1	••••^{W}	••••^{L}	••••^{H}
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	••••^{W}	••••^{L}	••••^{H}
23	Chlorination Building	1	••••^{W}	••••^{L}	••••^{H}
24	Engine Room	1	8.5^{W}	15.0^{L}	••••^{H}
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Figure 9.3.22 Layout plan of Bhagwanpur STP (Single-stage CND plan, Alternative)

Source: JICA Survey Team

3) Assumption of design

The following values should be calculated for design of biological reactors to remove nitrogen:

- Required volume to secure nitrification in aerobic tank,
- Required volume for denitrification in anoxic tank,
- Circulation rate of nitrified mixed-liquor to achieve desired nitrogen removal performance.

If the above values are appropriate, BOD removal performance also will be achieved. Since those values does not mentioned in the DPR, they are calculated by JICA Survey team, which are referred to "Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION", METCALF & EDDY/AECOM. Design condition for the calculation is shown in Table 9.3.14, which bases on the DPR, however some design values are arranged by JICA survey Team. And the result is shown in Table 9.3.15.

Table 9.3.14 Design Condition of Bhagwanpur STP

Item	Design Value			Remarks
Flow Rate	8,000m3/d			
Temperature	20 ℃			
MLSS	3,000mg/l			at effluent of final reactor
Water quality	Influent	After Primary Clarifier	Effluent	
BOD	250mg/l	175mg/l	10mg/l	reduction 30% at Primary
COD	450mg/l	315mg/l	50mg/l	reduction 30% at Primary
TSS	400mg/l	160mg/l	10mg/l	reduction 60% at Primary
VSS	280mg/l	112mg/l	-	
T-N	50mg/l	45mg/l	10mg/l	reduction 10% at Primary
NH4-N	37mg/l	33.3mg/l	2mg/l	reduction 10% at Primary

Source: JICA Survey Team

Table 9.3.15 Comparison of Bhagwanpur STP plans

Plan		DPR plan	Alternative 1
Process		SBR	Single-stage CND
Number of Series		2	2 (0.25Q) + 1 (0.5Q)
Reactor	Total	8,228	4,170
	Anoxic	-	2,021
	Aerobic	-	2,149
	Total HRT	24.0h	10.4h
Return Activated Sludge		-	60%
Internal Recycle		-	244%
Required Air		86,570	54,378

Source: JICA Survey Team

4) Comparison of plans

The demolished structures and rebuilt structures are shown in Table 9.3.16 and the comparison table is shown in Table 9.3.17.

Table 9.3.16 Demolished structures and renewal structure (Bhagwanpur STP)

Plan	DPR plan	Alternative 1
Process	SBR	Single-stage CND
Demolished Facilities	1. Primary Clarifier (Dia.14.6m x 2nos.) 2. Aeration tank (Dia.15.6m x 2nos.) 3. Secondary Clarifier (Dia.16m x 2nos.) 4. Primary Pump House 5. RAS Pump House	
Rebuilt Facilities	1. SBR (4,000m3 x 2nos.) 2 Sludge Thickener (Dia.9.5m x 2nos.) 3. Air Blower Room 4. Centrifuge Building 5. Electrical Building	1. Anoxic tank (715m3 x 1) 2. Aerobic tank (1,076m3 x 2nos.,) 3 Sludge Thickener (Dia.9.5m x 2nos.) 4. Air Blower Room 5. Centrifuge Building 6. Electrical Building

Source: JICA Survey Team

Table 9.3.17 Comparison table of Bhagwanpur STP plans

Plan	DPR plan	Alternative 1	Remarks
Process	SBR	Single-stage CND	
Treated water quality	4 x 2	4 x 2	
	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.	
Capital expense	4 x 2	5 x 2	
	SBR facility is expensive.	Existing Primary/Secondary Clarifiers can be reused. Reactor’s volume is smaller.	
Operational expense	4 x 2	5 x 2	
	The system is simpler.	Less electrical power.	
Easiness of maintenance	4 x 1	5 x 1	
	The system is simpler. Difficult maintenance in SBR basin.	Can operate flexibly while maintenance.	
Past record in India	4 x 1	4 x 1	
Total	32	37	

Evaluation Score: 5: Best, 4: Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)
Importance Level: 2: High, 1: Moderate

Source: JICA Survey Team

As a result of the above comparison, Single-stage CND plan is proposed.

(2) Proposed plan (Single-stage CND)

1) Design parameters

The minimum water temperature is set to 20 degrees, which is changed from the DPR.

Table 9.3.18 Design Parameters for Proposed Bhagwanpur STP

Facility		Unit	Design Value	Remarks
1	**Medium Screen**			
(1)	Opening	min	20	
(2)	Passage velocity	m/sec	Less than 0.8	at peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	1000	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	35	
4.	**Aerobic Tank**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	Final aerobic tank
(3)	SRT	day	4.9	
(4)	HRT	hour	6.4	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	244	
5.	**Anoxic Tank**			
(1)	HRT	hour	4.0	
6.	**Secondary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	25	
7.	**Chlorination Tank**		Not in scope of project	
8.	**Gravity Thickener**			
(1)	Sludge loading	kg/m2・day	50	
(2)	Thickened sludge	%	4	Combined sludge
9.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
11.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

Description of the proposed STP is as follows.

2) Headworks

The headworks facility comprises one Inlet Chamber, one Main Screen Channel, one Bypass Screen Channel, one Grit chamber, one Parshall Flume, one Main Distribution Chamber, and one Sub-distribution Chamber. All existing structures except one Distribution Chamber continue to be reused after the rehabilitations. All mechanical/ electrical equipment are replaced, gates, a medium screen, a grit collector, a grit classifier, a belt conveyer, etc. Main Distribution Chamber divides wastewater between existing Primary Clarifiers and a new Primary Clarifier, and besides, Sub-distribution Chamber divides the half of that into two existing Primary Clarifiers.

2) Primary Clarifier

Two existing Primary Clarifiers, peripheral drive circular type, continue to be used after the rehabilitation, and a half of design flowrate wastewater, 4 MLD as design average flowrate, flows to them from Distribution Chamber 2. Another one Primary Clarifier is built newly for the remaining wastewater, 4 MLD as average design flowrate. Primary sludge is withdrawn by Primary Sludge Pumps, which are transferred to Sludge Thickener.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)

The biological treatment facility consists of two existing series that have a capacity of 2MLD each, and one new series that have a capacity of 4MLD, and each series has one anoxic tank, one aerobic tank, and one secondary clarifier. The two existing series are upgraded from conventional ASP to Single-stage CND, which are completed by addition of new aerobic tanks and improvement of the existing aerobic tanks that are changed to anoxic tanks. Each Anoxic Tank has a volume of more than 4 hours as HRT, where a submersible mixer is installed for stirring. Each Aerobic Tank has a volume of more than 6.4 hours as HRT, where fine bubble diffusers having more than 30.5% of oxygen transfer rate efficiency are installed. Nitrified mixed-liquor is transferred from the pit following Aerobic Tank to Anoxic Tank by Circulation pump, submersible type with a screw impeller. As a result of calculation regarding nitrogen removal, circulation pumps are required more than 244% of internal recycle ratio. Two existing Secondary Clarifiers, peripheral drive circular type, continue to be used after the rehabilitation, and another Secondary Clarifier is built newly. Secondary sludge is withdrawn by PAS Pumps, which are transferred to the destination selected by manually valves, either Anoxic Tank or Sludge Thickener.

4) Chlorination facility

This facility is not in scope of project.

5) Sludge treatment facilities

Although primary/secondary sludge are being transferred to Sludge Digester directly at the existing facility, adding a Sludge Thickener is proposed to secure the required HRT in Sludge Digester. The thickened sludge is transferred to Sludge Digester by Thickened Sludge Pump, submersible type with screw impeller, in Thickened Sludge Sump.

Existing Sludge Digester facilities continue to be used after some safety devices are replaced.

The existing biogas holders are also capable, which can continue to be used. Following digesters, digested sludge are transferred to centrifugal facility, which consists of two centrifuges with a capacity of 12m3/h, two sludge feed pumps, two polyelectrolyte dosing system.

Table 9.3.19 Facility List of Proposed Bhagwanpur STP

A	Basins & Tanks					
Sr. no	Unit	Quantity	Width / Dia	Length	Liquid Depth	Free Board
			m	m	m	m
1	Inlet Chamber	1	1.2	1.2	****	****
2	Main Screen Channel	1	****	****	****	****
3	Bypass Screen Channel	1	****	****	****	****
4	Grit Chamber	1	****	****	****	****
5	Parshall Flume	1	0.35	****	****	****
6	Distribution Chamber 1	1	****	****	****	****
7	Distribution Chamber 2	1	****	****	****	****
8-1	Primary clarifier 1-1/2	2	14.6	-	3.5	0.5
8-2	Primary clarifier 2	1	14.6	-	3.5	0.5
9-1	Anoxic Tank 1-1/2	2	15.6	-	3.5	0.5
9-2	Anoxic Tank 2	1	12.0	10.0	5.5	0.5
10-1	Aerobic Tank 1-1/2	2	10.5	10.5	5.5	0.5
10-2	Aerobic Tank 2	1	12.0	20.0	5.5	0.5
11-1	Secondary Clarifier 1-1/2	2	16.0	-	3.5	0.5
11-2	Secondary Clarifier 2	1	16.0	-	3.5	0.5
12	Chlorine Contact tank	1	****	****	****	****
13	Sludge Thickener	1	9.0	-	3.5	0.5
14	Thickened Sludge Sump	1	2.0	2.0	12.5	0.5
15	Anaerobic Sludge Digester	2	18.0	-	9.8	1.5
16	Biogas Holder	2	7.5	-	4.0	0.5
17	Centrifuge Feed Sump	2	4.0	4.5	3.5	0.5
18	Sludge Drying Bed	9	12.0	28.0	****	****
19	Filtrate sump	1	****	****	****	****
B	**Buildings**					
Sr. no	Description	Quantity	Length	Width	Height above GL	
			m	m	m	
1	Primary sludge pump house	1	****	****	****	
2	Air blower room	1	10.0	10.0	4.0	
3	RAS pump house	1	****	****	****	
4	Chlorination building	1	****	****	****	
5	Gas engine room	1	8.5	15.0	****	
6	Biogas Flare	1	****	****	****	
7	Centrifuge Building, including electrical room, DG room	1	15.0	18.0	8.0	

Source: JICA Survey Team

Table 9.3.20 Equipment List of Proposed Bhagwanpur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 1.0(m)×Height :1.0(m)	-	2W
2. Bypass Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :1.0(m)	-	2W
3. Medium Screens (Mechanical)	Continuous Chain Scraper SS304	Channel Width :1.0 (m)×SWD :0.45 (m) ×Open Space:20(mm)	1.5	1W
4. Medium Screen (Manual)	Bar Screen SS304	Channel Width :0.5 (m)×SWD:0.45 (m) ×Open Space:50(mm)	-	1S
5. Belt Conveyor		Belt Width :0.60(m)×Length :4.0 (m)	1.50	1W
6. Grit Chamber	Grit removal travelling Type SS304	Width :2.0 (m)×Length :7.0(m)×SWD :1.3(m)	11.0	1W
7. Main Distribution Weir Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.5(m)	-	2W
8. Sub-distribution Weir Gates	Manually Operated Cast Iron	Width 0.3(m)×Height :0.4(m)	-	2W
9. Primary Clarifier	Peripheral driven Circular Clarifier MS+ Epoxy	Dia. 14.6(m)×Height :3.5(m)	0.75	3W
10. Primary Sludge Pumps	Vertical Centrifugal non-clog impeller Cast Iron	Dia. :80 (mm)×Discharge:10(m^3/h)×Total Head:15.0 (m)	2.2	2W+2S
11. Mixers for Anoxic Tank 1	Submersible SS304	Dia. :15.6 (m)×SWD :3.5(m)	4.0	2W
12. Mixers for Anoxic Tank 2	Submersible SS304	Width :12.0 (m)×Length :11.0(m)×SWD :5.5(m)	4.0	1W
13. Diffusers 1	Fine Bubble Membrane	SOR:44 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	2W
14. Diffusers 2	Fine Bubble Membrane	SOR:88 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	1W
15. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :150 (mm)× Air Flow :1200(m^3/h) ×Pressure: 65 (K Pa)	37.0	2W+1S
16. Circulation Pumps 1	Submersible Non-clog impeller Cast Iron	Dia. :150 (mm)×Discharge:210(m3/h)×Total Head:5.0 (m)	5.5	2W+2S
17. Circulation Pumps 2	Submersible Non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:410(m3/h)×Total Head:5.0 (m)	11.0	1W+1S
18. RAS Pumps 1	Horizontal Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:50(m^3/h)×Total Head:5.0 (m)	1.5	2W+1S
19. RAS Pumps 2	Horizontal Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:100(m^3/h)×Total Head:5.0 (m)	3.7	1W+1S

Items	Specification		kW	Pcs/Units
20. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3
21. Secondary Clarifier	Peripheral driven Circular Clarifier Cast Iron	Dia. 16.0(m)×Height :3.5(m)	0.75	3W
22. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 9.5(m)×Height :3.5(m)	0.4	1W
23. Thickened Sludge Pumps	Submersible Screw impeller Cast Iron / SS304	Dia.:100 (mm)×Discharge :15(m^3/h)×Total Head:15.0 (m)	2.2	1W+1S
24. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	1
25. Mixer for Centrifuge Feed Sump	Submersible SS304	Width :4.0 (m)×Length :4.5(m)×SWD :3.5(m)	5.0	2W
26. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :12 (m3/h)×Total Head:20.0 (m)	3.7	1W+1S
27. Centrifuge	Solids Bowl Type SS304	Capacity :12 (m3/h)	19.7	1W+1S
28. Crane for Centrifuge	Single-girder overhead	Capacity:2.0 (ton)×Lift:6.0 (m)	5.6	1W
29. Polyelectrolyte Dosing System		Width :1.2 (m)×Length :1.2(m)×SWD :1.5(m)	0.75	2W
30. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.4 (m3/h)×Total Head:20.0 (m)	0.4	1W+1S
31. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :70(m^3/h)×Total Head:15.0 (m)	7.5	2W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV,500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pcs 1pcs 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, ACB 630A x 1 LV feeder panels: IP52, 600V, MCCB 200 A x 3, MCCB 100 A x 9, Static capacitors MCC for Grit chamber MCCs for Liquid process (Primary clarifiers, aeration tanks, secondary clarifiers) Air blower starter panels with VFD MCCs for Solid process			1pc 1pc 2pcs 1pc 3pcs 1pc
3. Instrumentation devices	Inlet flow meter Level meter in inlet chamber Level meters of pre and post screens			1pc 1pc 2pcs

Items	Specification	kW	Pcs/Units
	Level meter in primary sludge sump		1pc
	Primary sludge flow meters		1pc
	Air blow flow meters		3pcs
	Air blow pressure meters		3pcs
	MLR (Mixed Liquor Recycle) flow meters		3pcs
	RAS (Return Activated Sludge) flow meters		3pcs
	DO analyzers		6pcs
	MLSS analyzers		3pcs
	Residual chlorine analyzer		1pc
	Effluent flow meter		1pc
	WAS (Waste Activated Sludge) flow meters		1pc
	Thickened sludge flow meter		1pc
	Level meter in thickened sludge sump		1pc
	Level meters in digester		2pcs
	Digested sludge flow meters		1pc
	Temperature meters in digester		6pcs
	Level meters in centrifuge sump		1pc
	Centrifuge feed flow meters		2pcs
	Level meter in polyelectrolyte solution tank		2pcs
	Polymer dosing flow meters		2pcs
	Generated biogas flow meter		1pc
	Generated biogas pressure meter		1pc
	Filtrate flow meter		1pc
4. Local SCADA system	Operator stations, SCADA servers, PLCs, router, etc.,		1ls

Source: JICA Survey Team

9.3.4 Ramna STP

(1) Design Parameter

As for the design condition of biological treatment, minimum water temperature and MLSS are set to 20 degrees and 3000ml/L respectively, which are changed from the DPR. It has been confirmed in changing of the design conditions above mentioned that dimension of proposed Anoxic tank and Aerobic tank in DPR are appropriate.

Table 9.3.21 Design Parameters for Proposed Ramna STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	100	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	35	
4.	**Aerobic Tank**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	
(3)	SRT	day	4.83	
(4)	HRT	hour	6.16	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	184	
5.	**Anoxic Tank**			
(1)	HRT	hour	3.0	
6.	**Secondary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	15.	or Equivalent Tube settler
7.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
7.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	75	
8.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
9.	**Sludge Drying Bed**			
(1)	Drying duration	day	12	
(2)	Sludge loading	kg/m2	30	

Source: JICA Survey Team

(2) Description of the proposed STP

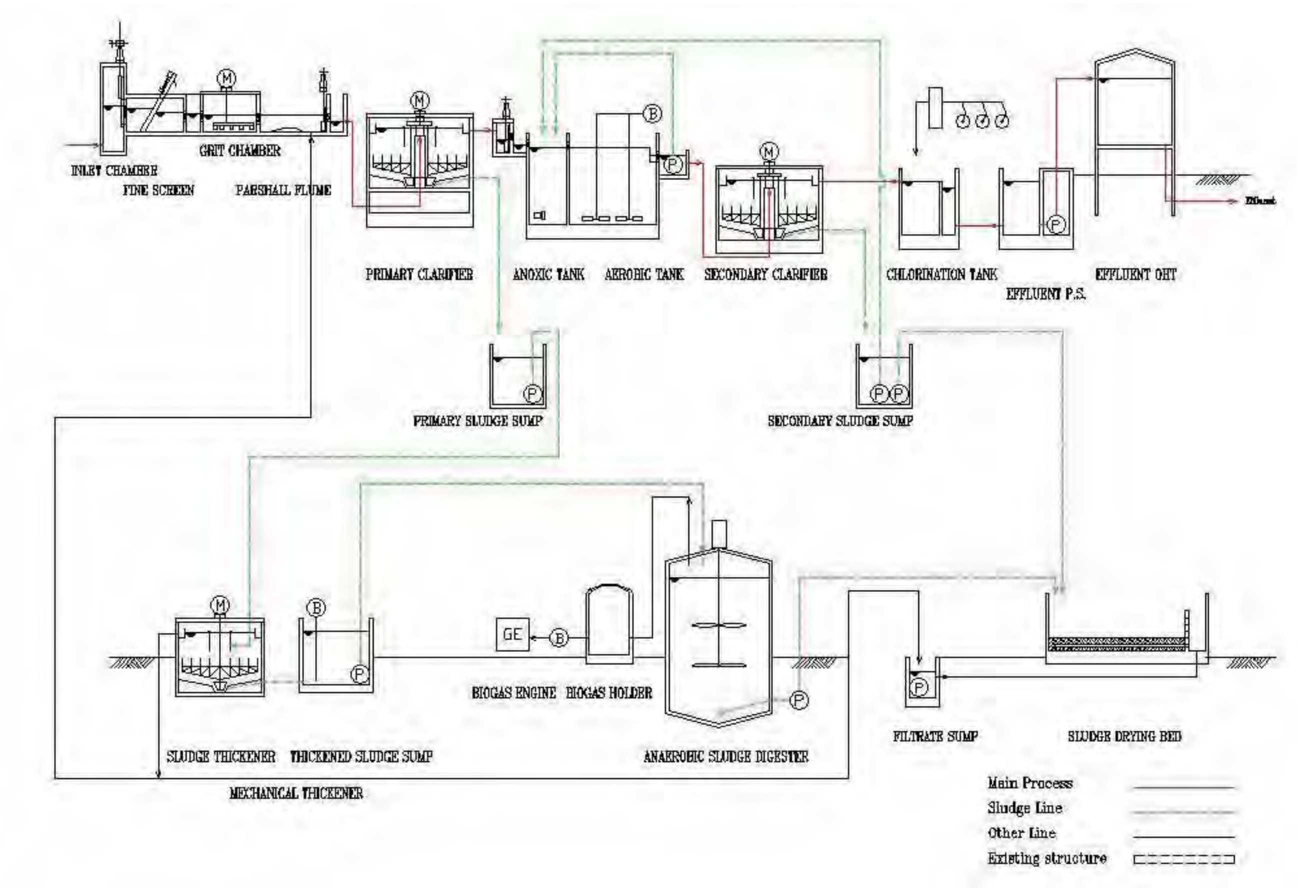


Figure 9.3.23 Layout plan of Ramna STP (Single-stage CND)

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet chamber, two Fine screen channels, two Grit chambers, and one Parshall Flume.

Manually operated gates before fine screen chambers are for the maintenance of the screens. “Step screen” type of the fine screens with opening of 6mm and “square horizontal-flow” type of the grit removal facility are adopted because a lot of them have been installed across India because of high reliability.

2) Primary Clarifier

Design surface loading rate of Primary Clarifier, Column-supported circular type, is 35m^3/m^2/day that is same as the DPR. The sludge is withdrawn by Primary Sludge Pumps which are installed in Primary Sludge Sump. The pumps and sump are placed separately in each Primary Clarifier for preventing imbalance of withdrawing sludge.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)

Biological Treatment comprises Anoxic Tanks, Aerobic Tanks and Secondary Clarifiers. Combination of these three parts enables both organic matter and nitrogen removal.

For stirring of Anoxic Tanks, submersible mixers are adopted, since they are available at reasonable price without bases and supports at upper portion.

Aeration Tanks are recommended to be Plug-flow reactors with the width of 8.0m, length of 190m and depth of 5.7m because it is more effective reaction and easy in maintenance of diffusers e.g. air flow adjustment. The Aerobic Tanks are baffled channels that do not need to change the layout plan from the DPR.

The oxygen transfer rate of the diffusers should be more efficient than 30.5% as fine bubble membrane type.

Nitrified liquid is transferred to Anoxic tank from the pit following Aerobic tank by Circulation pump that is submersible type equipped with a screw impeller. As a result of calculation of nitrogen removal, return sludge pumps are required to have a capacity of more than 60% of return rate, and circulation pumps are required to have a capacity of more than 184% of circulation rate.

4) Disinfection

Disinfection facility is gas chlorination system that is same as DPR. It has many track records in India.

5) Effluent Pumping station

It is same as the DPR. In the detailed design at later stage, it should be carefully studied whether water hammer will occur or not, its countermeasure if required.

6) Sludge treatment facilities

As shown in the DPR, the primary sludge goes to Sludge thickeners and then after digestion treatment it is transferred to Sludge Drying Bed. However, there is no treatment process for secondary sludge. At this preliminary design, secondary sludge is supposed to be conveyed to sludge drying bed directly as planned in the DPR. However, the secondary sludge is recommended to be treated by the same process as the primary sludge for stable sludge quality in agriculture use. Otherwise it should be treated by a mechanical thickener for shortening the sludge duration.

Primary Sludge, design sludge concentration 3%, is transferred to Sludge Thickener from Primary Sludge Sump and then is thickened by the gravity, design thickened sludge concentration 4%. Thickened sludge is transferred to Anaerobic Sludge digester that is high rate type.

The Sludge Digesters, vertical cylindrical tanks, Dia. 25m, SWD 10m, have the volume of 20 days as design retention time, which is supposed to operate by mesophilic bacteria.

For stirring of the tank, mechanical mixers with sufficient stirring force shall be applied.

Generated biogas is utilized for Biogas Power Generator.

Sludge temperature in the digester should be kept between 30 to 37 degrees for good operation by mesophilic bacteria. If sludge temperature lowers less than the suitable condition in winter, additional heating system is recommended.

7) Sludge Drying Bed

As a result of calculation base on DPR, sludge drying duration 12days, no. of the basins 12, sludge load 30kg/m^2, the dimension of a bed is width 20m×length 36m (720m2). However, when the secondary sludge （calculated sludge volume 1168m3/day,0.8%) is received, it is hard to dry sludge less than 80% of moisture contents within 12 days.

Table 9.3.22 Facility List of Proposed Ramna STP

A	Basins & Tanks					
Sr. no	Unit	Quantity	Length / Dia	Width	Liquid Depth	Free Board
			m	m	m	m
1	Inlet Chamber	1	5.0	4.8	3.0	0.5
2	Mechanical Fine Screen Channel	2	8.5	1.4	0.9	0.5
3	Manual Fine Screen Channel	1	8.5	1.2	0.9	0.5
4	Grit Distribution Chamber	1	6.0	2.0	1.2	0.5
5	Grit Chamber	2	7.1	7.1	1.0	0.5
6	Parshall Flume	1	8.5	1.3	0.8	0.5
7	Primary clarifier distribution Chamber	1	4.0	-	1.5	0.5
8	Primary clarifier	2	34.0	-	3.0	0.5
9	Primary Sludge Sump	1	5.6	-	2.0	0.5
10	Bioreactor Distribution Chamber	1	4.5	2.5	1.5	0.5
11	Anoxic Tank	2	14.0	40.0	5.8	0.6
12	Aerobic Tank	2	38.0	40.0	5.7	0.6
13	Secondary Clarifier Distribution Chamber	1	4.0	-	1.5	0.5
14	Secondary Clarifier	2	46.0	-	3.2	0.5
15	Chlorine Mixing tank	1	5.5	4.5	3.0	0.5
16	Chlorine Contact tank	2	18.0	20.0	3.0	0.5
17	Dechlorinatin Chamber	1	5.5	4.5	3.0	0.5
18	Recirculation Sludge Sump	1	9.0	-	4.2	0.5
19	Effluent Pumping Station	1	15.0	-	6.0	-
20	Effluent Overhead Tank	1	250 KL			
21	Sludge Thickener	2	13.5	-	3.5	0.5
22	Thickened Sludge Sump	1	6.2	-	3.0	0.5
23	Anaerobic Sludge Digester	2	30.0	-	10.0	1.5
24	Gas Holder	2	12.0	-	8.7	0.5
25	Digested Sludge Sump	2	4.5	3.0	3.5	0.5
26	Sludge Drying Bed	12	36.0	20.0	0.3	0.3
27	Primary Sludge Sump	1	5.6	-	2.0	0.5
28	Secondary Sludge Sump	1	9.0	-	4.2	0.5
29	Filterate sump	1	5.5	-	2.0	0.5
B	**Channels**					
Sr. no	Description	Quantity	Length	Width	Liquid Depth	Free Board
			m	m	m	m
1	Grit Inlet Channel	2	20.0	0.9	0.6	0.5
2	Grit Outlet Channel	2	20.0	0.9	0.6	0.5
3	Channel upstream of Parshall flume	1	15.0	1.3	0.8	0.5
4	Channel downstream of Parshall flume	1	12.0	1.3	0.8	0.5
5	Primary Clarifier Outlet Channel	2	15.0	0.8	0.7	0.5
6	Common Channel to bioreactor distribution chamber	1	30.0	1.3	1.0	0.5
7	Combined channel to secondary DC	1	12.0	1.3	1.0	0.5
8	Individual Secondary Clarifier Outlet Channel	2	25.0	1.0	1.0	0.5
C	**Buildings**					
Sr. no	Description	Quantity	Length	Width	Height above GL	
			m	m	m	
1	Primary sludge pumping station	1	8.0	5.5	4.0	
2	Process Air blower room	1	18.0	10.0	4.0	
3	RAS pumping station	1	10.0	6.0	4.0	
4	Chlorination building	1	5.0	3.5	4.0	
5	Chlorine tonner room	1	8.0	4.5	4.0	
6	Thickened sludge pumping station	1	6.5	4.0	4.0	
7	Digester control building(2 Floor)	1	15.0	8.0	8.0	
8	Sludge dewatering unit feed pumping station	1	6.5	4.0	4.0	
9	Gas engine building	1	20.0	9.0	4.0	
10	Substation & transformer yard	1	33.0	16.5	4.0	
11	HT panel room	1	10.0	5.0	4.0	
12	Meetring room	1	3.0	5.0	4.0	
13	Administration Building & LAB	1	35.0	18.0	8.0	
14	Maintenance work shop	1	15.0	10.0	4.0	
15	Guard room	2	5.0	4.0	4.0	
16	Storage room	1	10.0	5.0	4.0	
17	Parking shed	1	14.5	6.0	4.0	
18	Grit classifier platform	1	6.0	4.0	-	

Source: JICA Survey Team

Table 9.3.23 Equipment List of Proposed Ramna STP

Items		Specification		kW	Pcs/Units
(Mechanical)					
1.	Inlet Gates	Manually Operated Cast Iron	Width 0.8(m)×Height :1.2(m)	-	3
2.	Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.40 (m)×SWD :0.90 (m) ×Open Space:6(mm)	2.20	2W
3.	Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.90 (m) ×Open Space:20(mm)	-	1S
4.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5.	Grit Chamber	Square Horizontal SS304	Width :7.10 (m)×Length :7.10(m)×SWD :0.80 (m)	2.25	2W
6.	Primary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 34.0(m)×Height :3.0(m)	1.50	2W
7.	Primary Sludge Pumps	Submersible, non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:65(m^3/h)×Total Head:10.0 (m)	5.5	2W+2S
8.	Mixers for Anoxic Tank	Submersible SS304	Width :10.0 (m)×Length :14.0(m)×SWD :5.8(m)	5.0	8W
9.	Diffusers	Fine Bubble Membrane	SOR:455 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	2W
10.	Air Blowers	Rotary blower Tri-lobe Type	Dia. :250 (mm)× Air Flow :3300(m^3/h) ×Pressure: 65 (K Pa)	90.0	4W+2S
11.	Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :400 (mm)×Discharge:960(m3/h)×Total Head:5.0 (m)	30.0	4W+2S
12.	RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :250 (mm)×Discharge:320(m^3/h)×Total Head:5.0 (m)	11.0	4W+2S
13.	SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :25(m^3/h)×Total Head:15.0 (m)	3.70	2W+2S
14.	Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3
15.	Secondary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 46.0(m)×Height :3.5(m)	2.2	2W
16.	Chlorinators	Gas Chlorination System	Dosing Rate :25.0(kg/h)	1.00	1W+1S
17.	Chlorine Tonners		Volume:928(kg/Unit)	-	11
18.	Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
19.	Sludge Thickener	Bridge-supported Circular Clarifier Cast Iron	Dia. 13.5(m)×Height :3.5(m)	0.75	2W
20.	Air Blowers For Thickened Sludge Sump	Rotary blower Tri-lobe Type	Dia. :50 (mm)× Air Flow:160(m^3/h) ×Pressure: 40 (KPa)	3.70	2

Items	Specification		kW	Pcs/Units
21. Thickened Sludge Feed Pumps	Submersible Screw impeller Cast Iron	Dia.:100 (mm)×Discharge :30(m^3/h)×Total Head:20.0 (m)	11.0	2W+2S
22. Mixer for digester		Dia.:25 (m)×SWD :10(m)×Tank Volume:4900 (m3)	15.0	2W
23. Biogas power generator		Output:660(kW)	-	1W+1S
24. Desulfurization equipment		Capacity :210(m3/h)	-	2W
25. Biogas Holder		Capacity :800(m3)	-	2W
26. Biogas Flare		Capacity :410(m3/h)		1W+1S
27. Biogas Blower		Dia.:40 (mm)×Discharge :210 (m3/h)×Pressure:10.0 (kPa)	3.7	2W+1S
28. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:150 (mm)×Discharge :150(m^3/h)×Total Head:15.0 (m)	15.0	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 33kV, VCB HV outgoing feeder panels, IP52, 33kV, VCB Power transformers: outdoor use, 33/0.415-0.24 kV, 2000 kVA Diesel engine generator set: 415 V, 50 Hz, 1000 kVA Diesel engine generator set: 415 V, 50 Hz, 750 kVA			1pc 1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 4000A x 2, LV feeder panels: IP52, 600V, ABSs with 100 A, MCCBs Auto power factor correction panels MCC for Grit chamber MCCs for Liquid process (Primary clarifiers, Aeration tanks, Secondary clarifiers) Circulation pump starter panels, 30 kW Air blower starter panels with VFD, 90 kW Treated effluent pump starter panels, 330 kW Treated effluent pump starter panels, 110 kW MCCs for Solid process (Gravity thickener, Digester/biogas utilization facilities)			1pc 6pcs 2pcs 1pc 1pc 6pcs 6pcs 3pcs 2pcs 1pc
3. Instrumentation devices	Inlet flow meter Level meter in inlet chamber Level meters of pre and post screens Level meter in primary sludge sump Primary sludge flow meters Air blow flow meters Air blow pressure meters MLR (Mixed Liquor Recycle) flow meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge flow meters Level meter in thickened sludge sump Level meters in digester Digested sludge flow meters			1pc 1pc 1pc 1pc 4pcs 2pcs 2pcs 2pcs 2pcs 4pcs 2pcs 1pc 1pc 1pc 1pc 1pc 2pcs 1pc

Items	Specification	kW	Pcs/Units
	Temperature meters in digester Generated biogas flow meter Generated biogas pressure meter Filtrate flow meter		6pcs 1pc 1pc 1pc
4. Local SCADA system	Operator stations, engineering station, SCADA servers, PLCs, UPS, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.5 Mirzapur STP

(1) Assumption for preliminary design

In this site, upgrading the existing 14 MLD STP and establish of a new 18 MLD STP are planned, total capacity is 32MLD as average flowrate in 2030.

In existing 14 MLD, SBR process is added after the existing UASB, which continues to be used for saving operation expense. However, the SBR is designed to be capable of operating by itself.

For reducing cost and footprint, and for efficient operation, the chlorination facility and the sludge facility are a common between the 14MLD STP and the 18 MLD STP. To make a space for their footprint, a half of the existing oxidation pond is reclaimed. Although MPS-8 for 18 MLD STP was planned at the DPR, it is omitted, because all sewage as design flowrate can be conveyed directly from IPS-5.

Design parameters are shown in Table 9.3.24.

Table 9.3.24 Design Parameters for Proposed Mirzapur STP

Facility	Unit	Design Value	Remarks
1 Fine Screen			
(1) Opening	min	6	
(2) Passage velocity	m/sec	Less than 0.8	At peak flow
2 Grit Chamber			
(1) Surface Load	m^3/m^2/day	1000	At peak flow
3. SBR Tank			
(1) Temperature (min)	℃	20	
(2) No. of cycles per tank	Nos./day	5.0	
(3) Full liquid depth	m	5.5	At average flow
(4) Decant depth	%	30% 0f Full liquid depth	
(5) HRT	hour	16	At full liquid depth
(6) MLSS	mg/L	3,000	At full liquid depth
4. Chlorination Tank			
(1) Contact time	min	more than 30	
(2) Injection rate	mg/L	10.0	
5. Thickener		Gravity thickener	
(1) Sludge loading	kg/m2・day	40	

Facility		Unit	Design Value	Remarks
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

(2) Description of the 14 MLD STP

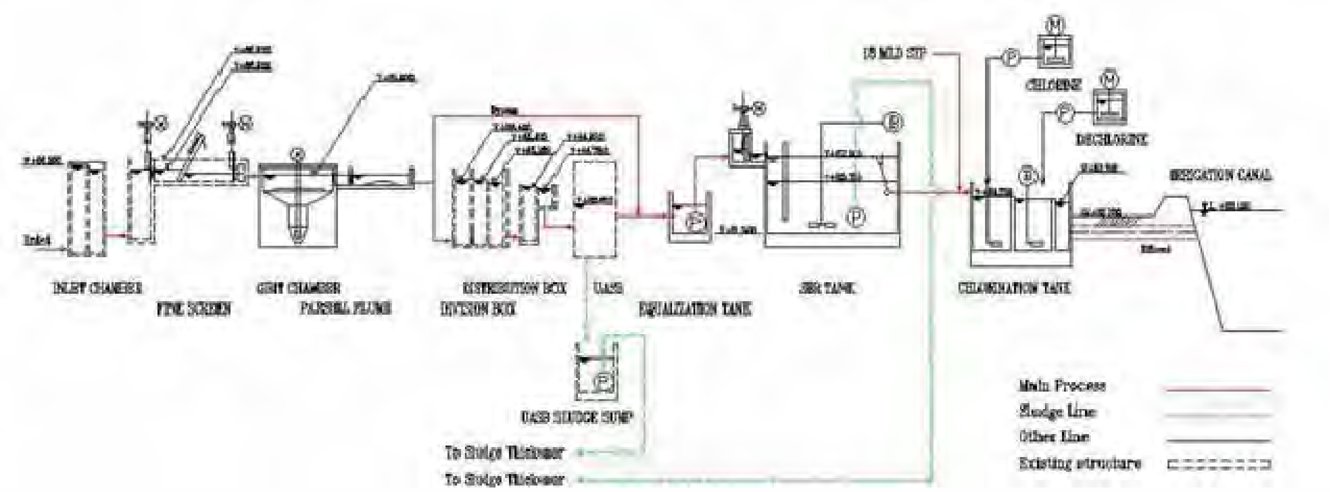


Figure 9.3.24 Schematic Process Diagram of Mirzapur 14 MLD STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, one Main Screen Channel, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume. The structure of the inlet chamber and fine screen are existing, however, a mechanical fine screen is replaced for aging and four gates are installed additionally at the upstream and downstream of the main/bypass screen channels. In the grit chambers, all structure and equipment are replaced and a Parshall Flume is added. Because the allowable footprint is narrow, Vortex type of grit cambers are adopted to save the footprint.

2) Biological Treatment (UASB, SBR)

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Mirzapur STP.

The process have to remove not only organic matter but also nitrogen to observe the new standards of effluent water quality, so that making aerobic and anoxic conditions in the SBR tank are required. There are two methods to do that generally, one is a method to operate anoxic and aeration time alternately in a cycle, the other is a method to establish the anoxic zone ahead of the main reactor in SBR tank. In either case, the required volume of SBR is larger than that of the SBR not to remove nitrogen. In this design, the later method is assumed, however, the SBR Tanks are also capable of the former method.

The existing UASB reactors continue to be used still and intended to reduce BOD and SS going to SBR Tanks as pre-treatment, however, the bypass line of UASB should be added, because SBR process may need more BOD as organic-carbon source for denitrification.

To relieve peak flow, Equalization Tank are added before the SBR, and the SBR's elevation is raised. Instead of that, CCT pumping station is omitted.

The SBR process has two tanks, and the HRT is 16 hours, which have increased from the value of the DPR.

The each series comprises one inlet gate, one SBR tank, one set of micro-bubble diffusers, one decanter, and one waste sludge pump in each unit. Further, six air blowers (two of them are for standby), are used as common to the two series.

Sludge generated at UASB and SBR is pumped up to common sludge thickener.

4) Chlorination Facility
The decanted water flows to common Chlorination Contact Tank (CCT) with the 18 MLD STP.

(3) Description of the 18MLD STP

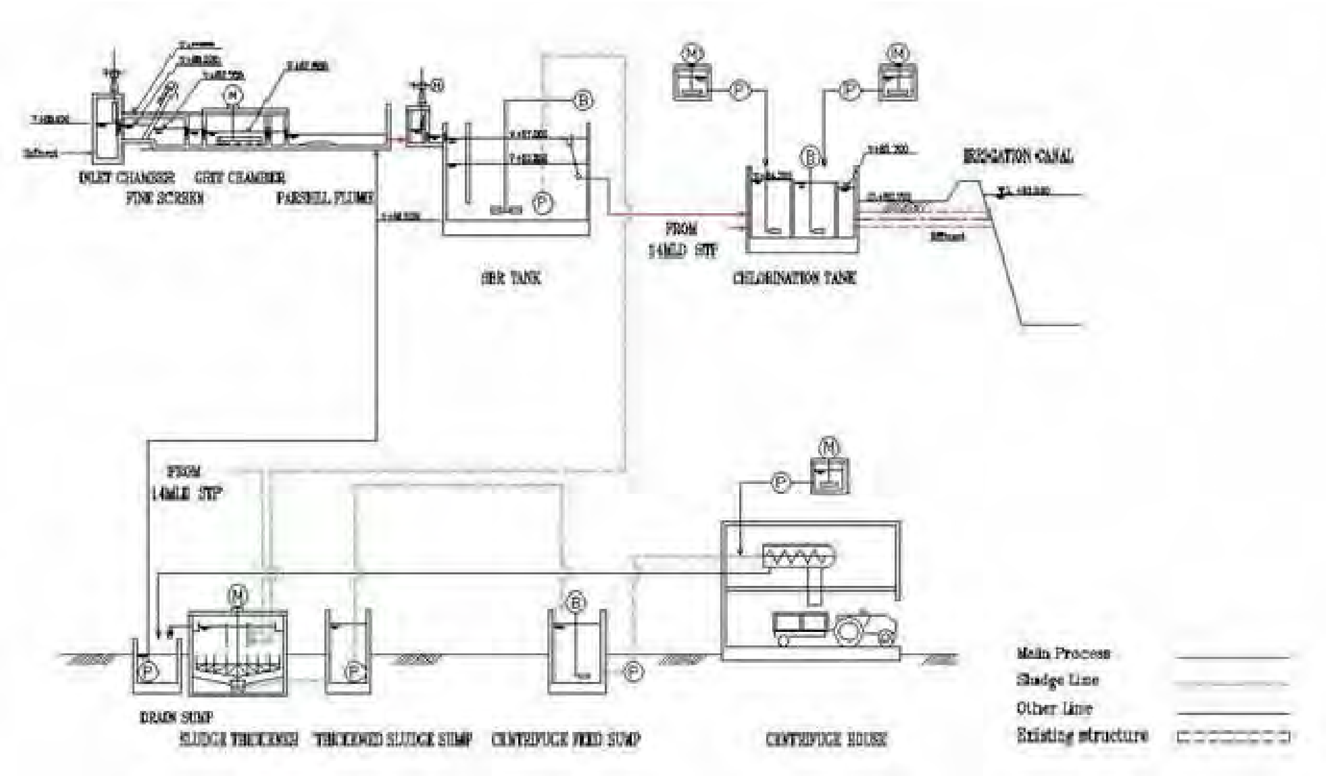


Figure 9.3.25 Schematic Process Diagram of Mirzapur 18 MLD STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, two Main Screen Channels, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume.

2) Biological Treatment

Although the details of design are not cleared in the DPR, in this design, the design HRT of SBR Tanks is determined to be 16 hours. The each unit comprises one inlet gate, one SBR tank, one set of micro-bubble diffusers, one decanter, and one waste sludge pump in each unit, so that cycle operation of filling, settling and decanting can be achieved. There are six numbers (4 working and 2 stand-by) air blowers proposed for four series SBR.

4) Chlorination facilities

The chlorine contact tank is designed as combined proposed 18 MLD STP and Existing 14 MLD STP due to efficient maintenance and saving expenses, HRT 30min, chlorine dosing rate 10 mg/l.

Although gas chlorination system is widely used in India, bleaching powder (Calcium Hypochlorite) dosing system are recommended due to more safety and easy operation. However, research of the purchase of chemicals is required at the detailed design.

5) Sludge treatment facilities

The sludge generated from the 14MLD STP and the 18 MLD STP is summarized and treated in common sludge treatment facilities to be concentrated for efficient operation and maintenance like the formation of the chlorine contact tank.

Sludge generated at the SBRs is transferred to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which have a capacity to continue operation of centrifuges in sufficient duration.

Centrifuges are introduced as dewatering equipment to the 14MLD and 18MLD STPs separately in the DPR. In this design, three Centrifuges having a capacity of 30 m3/h are proposed as common to the two STPs.

6) Electrical, instrumentation and SCADA

There are electricity power receiving/supply facilities proposed independently for both STPs with 14 MLD and 18 MLD. There are transformers with 630 kVA and 800 kVA introduced for 14 MLD STP and 18 MLD STP respectively to step down 11 kV to 415 V, while diesel generator sets with 500 kVA and 625 kVA are proposed for 14 MLD STP and 18 MLD STP respectively to back up essential equipment during power failure. The transformers and the diesel generator sets are to feed power to the equipment/facilities of the

STPs.

The incoming LV panels proposed for both the STPs are to receive power from the transformers and the diesel generator sets and distribute it to LV feeder panels followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers
- Residual chlorine analyzer
- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Thickened sludge feed flow meters (Centrifuge feed flow meters)
- Level meter in thickened sludge feed sump
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.25 Facility List of Proposed Mirzapur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**14 MLD STP**					
1	Inlet Chamber	1	4.0	5.5	4.0	0.5
2	Main Screen Channel	1	2.0	5.0	0.7	0.5
3	Bypass Screen Channel	1	***	***	***	***
4	Grit Chamber	2	3.0	-	3.0	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	Division Box	1	***	***	***	***
7	Distribution Box	4	***	***	***	***
8	UASB	2	17.0	28.0	5.5	***
9	Equalization Tank	1	7.0	30.0	2.0	0.5
10	DistributionChamber	1	3.0	3.5	2.0	0.5
11	SBR	2	29.0	30.0	5.5	1.0
12	UASB Sludge Sump	1	***	-	***	***
13	Filtrate Sump	1	***	-	***	***
14	Air Blower Room	1	12.0	25.0	6.0	-
B	**18 MLD STP**					
1	Inlet Chamber	1	3.2	4.5	2.0	0.5
2	Main Screen Channel	2	0.8	6.0	0.7	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.7	0.5
4	Grit Chamber	2	5.0	5.0	0.9	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	DistributionChamber	1	2.0	3.5	2.0	0.5
7	SBR	4	19.0	29.0	5.5	1.0
8	Air Blower Room	1	12.0	25.0	6.0	-
C	**Common**					
1	Chlorine Contact Tank	1	2.0	115.0	3.0	0.5
2	Sludge Thickener	2	13.5	-	4.0	0.5
3	Thickened Sludge Sump	2	2.5	2.5	3.0	0.5
4	Centrifuge Feed Sump	4	5.0	5.0	3.5	0.5
5	Sludge Drying Bed	4	***	***	***	***
6	Drain Sump	2	2.0	2.0	2.0	0.5
6	Chlorination Building	1	10.0	14.0	6.0	-
7	Centrifuge Building	1	16.0	30.0	10.0	-
8	Electrical Building	1	16.0	30.0	10.0	-

Source: JICA Survey Team

Table 9.3.26 Equipment List of Proposed Mirzapur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
[14MLD STP]				
1. Inlet Gates	Motorized Cast Iron	Width 0.8(m)×Height :0.8(m)	0.75	2W
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :2.0 (m)×SWD :0.67 (m) ×Open Space:6(mm)	2.20	1W
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :2.0 (m)×SWD:0.67 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Outlet Gates	Motorized Cast Iron	Width 0.8(m)×Height :0.8(m)	0.75	2W
6. Grit Chamber	Vortex Type SS304	Dia. :3.00 (m)	8.5	2W
7. SBR Feed Pumps	Submersible Non-clog impeller Cast Iron	Dia. :200 (mm)×Discharge:330(m3/h)×Total Head:8.0 (m)	15.0	4W+2S
8. SBR Inlet Gates	Motorized Cast Iron	Width 0.6(m)×Height :0.6(m)	0.75	2W
9. Decanter	Swing Type SS304	Width :29.0 (m)×Length :30.0(m)×SWD :5.5(m)	2.20	2W
10. Diffusers	Fine Bubble Membrane	SOR:608 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	2W
11. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2000(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
12. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :125 (mm)×Discharge:60(m3/h)×Total Head:5.0 (m)	2.2	2W+1S
13. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:12(m^3/h)×Total Head:7.0 (m)	1.5	2W+1S
14. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
[18MLD STP]				
15. Inlet Gates	Motorized Cast Iron	Width 0.6(m)×Height :0.9(m)	0.75	2W
16. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.7 (m) ×Open Space:6(mm)	1.5	2W
17. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.7 (m) ×Open Space:20(mm)	-	1S
18. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
19. Grit Chamber	Square Horizontal SS304	Width :5.0 (m)×Length :5.0(m)×SWD :0.6(m)	2.25	2W
20. SBR Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	4W
21. Decanter	Swing Type	Width :19.0 (m)×Length :29.0(m)×SWD :5.5(m)	2.20	4W

Items	Specification		kW	Pcs/Units
	SS304			
22. Diffusers	Fine Bubble Membrane	SOR:314 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	4W
23. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2200(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
24. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m3/h)×Total Head:5.0 (m)	1.5	4W+2S
25. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m^3/h)×Total Head:7.0 (m)	2.2	4W+2S
26. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
[Common]				
27. Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :300(l/h)×Total Head:20.0 (m)	0.4	2W+1S
28. Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :2.0 (m)×Length :2.0(m)× SWD :2.5(m)	2.2	2W
29. Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :130(l/h)×Total Head:20.0 (m)	0.4	2W+1S
30. Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :1.2 (m)×Length :1.2 (m)× SWD :1.5(m)	0.75	2W
31. Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :65 (mm)× Air Flow :120(m^3/h) ×Pressure: 45 (K Pa)	3.7	1W+1S
32. Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
33. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 13.5(m)×Height :4.0(m)	0.75	2W
34. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :70 (m^3/h)×Total Head:10.0 (m)	5.5	2W+2S
35. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :80 (mm)× Air Flow :210(m^3/h) ×Pressure: 40 (K Pa)	2.2	2W+1S
36. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :30 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
37. Centrifuge	Solids Bowl Type SS304	Capacity :30 (m3/h)	62.5	2W+1S
38. Crane for Centrifuge	Single-girder overhead	Capacity:5.0 (ton)×Lift:6.0 (m)	17.1	1W
39. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W

Items	Specification	kW	Pcs/Units
40. Polyelectrolyte Dosing System	Width :2.0 (m)×Length :2.0(m)×SWD :2.0(m)	2.2	2W
41. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity Dia.:40 (mm)×Discharge :0.83 (m3/h)×Total Head:20.0 (m) SS304	0.75	2W+1S
42. Filtrate Transfer Pumps	Submersible Dia:100 (mm)×Discharge :100(m^3/h)×Total Head:15.0 (m) Non-clog impeller Cast Iron	15.0	2W+2S
(Electrical)			
[14MLD STP]			
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV,630 kVA Diesel engine generator set: 415 V, 50 Hz, 500 kVA		1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 1, 800A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 9, 100A x 6, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 6pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers WAS (Waste Activated Sludge) flow meter		1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc
[18MLD STP]			
4. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 800 kVA Diesel engine generator set: 415 V, 50 Hz, 625 kVA		1pc 1pc 1pc 1pc
5. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 2 No.1 LV feeder panels: IP52, 600V, MCCB 200A x 7, 100A x 3 No.2 LV feeder panels: IP52, 600V, MCCB 400A x 2, 200A x 1, 100A x 5, Static capacitor 20kVar x 40kVar x 1, 80kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 1pc 6pcs 1pcs
6. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters		1pc 4pcs 4pcs 4pcs 4pcs

Items	Specification	kW	Pcs/Units
	DO analyzers MLSS analyzers Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge feed flow meters Level meter in thickened sludge feed sump Level meter in polyelectrolyte solution tank Polymer dosing flow meters		4pcs 4pcs 1pc 1pc 1pc 3pcs 1pc 2pcs 3pcs
7. Local SCADA system	Operator stations, PLCs, UPS, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.6 Vindhyachal STP

(1) Existing 4MLD STP

The sewage treatment process of existing STP is Wastewater Stabilization Ponds (WSP), which is said to be the simplest operation and lowest operational expense in sewage treatment processes. However, according to the operation record attached to the DPR, the treated water has not achieved to the expected level, BOD 20mg/l and TSS 30mg/l, even if influent flowrate is less than a half of 4MLD. Therefore, improvement of the performance is required for the STP to treat full capacity.

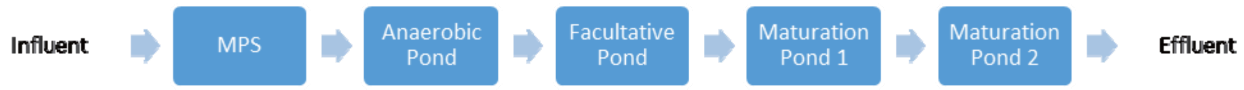


Figure 9.3.26 Process flow of existing Vindhyachal STP

(2) Description of the DPR's plan

As based on the DPR, the STP must increase a capacity from 4MLD to 6MLD and due to the revision of effluent standards its performance must be improved effluent water quality. In the DPR, the existing 4MLD STP is upgraded from WSP to Aerated Lagoon process, and for the remaining 2MLD, establishing new STP is proposed.

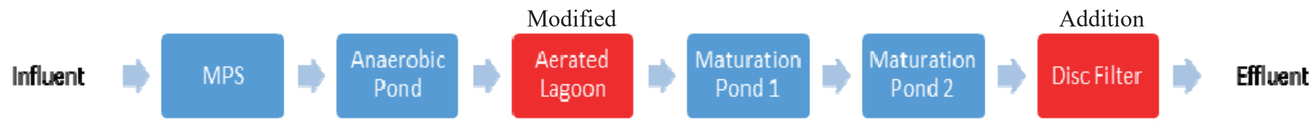


Figure 9.3.27 Process flow of Vindhyachal STP of DPR's plan

However, the plan has some shortcoming as follows:

- The upgrading 4MLD STP does not meet the new effluent standards of PCBC, since it does not have the performance of removing nitrogen.
- BOD/TSS at the inlet of the disc filters may be higher than the assumed value in the DPR; BOD 20mg/l, TSS 30mg/l are assumed.
- The two different sewage treatment processes make operation and operational expense inefficiency, since operation and maintenance for equipment increase.
- Footprint for expansion of future cannot be secured, because the proposed 2MLD STP needs large area for sludge treatment facilities, hence the area for future does not remain. In the DPR. (The layout plan of proposed 2MLD STP has not drawn.)
-

Figure 9.3.28 Layout at upgraded Vindhyachal STP (DPR plan)

Source: DPR for rehabilitation and process upgradation of existing STPs in Mirzapur.

(3) Comparison between DPR plan and alternative plan

To solve the matter mentioned above, SBR plan as alternative is proposed by JICA Survey Team, and the two plans are compared.

The comparison table is shown in Table 9.3.27, and the schematic process diagram and layout plan of SBR plan are shown in Figure 9.3.29, Figure 9.3.30 respectively.

Table 9.3.27 Comparison table of Vindhyacal STP plans

Plan	DPR plan	Alternative	Remarks
Process	4MLD Aerated Lagoon + 2MLD SBR	6MLD SBR	
Treated water quality	2 x 2	5 x 2	
	Not Capable of T-N removal.	Capable of T-N, BOD, TSS removal.	
Capital expense	4 x 2	4 x 2	
	Few difference	Few difference	
Operational expense	5 x 2	4 x 2	
	Less electrical power	More electrical power	
Easiness of maintenance	3 x 1	5 x 1	
	Inefficient for dispersed facility	Facility centralized	
Past records in India	3 x 1	5 x 1	
	Aerated lagoon is poor records	Many past records	
Total	28	36	

Evaluation Score: 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)

Importance Level: 2:High, 1:Moderate

Source: JICA Survey Team

As a result of the consideration above, 6MLD SBR plan is proposed.

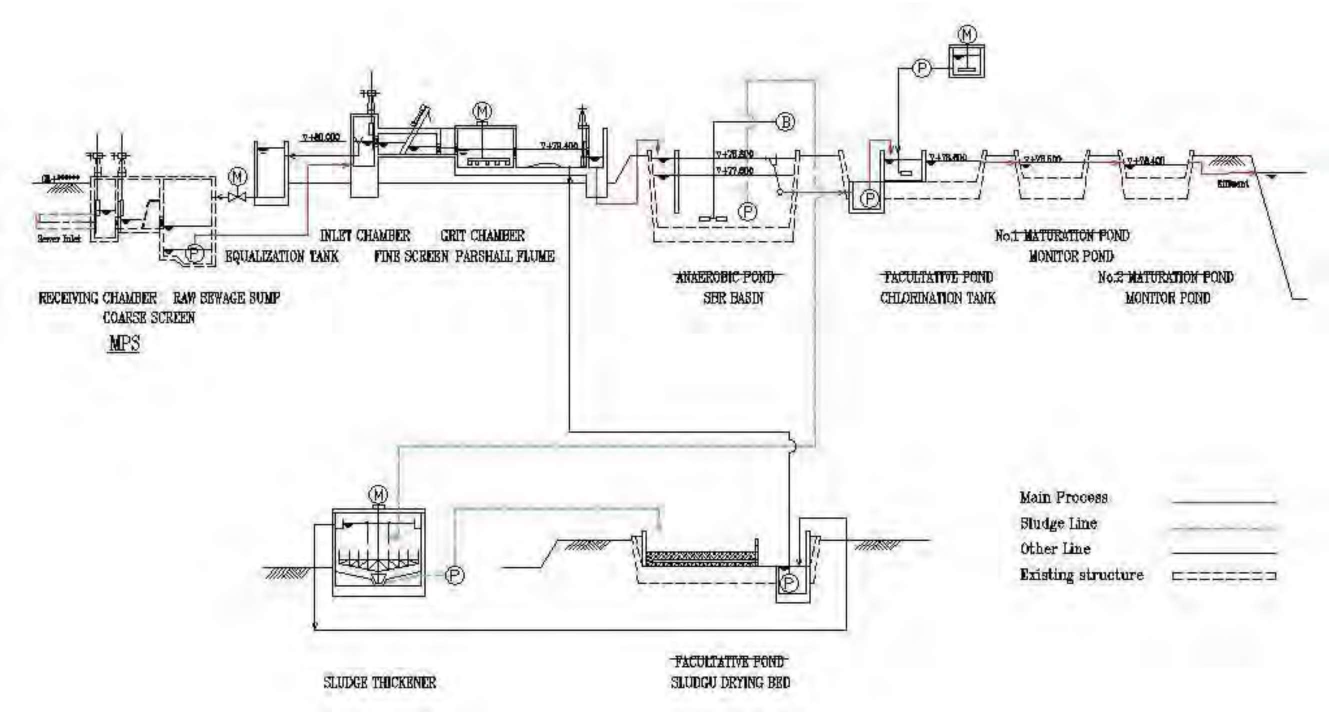
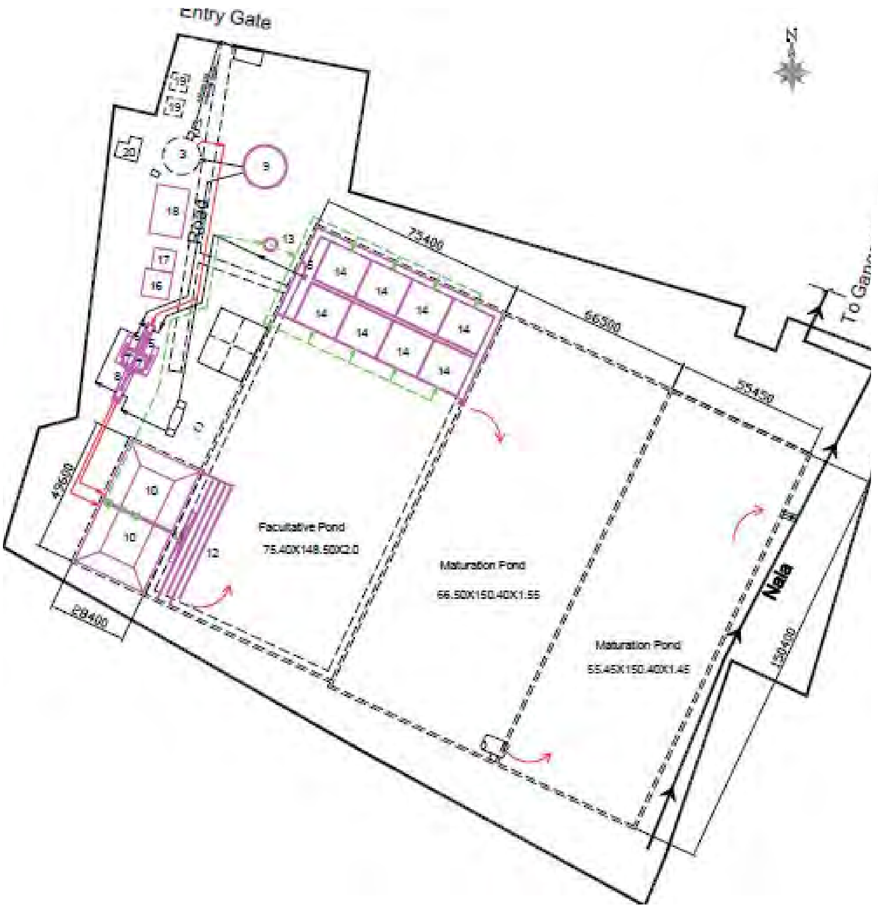


Figure 9.3.29 Schematic Process diagram of Proposed Vindhyachal STP (SBR plan)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
	MPS				
01	Inlet Chamber	1	1.1^{W}	2.6^{L}	3.4^{H}
02	Distribution Chamber	1	2.6^{W}	2.0^{L}	3.9^{H}
03	Wet Well	1	$6.5^{Dia.}$		6.5^{H}
	STP				
04	Inlet Chamber	1	2.1^{W}	2.5^{L}	1.8^{SDW}
05	Main Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
06	Bypass Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
07	Grit Chamber	2	3.0^{W}	3.0^{L}	0.6^{SDW}
08	Parshall Flume	1	0.8^{W}	6.0^{L}	0.7^{SWD}
09	Equalization Tank	1	$15.0^{Dia.}$		3.0^{SWD}
10	SBR *At middle depth	2	$*20.4^{W}$	$*20.4^{L}$	5.0^{SWD}
11	Decanted Water Pit	1	2.0^{W}	20.0^{L}	2.0^{SWD}
12	Chlorine Contact Tank	1	2.0^{W}	138.0^{L}	1.5^{SWD}
13	Sludge Thickener	1	$8.0^{Dia.}$		4.0^{SWD}
14	Sludge Drying Bed	8	15.0^{W}	16.0^{L}	2.5^{H}
15	Filtrate Sump	1	1.5^{W}	1.5^{L}	1.5^{H}
16	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
17	Chlorination Building	1	8.0^{W}	8.0^{L}	5.0^{H}
18	Administration Building	1	12.0^{W}	18.0^{L}	8.0^{H}
19	Staff Quarters	2	6.3^{W}	6.3^{L}	4.0^{H}
20	Laboratory	1	6.3^{W}	6.3^{L}	4.0^{H}

Figure 9.3.30 Layout plan of Proposed Vindhyachal STP (SBR plan)

Source: JICA Survey Tea

(2) Assumption of design

Design condition for the calculation is shown in Table 9.3.28, which bases on the DPR, however some design values are arranged by JICA survey Team. .

The calculations are referred to “Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION”, METCALF & EDDY/AECOM.

Table 9.3.28 Design Condition for Proposed Vindhyachal STP

Item	Design Value	
Flow Rate	6,000m3/d	
Temperature	20 ℃	
MLSS	3,000mg/l	
Water quality	Influent	Effluent
BOD	250mg/l	10mg/l
COD	450mg/l	50mg/l
TSS	400mg/l	10mg/l
VSS	280mg/l	-
T-N	40mg/l	10mg/l
NH4-N	25mg/l	2mg/l

Source: JICA Survey Team

(3) Design parameters

Table 9.3.29 Design Parameters for Proposed Vindhyachal STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.0	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Sludge Drying Bed**			
(1)	Drying duration	day	12	
(2)	Sludge loading	kg/m2	20	

Source: JICA Survey Team

(4) Description of the proposed STP

1) MPS

MPS exists in the STP site and continues to be used, however, sewage pumps, discharge pipes, and valves are replaced.

2) Headworks

The headworks facility comprises one Inlet chamber, one Main Screen channel, one Bypass Screen Channel, two Grit chambers, one Parshall Flume, and one Distribution Chamber. All structures and equipment are built newly, however, existing headworks facility remains for emergency. Manually operated gates before Main/Bypass Screen channels are installed for the maintenance of Fine Screen, "Step screen" type of openings 6mm.

2) Biological Treatment

As mentioned the above, the 6MLD SBR plan improved from existing anaerobic pond is adopted as compared to the DPR plan. The two SBR basins have the volume of HRT 16 hours, in which one set of micro-bubble diffusers, one decanter, one RAS pump, and one SAS pumps are installed. Further, three Air Blowers, two working and one standby, are proposed, which are used alternately for the two SBRs. Because the SBRs cannot have a buffering volume above itself, Equalization Tank is added separately to relieve peak flow. Decanted water from the SBR basin flows to Decanted Water Pit, which is built in the existing Facultative Pond, and then pumps up to Chlorine Contact Tank.

4) Disinfection

As the chemicals for chlorination, bleaching powder is proposed, which is more safety and easier operation than gas chlorination system. However, research of the purchase of chemicals will be necessary at the detailed design. Chlorination Contact Tank is built in the existing Facultative Pond that is demolished.

5) Sludge treatment facilities

The waste activated sludge is transferred from the SBR basin to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Sludge Drying Bed, which is built in the demolished Facultative Pond.

Table 9.3.30 Facility List of Proposed Vindhyachal STP

Sr. no	Unit	Quantity	Width /Dia	Length	Liquid Depth /Height	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	1.1	2.6	3.4	-
2	Distribution Channel	1	2.6	2.0	3.9	-
3	Wet Well	1	6.5	-	6.5	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	2.1	2.5	1.8	0.5
2	Main Screen Channel	1	0.8	6.0	0.5	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.5	0.5
4	Grit Distribution Chamber	1	2.1	1.0	0.6	0.5
5	Grit Inlet Channel	2	3.0	2.0	0.3	0.5
6	Grit Chamber	2	3.0	3.0	0.9	0.5
7	Grit Classifier Platform	2	2.0	10.0	-	-
8	Grit Outlet Channel	2	3.0	1.5	0.4	0.5
9	Parshall Flume	1	0.8	6.0	0.7	0.5
10	Bifurcation Chamber	1	2.1	3.0	2.0	0.5
11	Distribution Box	2	0.8	1.0	0.5	0.5
12	SBR Reactor *at middle water depth	2	20.4	20.4	5.0	0.5
13	Decanted Water Sump	1	2.0	20.0	2.0	0.5
14	Chlorine Contact Tank	1	2.0	138.0	1.5	0.5
15	Sludge Thickener	1	8.0	-	4.0	0.3
16	Sludge Drying Bed	8	15.0	16.0	2.5	-
17	Sludge Drying Bed (existing)	4	8.0	10.0	1.5	-
18	Filtrate Sump	1	1.5	1.5	1.5	-
B	**Buildings**					
19	Air Blower Room	1	10.0	10.0	4.0	-
20	Chlorination Building	1	8.0	8.0	5.0	-
21	Administration Building, including Electrical Room, DG Room,	1	12.0	18.0	8.0	-
22	Staff Quarters (existing)	2	6.3	6.3	4.0	-
23	Laboratory (existing)	1	6.3	6.3	4.0	-

Source: JICA Survey Team

Table 9.3.31 Equipment List of Proposed Vindhyachal STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
Inlet Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W
Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.5 (m) ×Open Space:6(mm)	2.20	1W
Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.5 (m) ×Open Space:20(mm)	-	1S
Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
Grit Chamber	Square Horizontal Type Cast Iron	Width :3.0 (m)×Length :3.0(m)×SWD :0.6(m)	2.25	2W
Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	2W
Decanter	Swing Type SS304	Width :20.4 (m) × Length :20.4(m) × SWD :5.0(m)	2.20	2W
Diffusers	Fine Bubble Membrane	SOR:225 (kg/h・basin)×setting Depth :4.5(m) ×Efficiency:27.5 %	-	2W
Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :1600(m^3/h) ×Pressure: 60 (K Pa)	55.0	2W+1S
RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:13(m3/h)×Total Head:5.0 (m)	1.5	2W+1S
SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:30(m^3/h)×Total Head:7.0 (m)	2.2	1W+1S
Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2W
Decanted Water Pumps	Submersible Non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:400(m^3/h)×Total Head:5.0 (m)	15.0	2W+2S
Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :200(l/h)×Total Head:20.0 (m)	0.4	2W+1S
Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.0 (m) × Length :1.0(m) × SWD :1.5(m)	0.4	2W
Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 8.0(m)×Height :4.0(m)	0.4	2W
Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :15(m^3/h)×Total Head:20.0 (m)	1.5	1W+1S
Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :20(m^3/h)×Total Head:15.0 (m)	1.5	1W+1S
(Electrical)				

Items	Specification	kW	Pcs/Units
Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 375 kVA		1pc 1pc 1pc 1pc
LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 10, Static capacitor 5kVar x 1, 10kVar x 1, 20kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 55 kW Raw sewage pump starter panels with Soft Starter, 37 k W MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 3pcs 3pcs 1pcs
Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge feed flow meter Polymer dosing flow meters		1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc
Local SCADA system	Operator stations, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.7 Ramnagar STP

Based on calculation sheets attached on Ramna and Ramnagar DPR (Both STP adopted CND), recalculated in light of the 2013CPHEEO manual.

Table 9.3.32 Facility List of Proposed Ramnagar STP in design year

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**Basins & Tanks**					
1	Inlet Chamber	1	3.2	3.5	2.0	0.5
2	Main Screen Channel	2	0.8	7.5	0.5	0.5
3	Bypass Screen Channel	1	0.8	7.5	0.5	0.5
4	Grit Chamber	2	4.0	4.0	0.8	0.5
5	Parshall Flume	1	1.5	10.0	0.7	0.5
6	Distribution Chamber	1	***	***	***	***
7	Anoxic Tank	2	8.0	29.0	5.0	0.5
8	Aerobic Tank	2	8.0	87.0	5.0	0.5
9	Secondary Clarifier	2	24.0	-	3.5	0.5
10	Chlorine Contact tank	1	2.0	70.0	2.0	0.5
11	Dechlorine Mixing tank	1	13.0	4.0	2.0	0.5
12	Secondary Sludge Sump	2	3.0	3.0	4.0	0.5
13	Sludge Thickener	2	9.0	-	4.0	0.5
14	Thickened Sludge Sump	2	3.0	3.0	3.0	0.5
15	Centrifuge Feed Sump	1	4.0	5.0	3.5	0.5
16	Filtrate Sludge Sump	1	3.0	3.0	3.0	0.5
B	**Buildings**					
17	Air Blower Room	1	12.0	25.0	6.0	
18	Chlorination building	1	10.0	15.0	6.0	
19	Centrifuge Building	1	12.0	18.0	10.0	
20	Administration Building	1	15.0	25.0	10.0	

Source: JICA Survey Team

Table 9.3.33 Design Conditions for Proposed Ramnagar STP

Facility	Unit	Design Value	Remarks
1 **Pump Sump**			
(1) Duration	min	8	
2 **Coarse Screen**			
(1) Opening	min	50	
(2) Passage velocity	m/sec	Less than 0.8	At peak flow
3 **Fine Screen**			
(1) Opening	min	6	
(2) Passage velocity	m/sec	Less than 0.8	At peak flow
4 **Grit Chamber**			
(1) Surface Load	$m^3/m^2/day$	100	at peak flow
5. **Aerobic Tank**			
(1) Temperature (min)	℃	20	
(2) MLSS	mg/L	3,000	
(3) SRT	day	4.83	
(4) HRT	hour	12.3	
(5) Return sludge ratio	%	60	
(6) Circulation ratio	%	60	
6. **Anoxic Tank**			
(1) HRT	hour	4.0	
7. **Secondary Clarifier**			
(1) Surface Load	$m^3/m^2/day$	15	or Equivalent Tube settler
8. **Chlorination Tank**			
(1) Contact time	min	more than 30	
(2) Injection rate	mg/L	10.0	
9. **Sludge Thickener**		Gravity thickener	
(1) Sludge loading	kg/m2・day	40	
10. **Dewatering**		Centrifuge	
(1) Operating time	hr/day	8.0	6days per a week
(2) Water contents	%	82	
(3) Polyelectrolyte dosage rate	%	0.15	

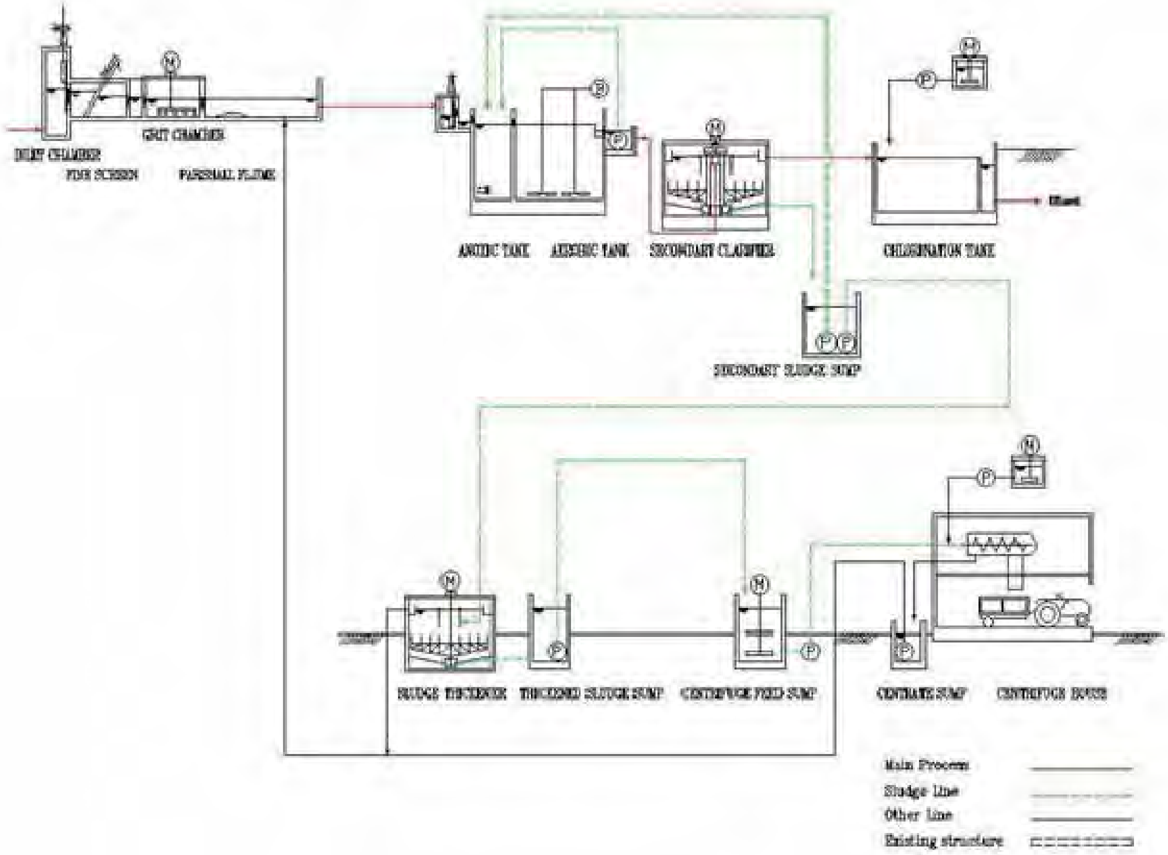


Figure 9.3.31 Schematic Process Diagram of Ramnagar STP

Source: JICA Survey Team

1) Headworks

Headworks facility comprises one Inlet chamber, two Fine screen channels, two Grit chambers, and one Parshall Flume. Inlet chamber, Fine screen and Grit chamber are designed in same design concept as Ramnagar STP. Manually operated gates before fine screen chambers are proposed for the maintenance of the screens. “Step screen” type of the fine screens with opening of 6mm and “square horizontal-flow” type of the grit removal facility, which have been installed across India, are adopted.

2) Anoxic & aerobic tank

Biological Treatment comprises anoxic tank, aerobic tank and secondary clarifier. Combination of these three parts enables both organic matter and nitrification removal. For stirring of Anoxic tanks, submersible mixers are adopted, since they are available at reasonable price without bases and supports at upper portion.

Aeration tanks are recommended to be Plug-flow reactors with the width of 7.2m, length of 160m and depth of 5.0m because it is more effective reaction and easy in maintenance of diffusers e.g. air flow adjustment. The Aerobic tanks are baffled channels that do not need to change the layout plan from the DPR. The oxygen transfer rate of the diffusers should be more efficient than 30.5% as fine bubble membrane type. Nitrified liquid is transferred to Anoxic tank from the pit following Aerobic tank by Circulation pump that is submersible type equipped with a screw impeller. The return sludge pumps are more than 60% of return rate, and circulation pumps are more than 110% of circulation rate.

3) Disinfection

Basing on the DPR, solution of bleaching powder is used for disinfection. The works of the chemical solution are manually operation. As design condition, effective concentration of chlorine 70%, dissolution concentration 2% are assumed. Two Solution tanks have 2 days of volume at 5mg/l of dosing rate. Chlorine Dosing Pump is Progress Cavity type that cannot be clogged by undissolved flour.

4) Sludge treatment facilities

Secondary sludge is transferred to sludge thickener and then thickened sludge is transferred to centrifuge facility. The operation period of a centrifuge is 8 hours per day, 6 days per week.

Table 9.3.34 Equipment List of Proposed Ramnagar STP

Items		Specification		kW	Pcs/Units
(Mechanical)					
1.	Inlet Gates	Manually Operated Cast Iron	Width 0.6(m)×Height :0.9(m)	-	2W
2.	Coarse Screens (Mechanical)	Climber Type SS304	Channel Width :1.0 (m)×SWD :0.80 (m) ×Open Space:20(mm)	1.50	2W
3.	Coarse Screens (Manual)	Manual Type SS304	Channel Width :1.0 (m)×SWD :0.80 (m) ×Open Space:50(mm)	-	2W
4.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5.	Sewage Pumps	Submersible, non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:375(m^3/h)×Total Head:20.0 (m)	55.0	2W+1S
6.	Sewage Pumps	Submersible, non-clog impeller Cast Iron	Dia. :150 (mm)×Discharge:188(m^3/h)×Total Head:20.0 (m)	22.0	1W+1S
7.	Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1W
8.	Inlet Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W+1S
9.	Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.80 (m)×SWD :0.50 (m) ×Open Space:6(mm)	1.50	2W
10.	Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.80 (m)×SWD:0.50 (m) ×Open Space:20(mm)	-	1S
11.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W

Items	Specification		kW	Pcs/Units
12. Grit Chamber	Square Horizontal SS304	Width :4.00 (m)×Length :4.00(m)×SWD :0.80 (m)	2.25	2W
13. Inlet Weir Gates	Manually Operated Cast Iron	Width 0.8(m)×Height :0.5(m)	-	2W
14. Mixers for Anoxic Tank	Submersible SS304	Width :8.0 (m)×Length :9.7(m)×SWD :5.0(m)	4.0	6W
15. Diffusers	Fine Bubble Membrane	SOR:127 (kg/h・basin)×setting Depth :4.7(m) ×Efficiency:28.5 %	-	2W
16. Air Blowers	Rotary blower Tri-lobe Type	Dia. :150 (mm)× Air Flow :900(m^3/h) ×Pressure: 60 (K Pa)	30.0	4W+2S
17. Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :100 (mm)×Discharge:125(m3/h)×Total Head:5.0 (m)	3.70	2W+2S
18. RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :100 (mm)×Discharge:125(m^3/h)×Total Head:5.0 (m)	3.70	2W+2S
19. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.50	2W+2S
20. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3W
21. Final Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 24.0(m)×Height :3.5(m)	1.5	2W
22. Mixers for chlorine solution	Vertical propeller	Width :1.50 (m)×Length :1.50(m)×SWD :1.50 (m)	1.50	2W
23. Chlorine dosing Pump	Progress Cavity	Dia.:15 (mm)×Discharge :100(L/h)×Total Head:20.0 (m)	0.40	2W+2S
24. Mixers for Dechlorine solution	Vertical propeller	Capacity :0.3 (m3)	0.10	2W
25. Dechlorine dosing Pump	Progress Cavity	Dia.:20 (mm)×Discharge :12(L/h)×Total Head:20.0 (m)	0.40	1W+1S
26. Air Blowers For Dechlorine Mixing Tank	Rotary blower Tri-lobe Type	Dia. :50 (mm)× Air Flow:104(m^3/h) ×Pressure: 35(K Pa)	2.20	1W+1S
27. Electric Hoist for Tonners		Rated Load :1.0(Ton)×Lift :6(m)	8.50	1W
28. Sludge Thickener	Bridge-supported Circular Clarifier Cast Iron	Dia. 9.0(m)×Height :4.0(m)	0.40	2W
29. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.50	2W+2S
30. Air Blowers For Thickened Sludge Sump	Rotary blower Tri-lobe Type	Dia. :65 (mm)× Air Flow:168(m^3/h) ×Pressure: 40 (K Pa)	3.70	1W+1S
31. Centrifuge Feed Pumps	Progress Cavity Cast Iron	Dia.:100 (mm)×Discharge :19(m^3/h)×Total Head:20.0 (m)	5.50	1W+1S

Items	Specification		kW	Pcs/Units
32. Centrifuge	Solis Bowl Type SS304	Capacity :19(m3/h)	44.5	1W+1S
33. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	17.10	1W
34. Polyelectrolyte Dosing System	Vertical propeller	Width :1.50 (m)×Length :2.0(m)×SWD :2.00 (m)	1.50	2W
35. Polyelectrolyte Dosing Pump	Progress Cavity	Dia.:20 (mm)×Discharge :0.52 (m3/h)×Total Head:20.0 (m)	0.40	1W+1S
36. Centrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	1.50	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 6, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 30 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters MLR (Mixed Liquor Recycle) flow meters Level meter in secondary sludge sump DO analyzers MLSS analyzers Chlorine dosing flow meters De-chlorine dosing flow meters Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meter Level meter in centrifuge sump Centrifuge feed flow meter Polymer dosing flow meters Filtrate flow meter			1pc 4pcs 2pcs 2pcs 2pcs 2pcs 1pc 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 1pc 2pcs 2pcs 1pc
4. Local SCADA system	Operator stations, SCADA/data servers, PLCs, Ethernet switch, etc.,			1ls

Source: JICA Survey Team

9.3.8 Chunar STP

Based on calculation sheets attached on Chunar DPR and other DPRs which employed SBR process, recalculation was made in light of the 2013CPHEEO manual.

Table 9.3.35 Facility List of Proposed Chunar STP

Sr. no	Unit	Quantity	Width /Dia	Length	Liquid Depth /Height	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	2.0	3.7	1.0	-
2	Main Screen Channel	1	0.8	7.5	0.7	-
3	Bypass Screen Channel	1	0.8	7.5	0.7	-
4	Wet Well	1	8.0	-	-	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	2.1	2.5	1.8	0.5
2	Main Screen Channel	1	0.8	6.0	0.5	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.5	0.5
4	Grit Distribution Chamber	1	2.1	1.0	0.6	0.5
5	Grit Inlet Channel	2	3.0	2.0	0.3	0.5
6	Grit Chamber	2	3.0	3.0	0.9	0.5
7	Grit Classifier Platform	2	2.0	10.0	-	-
8	Grit Outlet Channel	2	3.0	1.5	0.4	0.5
9	Parshall Flume	1	0.8	6.0	0.7	0.5
10	Bifurcation Chamber	1	2.1	3.0	2.0	0.5
11	Distribution Box	2	0.8	1.0	0.5	0.5
12	SBR	2	20.0	20.0	5.5	1.0
13	Chlorine Contact Tank	1	2.0	120.0	2.0	0.5
14	Dechlorine Mixing Tank	1	15.0	5.0	2.0	0.5
15	Sludge Thickener	1	8.5	-	4.0	0.5
16	Thickened Sludge Sump	1	1.5	2.0	2.0	0.5
17	Centrifuge Feed Sump	2	3.0	4.0	3.0	0.5
18	Filtrate Sump	1	1.5	1.5	1.5	0.5
B	**Buildings**					
19	Air Blower Room	1	10.0	10.0	4.0	-
20	Chlorination Building	1	8.0	15.0	5.0	-
21	Centrifuge Building	1	8.0	15.0	8.0	-
22	Administration Building, including Electrical Room, DG Room,	1	12.0	18.0	8.0	-

Source: JICA Survey Team

Table 9.3.36 Design Parameters for Proposed 6.5 MLD Chunar STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	m^3/m^2/day	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.5	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

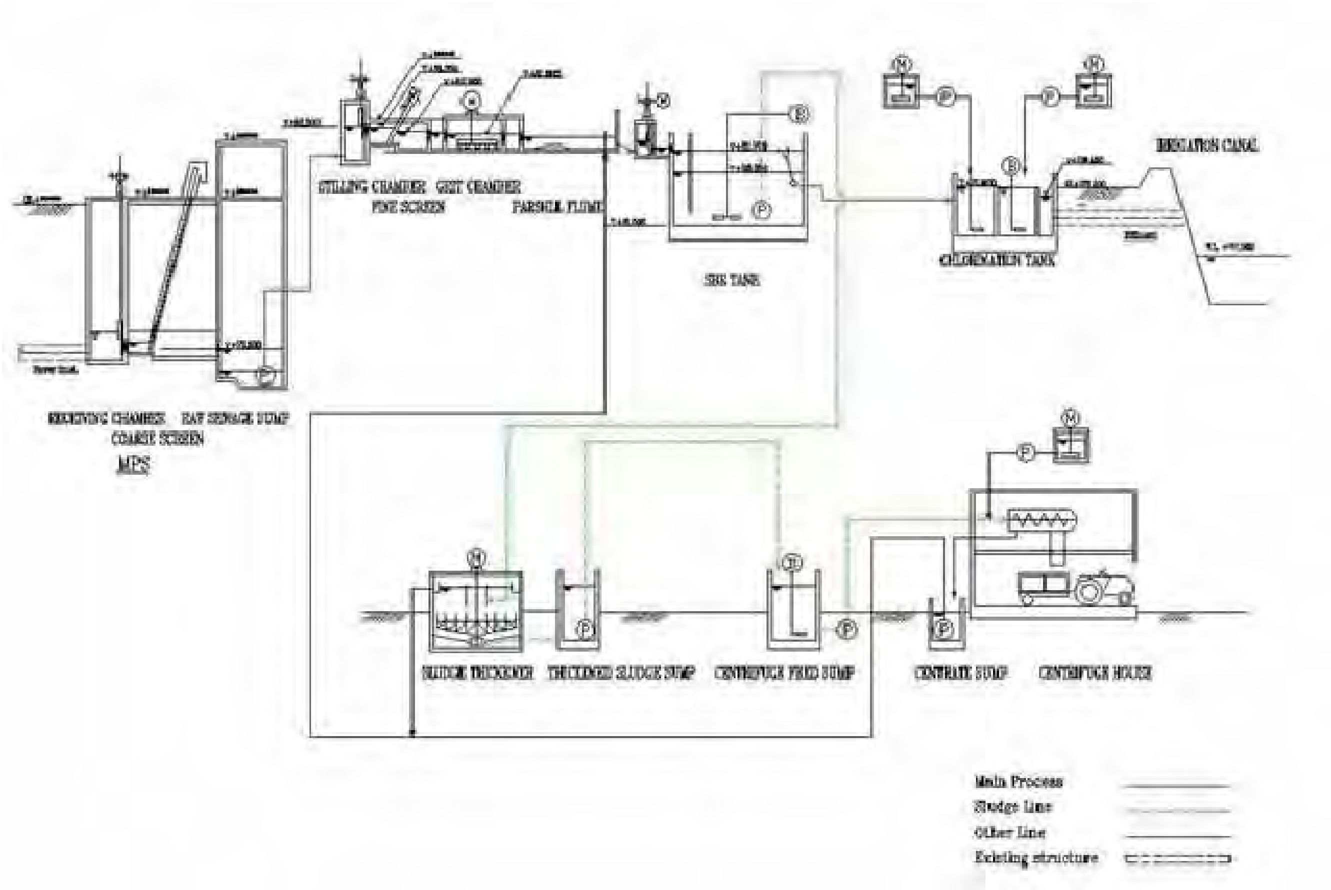


Figure 9.3.32 Schematic Process Diagram of Chunar STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet chamber, one Main Screen Channel, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume.

2) Biological Treatment

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Chunar STP. For removing nitrogen, the two SBR tanks have the volume of HRT 16 hours which were extended from the original design of DPR. The each unit comprises one inlet gates, one selector, one SBR tank, one set of micro-bubble diffuser, one decanter, and one waste sludge pumps in each unit, by which cycle operation of filling, settling and decanting can be achieved. Further, three numbers (2 working and 1 standby) air blowers were proposed.

4) Disinfection

As the chemicals for chlorination, bleaching powder is proposed, which has been changed from gas chlorination system. DPR proposes the system due to safety and easy operation. However, research of the purchase of chemicals will be necessary at the detailed design.

5) Sludge treatment facilities

The waste activated sludge is transferred from the SBR tank to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which should keep the volume to operate the centrifuges for sufficient duration. Centrifuges are introduced as dewatering units to the proposed and the existing STPs separately in the DPR. The generated sludge and the capacity of the facilities were increased from DPR after review.

6) Electrical, instrumentation and SCADA

There is a transformer with 500 kVA and a diesel generator set with 300 kVA provided for the 6.5 MLD STP as the power receiving/supply facilities. The diesel generator set is to back up essential equipment during power failure. The transformer and the diesel generator set are to feed power to the equipment/facilities of the STPs.

The incoming LV panels proposed for the STP is to receive power from the transformer and the diesel generator set and distribute it to LV feeder panel followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers
- Chlorine doing flow meter
- Residual chlorine analyzer

- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Level meter in thickened sludge sump
- Thickened sludge flow meters
- Level meter in centrifuge sump
- Centrifuge feed flow meters
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters
- Filtrate flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.37 Equipment List of Proposed Chunar STP

Items		Specification		kW	Pcs/Units
(Mechanical)					
1.	Inlet Gates	Manually Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W
2.	Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.5 (m) ×Open Space:6(mm)	2.2	1W
3.	Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.5 (m) ×Open Space:20(mm)	-	1S
4.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5.	Grit Chamber	Square Horizontal SS304	Width :3.0 (m)×Length :3.0(m)×SWD :0.6(m)	2.25	2W
6.	SBR Inlet Gates	Motorized Cast Iron	Width 0.3(m)×Height :0.3(m)	0.4	2W
7.	Decantor	Swing Type SS304	Width :20.0 (m)×Length :20.0(m)×SWD :5.5(m)	2.20	2W
8.	Diffusers	Fine Bubble Membrane	SOR:242 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	2W
9.	Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :1600(m^3/h) ×Pressure: 65 (K Pa)	55.0	2W+1S
10.	RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:14(m3/h)×Total Head:5.0 (m)	1.5	2W+1S
11.	SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:30(m^3/h)×Total Head:7.0 (m)	2.2	2W+1S
12.	Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
13.	Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :200(l/h)×Total Head:20.0 (m)	0.4	2W+1S
14.	Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.0 (m)×Length :1.0(m)× SWD :1.5(m)	0.4	2W
15.	Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :20(l/h)×Total Head:20.0 (m)	0.4	2W+1S
16.	Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :0.8 (m)×Length :0.8 (m)× SWD :0.8(m)	0.2	2W
17.	Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :75(m^3/h) ×Pressure: 35 (K Pa)	1.5	1W+1S
18.	Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
19.	Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 8.5(m)×Height :4.0(m)	0.75	2W
20.	Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :20 (m^3/h)×Total Head:10.0 (m)	1.5	1W+1S

Items	Specification		kW	Pcs/Units
21. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :90(m^3/h) ×Pressure: 40 (K Pa)	3.7	1W+1S
22. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :12 (m3/h)×Total Head:20.0 (m)	3.7	1W+1S
23. Centrifuge	Solids Bowl Type SS304	Capacity :12 (m3/h)	19.7	1W+1S
24. Crane for Centrifuge	Single-girder overhead	Capacity:3.0 (ton)×Lift:6.0 (m)	8.5	1W
25. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
26. Polyelectrolyte Dosing System		Width :1.0 (m)×Length :1.5(m)×SWD :2.0(m)	2.2	2W
27. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.32 (m3/h)×Total Head:20.0 (m)	0.4	1W+1S
28. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :30(m^3/h)×Total Head:15.0 (m)	3.7	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 10, Static capacitor 10kVar x 1, 20kVar x 1, 40kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 55 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow meter Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meters Level meter in centrifuge sump Centrifuge feed flow meters Level meter in polyelectrolyte solution tank			1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 2pcs 2pcs

Items	Specification	kW	Pcs/Units
	Polymer dosing flow meters Filtrate flow meter		2pcs 1pc
4. Local SCADA system	Operator stations, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.9 Ghazipur STP

Adopted STP process is SBR process. Based on calculation sheets attached on Chunar DPR and other SBR adopted DPR, recalculation was made in light of the 2013CPHEEO manual.

Table 9.3.38 Facility List of Ghazipur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	2.5	3.7	2.0	-
2	Main Screen Channel	2	1.0	7.5	0.7	-
3	Bypass Screen Channel	1	1.0	7.5	0.7	-
4	Wet Well	1	12.0	-	-	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	3.2	4.5	2.0	0.5
2	Main Screen Channel	2	0.8	6.0	0.7	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.7	0.5
4	Grit Chamber	2	5.0	5.0	0.9	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	DistributionChamber	1	2.0	3.5	2.0	0.5
7	SBR	4	17.0	33.0	5.5	1.0
8	Chlorine Contact Tank	1	2.0	156.0	2.0	0.5
9	Dechlorine Mixing Tank	1	7.0	15.0	2.0	0.5
10	Sludge Thickener	2	7.5	-	4.0	0.5
11	Thickened Sludge Sump	2	2.0	1.5	2.0	0.5
12	Centrifuge Feed Sump	2	4.0	5.0	3.0	0.5
13	Centrate Sump	2	2.0	2.0	2.0	0.5
B	**Buildings**					
14	Air Blower Room	1	12.0	25.0	6.0	-
15	Chlorination Building	1	10.0	15.0	6.0	-
16	Centrifuge Building	1	10.0	25.0	10.0	-
17	Administration/Electrical Building	1	16.0	25.0	10.0	-

Source: JICA Survey Team

Table 9.3.39 Design Parameters for Proposed 18 MLD Ghazipur STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	m^3/m^2/day	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.5	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

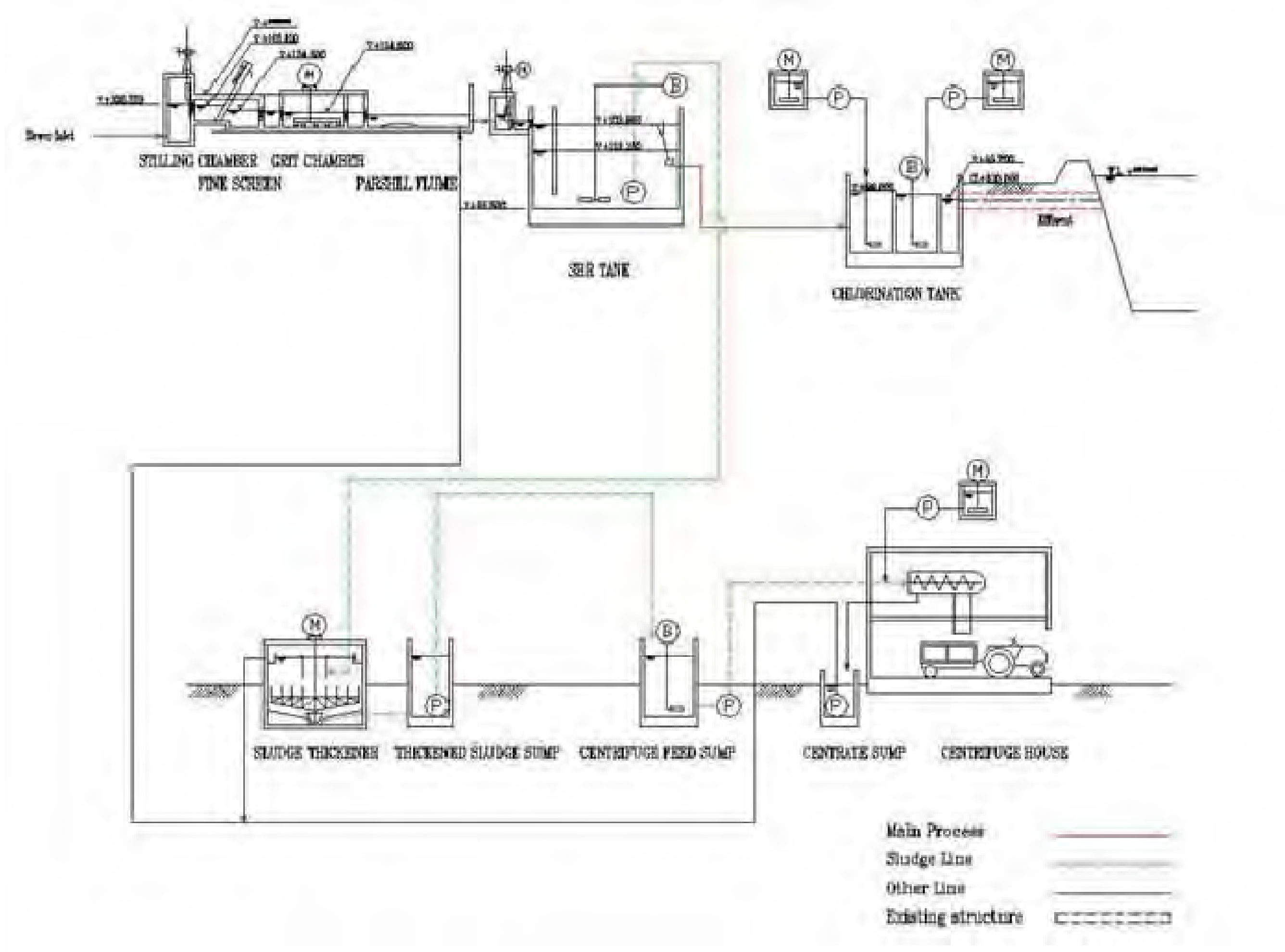


Figure 9.3.33 Schematic Process Diagram of Ghazipur STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, two Main Screen Channels, one Bypass Screen Channel, two Grit Chambers, and one Parshall Flume.

2) Biological Treatment

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Ghazipur STP. For removing nitrogen, the four SBR tanks have the volume of HRT 16 hours, which have increased from the original design of DPR. The each unit comprises one inlet gates, one selector, one SBR tank, one set of micro-bubble diffuser, one decanter, and one waste sludge pump in each unit, so that cycle operation of filling, settling and decanting can be achieved. Further, six numbers (4 working and 2 standby) air blowers were proposed.

3) Disinfection

Regarding the chemicals for chlorination, bleaching powder is proposed, which has been changed from gas chlorination system DPR proposes due to safety and easy operation. However, research of the purchase of chemicals will be necessary at the detailed design.

4) Sludge treatment facilities

The waste activated sludge is transferred from the SBR tank to Sludge Thickeners for stabilization and reducing the volume. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which should keep the volume to operate the centrifuges for sufficient duration. Two units of Centrifuges are introduced as dewatering units to the proposed system with a unit capacity of 10 m^3/h.

5) Electrical, instrumentation and SCADA

There are a transformer with 630 kVA and a diesel generator set with 500 kVA provided for the 18 MLD STP as the power receiving/supply facilities. The diesel generator set is to back up essential equipment during power failure. The transformer and the diesel generator set are to feed power to the equipment/facilities of the STP.

The incoming LV panels proposed for the STP is to receive power from the transformer and the diesel generator set and distribute it to LV feeder panel followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters in pump wet well
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers

- Chlorine doing flow meter
- De-chlorine doing flow meter
- Residual chlorine analyzer
- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Level meter in thickened sludge sump
- Thickened sludge flow meters
- Level meter in centrifuge sump
- Centrifuge feed flow meters
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters
- Filtrate flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.40 Equipment List of Proposed Ghazipur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Cast Iron	Width 0.6(m)×Height :0.9(m)	-	3W
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.7 (m) ×Open Space:6(mm)	1.5	2W
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.7 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Grit Chamber	Square Horizontal SS304	Width :5.0 (m)×Length :5.0(m)×SWD :0.6(m)	2.25	2W
6. SBR Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	4W
7. Decantor	Swing Type SS304	Width :17.0 (m)×Length :33.0(m)×SWD :5.5(m)	2.20	4W
8. Diffusers	Fine Bubble Membrane	SOR:357 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	4W
9. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2400(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
10. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m3/h)×Total Head:5.0 (m)	1.5	4W+2S
11. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:25(m^3/h)×Total Head:7.0 (m)	2.2	4W+2S
12. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
13. Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :300(l/h)×Total Head:20.0 (m)	0.4	2W+1S
14. Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.7 (m)×Length :1.7(m)× SWD :2.0(m)	1.5	2W
15. Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :30(l/h)×Total Head:20.0 (m)	0.4	2W+1S
16. Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :1.0 (m)×Length :1.0 (m)× SWD :1.5(m)	0.4	2W
17. Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :65(m^3/h) ×Pressure: 45 (K Pa)	2.2	1W+1S
18. Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
19. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 7.5(m)×Height :4.0(m)	0.4	2W
20. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :11(m^3/h)×Total Head:10.0 (m)	1.5	2W+2S

Items	Specification		kW	Pcs/Units
21. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :65 (mm)× Air Flow :150(m^3/h) ×Pressure: 40 (K Pa)	3.7	1W+1S
22. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :10 (m3/h)×Total Head:20.0 (m)	3.7	2W+1S
23. Centrifuge	Solids Bowl Type SS304	Capacity :10 (m3/h)	18.7	2W+1S
24. Crane for Centrifuge	Single-girder overhead	Capacity:3.0 (ton)×Lift:6.0 (m)	8.5	1W
25. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
26. Polyelectrolyte Dosing System		Width :1.5(m)×Length :1.5(m)×SWD :2.0(m)	1.5	2W
27. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.26 (m3/h)×Total Head:20.0 (m)	0.4	2W+1S
28. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.5	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 630 kVA Diesel engine generator set: 415 V, 50 Hz, 500 kVA			1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 1, 800A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 8, 100A x 9, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters in pump wet well Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow meter De-chlorine dosing flow meter Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meters Level meter in centrifuge sump			1pc 2pcs 4pcs 4pcs 4pcs 4pcs 4pcs 4pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 1pc

Items	Specification	kW	Pcs/Units
	Centrifuge feed flow meters Level meter in polyelectrolyte solution tank Polymer dosing flow meters Filtrate flow meter		3pcs 2pcs 3pcs 1pc
4. Local SCADA system	Operator stations, SCADA/data servers, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.10 Summary Table of STP

Table 9.3.41 shows the result of the preliminary design for STPs. Effluent water quality from each STPs is in compliant with the New Effluent Standard which was disclosed in 2016 in CPHEEO.

In the table, Saidpur was excluded from the list due to no prospect of getting the site lot as well as no submission of DPR.

Table 0.1 Summary table of STP based on DPRs

STP Spec from DPR | Update: 22th-May.-2017

Item			Varanasi			Mirzapur				Ghazipur STP	Ramnagar STP	Chunar STP	Saidpur STP	New Standard (Planned)
			Dinapur STP	Bhagwanpur STP	RamnaSTP	Mirzapur STP (old)	Mirzapur STP (new)	Vindhyachal STP (old)	Vindhyachal STP (new)					
Base Year		-	2020	2020	2020	2020		2020		2015	2020	2020		
Target Year		-	2030	2030	2050	2050		2050		2045	2050	2050		
Project Area		ha	-	-	-	1,795.44		292.82		2000	494.66	831.2		
Population Projection		no.	-	-	-	347,938		75,686		205,000	118,503	80,000		
Density of Population		no./ha	-	-	-	193.8		258.5		102.5	239.6	96.2		
Unit Rate of water supply		lpcd	150	150	150	135		135		135	135	135		
Sewage Generation (Daily Ave.)		MLD	-	-	-	41		9		24.36	14.06	9.48		
STP Spec	Existing	MLD	80	8	-	14	-	4	-	-	-	-		
	Future	MLD	80	8	50	14 (2030)	18 (2030)	4	2 (2030)	18 (2025)	13 (2050)	6.5 (2030)		
Raw Sewage Quality	pH	-	6-8	6-8	7-8	7-8	7-8	7-8		6-8	7-7.5	7-8		
	COD	mg/l	450	450	350	450	450	450		450	450	450		
	BOD	mg/l	250	250	200	250	250	250		250	250	250		
	SS	mg/l	400	400	600	400	400	400		250	400	400		
	NH_4-N	mg/l	37	37	25	25	25	25		25	10	25		
	TK-N	mg/l	50	50	40	40	40	40		35	30	35		
	Fecal Coliform	MPN/100 ml	10^8	10^8	10^7	10^8	10^8	10^8		10^8	10^8	10^8		
Treated Effluent Quality	pH	-	6.5-9	6.5-9	6.5-9	6.5-9	6.5-9	6.5-9		6.5-9	6.5-9	6.5-9		6.5-9
	COD	mg/l	≦50	≦50	≦50	≦50	≦50	≦50		≦50	≦50	≦50		≦50
	BOD	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	SS	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	NH_4-N	mg/l	≦5	≦5	≦5	≦5	≦5	≦5		≦5	≦5	≦5		≦5
	T-N	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	Fecal Coliform	MPN/100 ml	<230	<230	<230	<230	<230	<230		<230	<230	<230		<230
Sewage Treatment Process	Existing	-	ASP	ASP	-	UASB	-	WSP	-	-	-	-		
	Proposed in DPR		CND (Single-stage)	Advanced SBR	CND (Single-stage)	UASB +SBR	SBR	Aerated Lagoon	SBR	Advanced SBR	CND (Single-stage)	SBR		
	Proposed in JICA survey team		CND (Double-stage)	CND (Single-stage)		UASB +Advanced SBR	Advanced SBR	Advanced SBR				Advanced SBR		
		-			OK					OK	OK			
Disinfection Process		-	Chlorine Contact											
Sludge Treatment Process		-	Thickener Digestion Centrifuge / SDB	Thickener Digestion Centrifuge / SDB	Thickener Digestion SDB	Thickener Digestion Centrifuge / SDB		Sludge drying bed		Thickener Digestion Centrifuge	Thickener Digestion Centrifuge	Thickener Digestion Centrifuge		

Source: JICA Survey Team

9.4 SCADA system

1) Ramna STP

a) Local SCADA system at Ramna STP

There is no plan about instrumentation, PLC for automatic control of the plant equipment, and SCADA system for the Ramna STP in DPR. It is preferable to introduce the instrumentation, the PLC, and the SCADA system into the Ramna STP for effective and/or smooth operation and maintenance of the STP so that the STP would be in the similar condition with the on-going 140 MLD Dinapur STP.

There are three PLCs proposed to control and monitor the plant equipment in redundant hot standby formation at the electrical sub-station for head works and primary clarifiers, the blower house for the liquid process and the sludge treatment house for sludge process respectively. The instrumentation devices, such as flow meters, level meters, water quality analyzers etc., are proposed at the field level as sensors in the treatment plant to the PLCs to enable an automatic control of plant processes. The PLCs can control the plant processes in the auto mode according to a sequential control logic and/or a set-point control logic programmed in association of the instrumentation devices at the field level as mentioned above.

A PC based operator station is proposed as core component of the local SCADA system for the Ramna STP at the control room of the administration building. The operator station functions as HMI (Human-machine interface), engineering the system, reporting the plant equipment statuses and process values, alarming the abnormal conditions of the plant equipment and the process values. Further, there are a printer and an Ethernet Hub switch at the control room of the administration building for reporting and alarming, and interconnecting the SCADA system components respectively.

b) Master SCADA system at Ramna STP

Since there are many intermediate pump stations and STPs in Varanasi as follows, it is proposed to establish the master SCADA centre at the Ramna STP for monitoring the sewerage facilities entirely within Varanasi service area.

- Dinapur STP with 80 MLD at District I (existing)
- Five (5) Ghat Pump Stations, viz Harischandra SPS, Mansarovar SPS, Dr. R.P. Ghat SPS, Jalesan Ghat SPS, Trilochan Ghat SPS,
- Konia Main Pump Station
- Dinapur STP with 140 MLD (on-going, expansion within the existing Dinapur STP campus)
- Three pump stations (on-going), viz Chaukaghat pump station with 140 MLD, Phulwaria pump station with 7.6 MLD and Saraiya pump station with 3.7 MLD
- Bhagwanpur with 8.0 MLD (existing), which will be decommissioned at the end of its useful life,
- Diesel Locomotive Works (DLW) STP with 120 MLD (on-going under JNNURM funding project)

- Golthaha STP with 120 MLD (under construction in JNNURM funded project)

The master SCADA system comprises the components as follows;

- Operator station functioning as HMI
- Front end processor functioning as interface between the local SCADA systems at each intermediate pump station and each STP to reduce the burden of the servers,
- SCADA servers in redundant hot standby formation functioning as engineering the SCADA system, reporting the plant equipment statuses and abnormal conditions at daily, monthly yearly basis,
- LCD large screen functioning as demonstration for operating staffs and visitors so that a lot of people can see the graphics showing the plant equipment statuses simultaneously.
- Ethernet Hub switch interconnecting the components to control data transmission,
- Router and fibre optic cable patch panel functioning as data transmission terminal device through which data can be transferred from the outstations to the master SCADA centre,
- UPS (Uninterruptible Power Supply) system,

A router, a fibre optic cable patch panel and fibre optic cable will be provided as data transmission medium and terminal device on the Master SCADA system by an internet service provider, who may offer a reliable internet service in Varanasi. The fibre optic cable is suitable data transmission medium in dealing with big data volume at like the master SCADA centre. In the meantime, a GSP based GPRS module is applied as a data transmission terminal device to the local SCADA system of outstations, which are integrated into the master SCADA system. Existing IPSs such STPs will be integrated into the master SCADA centre when they are rehabilitated/replaced in future.

The master SCADA system configuration is shown in Figure 9.4.1 below.

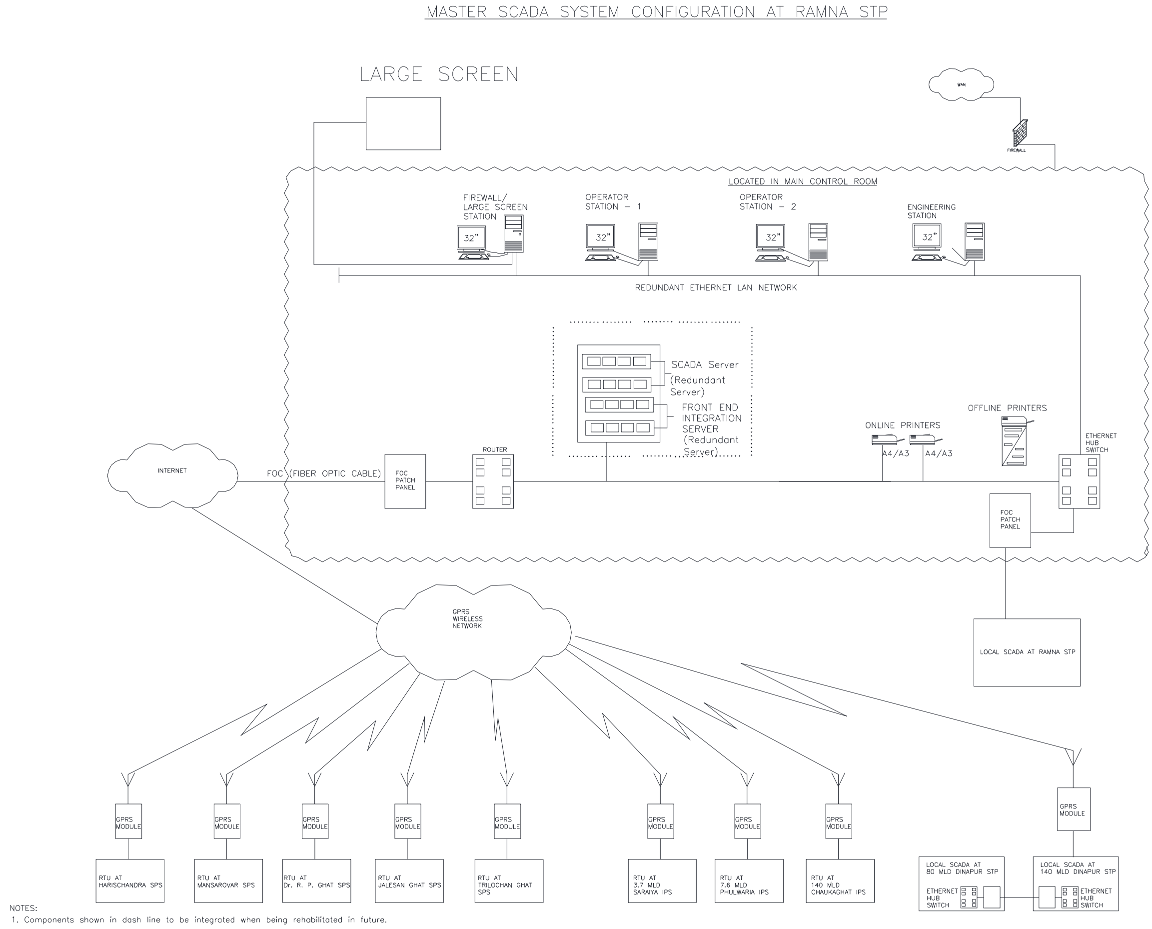


Figure 9.4.1 Master SCADA System Configuration

2) Other STPs

The local SCADA system at the on-going 140 MLD STP at Dinapur is under implementation in the Package 3 of GAP II of JICA assisted project. The system configuration is almost same as that of the Ramna STP. The local SCADS system at the existing 80 MLD Dinapur STP will be established in the same formation of that of the Ramna STP.

The local SCADA system at proposed STPs for other municipal councils such as Mirzapur, Ramnagar, Systems in Chunar, and Ghazipur will be established in the same concept of that of Ramna STP.

3) Pump Stations

A PLC based control and monitoring system will be established at the five Ghat pump stations and the three on-going pump stations to integrate them into the master SCADA system. The PLC and the GPRS module are mounted in a control panel, on which a LCD touch screen is flush mounted to function as HMI.

CHAPTER 10 Operation and Maintenance of Sewerage Facilities

<Objective of the study>

The followings are confirmed/studied in this Chapter: 1) Confirmation of current practice of the sewerage sector, 2) Guidelines for the O&M, 3) Existing sewerage assets, 4) Performance Indicator, 5) O&M costs, 6) Capacity building, 7) Training Plan,

<Result of the study>

Based on the collected information and analysis on it, Survey Team is suggesting some improvement plans in performance indicators, effluent quality, modification of responsibilities, capacity building as well as training plans.

10.1 Introduction

Sewerage facilities to be operated and maintained include sewers, intermediate pump stations (IPSs) and sewage treatment plants (STPs) in the Project Area that consists of Varanasi city and nearby towns of Chunar, Mirzapur, Saidpur, Ghazipur and Ramnagar. Presently, O&M of these facilities is performed by the government agencies through their own staff and there is no outsourcing of the O&M. However, the guidelines of the current government schemes such as Mission for Clean Ganga and AMRUT require the initial five years of O&M to be included in the scope of the construction contractor, which will require a shift in the O&M policy.

This section will provide information on the current O&M practice, requirement of the current government schemes, information on the current assets and proposed assets that will be required O&M and a list of issues to be addressed during this Preparatory Survey.

10.2 Current Practice and NGRBA/NMCG Guidelines for O&M

10.2.1 Current Practice

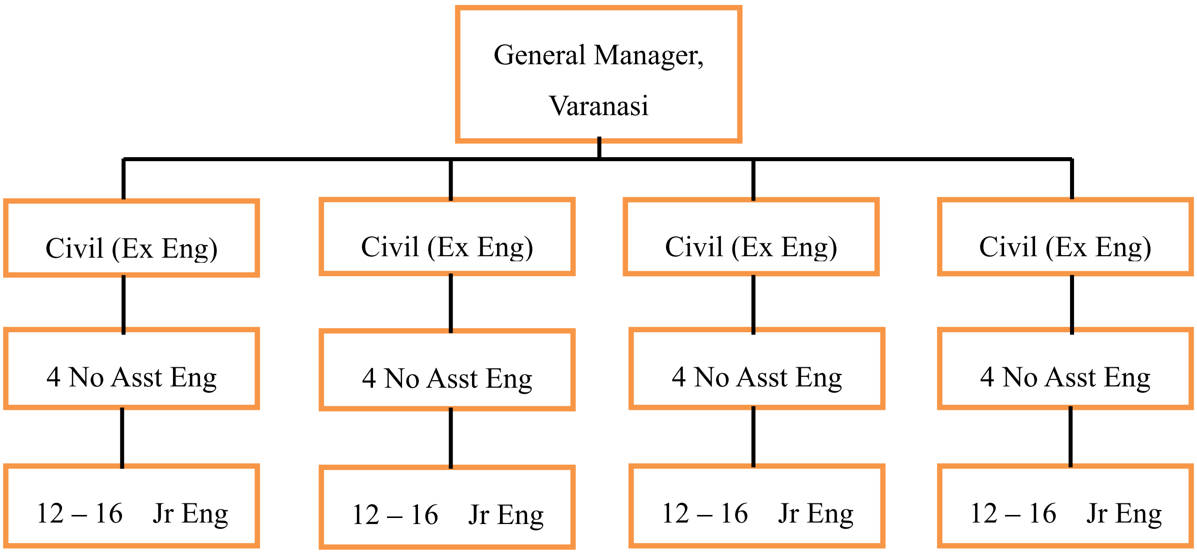
The Jalkal operates under the Nagar Nigam and looks after O&M of all the water supply infrastructure (treatment plant to house connection) and underground sewer network (home connection to pump station or STP inlet). Though the UP Jal Nigam is primarily as executing agency that undertakes construction of water supply and sewerage works, it also looks after the O&M of sewage pump stations and sewage treatment plants on behalf of Nagar Nigam, as the Nagar Nigam does not have the technical knowhow to maintain these assets. This arrangement for O&M is practiced throughout the State of Uttar Pradesh.

The UPJN regional office, such as the UPJN office in Varanasi prepares the estimate for annual O&M of the sewage pump stations and STPs in Varanasi City as well as in nearby towns such as Mirzapur. The O&M budget is prepared as per the NGRBA (National Ganga River Basin Authority), Government of India, guidelines, which specify the staff and other O&M requirements for different capacity STPs and based on capital cost. The costs such calculated are used for tendering purpose.

The O&M estimate is sent to respective Nagar Nigam offices for review and counter signature. Once signed by the Nagar Nigam, the estimate is forwarded by UPJN, Varanasi office to the UPJN head office in Lucknow. UPJN head office compiles such O&M budgets received from various offices and then gets the funds from the State Government, which are then utilized for the O&M. The O&M budget is inclusive of electricity charges, and these are directly paid by the UPJN head office to the Uttar Pradesh State Electricity Board. The remaining amount is transferred to the respective offices for O&M of STPs and pump stations.

The O&M budget for Varanasi City sewage facilities for 2015-16 is Rs 252.5 million.

The UPJN, Varanasi office has the following organization chart.



Thus, the General Manager has 4 Executive Engineers, 16 Assistant Engineers and about 50 – 60 Junior Engineers under him to execute the capital works as well as to perform O&M of the sewage pump stations and treatment plants. ~~There is no dedicated O&M wing in UPJN.~~ The Bhagwanpur and Dinapur STPs are operated by the Ganga Pollution Prevention Unit (GPPU) of UPJN.

For O&M of the sewer network, following equipment is available with Varanasi Jalkal office:

- 6 nos of jetting cum sucker machines. Out of these, two machines were procured in 2013 and four were procured in 2014
- 1 no of super sucker machine
- 2 nos of bucket machines
- 4 nos of old jetting cum sucker machines, which are to be renovated

Machines for septage management are proposed under the GAP II, and Rs 30 million budgetary provision has been made for this purpose through the capacity building component. Jalkal officials have expressed desire to procure additional septage management machines due to large number of unconnected houses with septic tanks.

10.2.2 NMCG / NGRBA / AMRUT Guidelines for O&M

National Mission for Clean Ganga (NMCG) is the implementation wing of National Ganga River Basin Authority (NGRBA). It is a registered society originally formed by Ministry of Environment, Forests and Climate Change (MoEFCC) on 12th August 2011 under the Societies Registration Act, 1860. As per the 306th amendment in the Government of India (Allocation of Business) Rules, 1961, both NGRBA and NMCG are allocated to the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR,RD &GR). As per the approval of the Cabinet Committee on Economic Affairs (CCEA), the mandate of NGRBA is being implemented by the National Mission for Clean Ganga (NMCG). At national level NMCG is the coordinating body and is being supported by States Level Program Management Groups (SPMGs) of Uttar Pradesh, Uttarakhand, Bihar and West Bengal which, are also registered as societies under Societies Registration Act, 1860 and a dedicated Nodal Cell in Jharkhand.

The area of operation of NMCG is the Ganga River Basin, including the states through which Ganga flows, as well as the National Capital Territory of Delhi, and the guidelines of NGRBA are applicable to the Ganga Rejuvenation project being proposed for Varanasi and surrounding towns.

The NGRBA Guidelines state that:

i. First 5 years O & M cost to be in-built in the project cost. This will ensure unhindered O & M of assets which is necessary for achieving the river cleaning objectives.

ii. Next 10 years O & M cost to be also worked out with revenue generation plan. The O & M responsibility beyond 5th year will rest with the State Government/ ULB.

iii. Tripartite MoA amongst MoEF, State Government and the local body is also to be signed. State governments are expected to take all necessary measures available at their control to address this problem in a sustainable manner.

iv. Funds for O&M for a period of 5 years initially, would be shared in the ratio of 70:30 between the Centre and the State Government.

v. It is necessary to accurately work out O&M cost. The records of O&M of assets created under

GAP/NRCP may be examined carefully and updated to the current levels as well as the periods when new facilities would be ready for operation. Cost of electricity is the major component of O&M accounting singly for 65-70%. These as well as other components like manpower, consumables, etc. should be calculated on a realistic basis to arrive at the total annual cost to operate an asset. Continuous availability of electricity for both STPs and PSs must be ensured on round the clock basis by the implementing agency.

vi. Preventive maintenance or repairs needed after a few year's initial operations are often lost sight of. This is an important element of overall O&M cost and must be provided for appropriately.

vii. The DPR must clearly reflect the total component-wise funds needed for O&M and how and wherefrom these would be provided.

The NGRBA has also provided detailed guidelines for providing O&M Staff and O&M Staff quarters in Annexure 7 of the 'Guidelines for Preparation of Project Reports under National River Conservation Plan and National Ganga River Basin Authority' published in December 2010. This Annexure 7 is reproduced and enclosed as Annex-I. Though these guidelines are for calculation of the O&M cost when O&M is performed by the government departments, the same will be used for calculating O&M expenditure, with suitable margin for contractor's profit.

AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme was launched by the Central Government in 2014, and it intends to take up 500 Indian cities with more than 100,000 population with purpose to (i) ensure that every household has access to a tap with assured supply of water and a sewerage connection; (ii) increase the amenity value of cities by developing greenery and well maintained open spaces (e.g. parks); and (iii) reduce pollution by switching to public transport or constructing facilities for non-motorized transport (e.g. walking and cycling). Under the AMRUT scheme, 100 cities will be transformed into Smart Cities, and Varanasi is on this list. Therefore, it is necessary to consider the guidelines proposed by AMRUT for O&M, which are given below, and are more concerned with service levels to be provided to the consumers:

i. Experience with past programmes has shown that once projects are completed the ULBs pay little attention to the operation and maintenance of infrastructure assets created. Therefore, the tender should include O & M for five years based on user charges. For the purpose of calculation of the project cost, the O&M cost will be excluded; however, the States/ULBs will fund the O&M through an appropriate cost recovery mechanism in order to make them self-reliant and cost-effective.

ii. The Service Level Improvement Plans will first provide for provision of water and sewerage connections to all households.

Thus, it is observed that both the NGRBA guidelines for O&M are more extensive than AMRUT; however, both the guidelines require the first five years of O&M to be included in the tender. Schemes under the NGRBA will provide for 70% of the O&M cost for the first five years, whereas schemes under AMRUT require user fees to be collected for funding the O&M cost. It should be noted that, at this moment, the eligibility of O&M cost requires the internal review of JICA.

10.3 List of Assets for O&M at the End of the Project

The Project Area has some existing sewerage assets, and some are being created under the currently ongoing Ganga Action Plan II. These assets are tabulated below.

Table 10.3.1 List of Existing Sewerage Assets in Project Area

Town	Sewerage Network Assets	Sewage Treatment Plant Assets
Chunar	There is no sewerage system. Some houses have own septic tanks whereas most of the houses discharge directly to Nalas that flow into the Ganga.	None
Mirzapur	Has existing sewerage network that is determined to be mostly functional except for a sewer of 4.5km length. There are 4 sewage pump stations	2 STPs: 4mld at Vindhyachal on WSP technology and 14mld at Mirzapur on UASB technology
Saidpur	no existing sewerage	None
Ghazipur	no existing sewerage	None
Varanasi Dist I	Almost 80% sewerage coverage	3 STPs: Dinapur STP 80mld, activated sludge process with roughing filter; BHU/Bhagwanpur STP 8mld, activated sludge with surface aeration; DLW STP 12mld
Varanasi Dist II	Partial sewerage system	Sewage from Dist II is treated at Dinapur STP in Dist I
Varanasi Dist III	Partial sewerage system; BHU area fully sewered with sewage flow to BHU/Bhagwanpur STP	2 STPs: Bhagwanpur STPs of 1.8mld and 8mld capacity
Varanasi Dist IV	No sewerage system, the area is outside municipal	None

	limits	
Ramnagar	35km of sewerage existing in Ramnagar area but there is no clear network of these sewer lines as many interconnections have not been constructed. There is no sewerage network in Padao area. Only few houses have septic tanks.	None
Total	Partial sewerage network in the Project Area with sewage pumping stations	7 STPs of capacities ranging from 1.8mld to 80mld with aerobic and anaerobic processes

Source: Discussion with GAP II Team

The Ganga Action Plan II is being implemented only in the City of Varanasi, and the list of assets being created in GAP II is given below.

Table 10.3.2 List of Sewerage Assets Being Created under GAP II in Varanasi

Town	Sewerage Network	Sewage Treatment Plant
Varanasi Dist I	Rehabilitation of existing old trunk sewer; Rehabilitation of Konia MPS; Rehabilitation of Ghat pumping stations; Sarai IPS (new); Narokar pumping station (new)	Construction of new 140mld STP to treat sewage from Dist II, STP with ASP process and digestion and power generation
Varanasi Dist II	Relief trunk sewer (new); Chauka Ghat pump station (new); Varuna River interceptor sewer (new); Phulwaria pumping station (new)	None
Varanasi Dist III	Assi nala interceptor sewer (new); Nagwa pumping station (constructed but not yet commissioned)	Ramana STP of 50mld capacity (new) is under bidding process as of April 2017;
Varanasi Dist IV	None as not in municipal area	None as not in municipal area
Total	Extensive sewerage network in Varanasi with rehabilitation of existing pump stations and new pump stations	2 new STPs of 50mld and 140mld capacity

Source: Discussion with GAP II Team

The DPRs provided to the Preparatory Survey team were studied and the proposed works in the Project Area are listed below. The sewerage facilities are proposed with Base Year 2020, and as per the

CPHEEO Manual, the design year for the sewerage network is considered as 2050 (30 year design horizon) and the STPs are proposed with design year of 2030 (10 year design horizon).

Table 10.3.3 List of Sewerage Assets Proposed in the Project Area

Town	Sewerage Network Assets	Sewage Treatment Plant Assets
Chunar	60.7km of sewerage network including mains, sub-mains and lateral sewers with sewer diameters from 200mm to 700mm dia Flushing mobile van to flush the sewers as velocities will be low	6.5 mld on WSP (waste stabilization ponds) technology followed by disinfection
Mirzapur	245.4km of sewerage network including mains, sub-mains and lateral sewers with sewer diameters from 200mm to 1000mm dia Replacement of non-functional sewer length of 4.5km	Upgrade the Vindhyachal STP to 6mld capacity with disinfection; Construct a new STP of 18mld capacity with SBR technology in Mirzapur; Upgradation of the existing 14mld STP with MBBR addition
Saidpur	DPR not yet available	DPR not yet available
Ghazipur	DPR not yet available	DPR not yet available
Varanasi Dist I	Almost 80% sewerage coverage	Rahab of existing Dinapur 80mld STP
Varanasi Dist II	Secondary and branch sewers being designed to achieve 100% coverage	Sewage flow to be treated at new 140mld STP at Dinapur located in Dist I
Varanasi Dist III	Secondary sewers and branch sewers with final outlet to Ramna STP through Nagwa Pump station	Ramana STP (being designed by UPJN under another project)
Varanasi Dist IV	DPR not yet available	DPR not yet available
Ramnagar	Sewage pump station at Ramnagar of 20.7 mld peak capacity Sewage pump station at Padao of 3mld peak capacity Main pump station at Kodopur of 32mld peak capacity	1 STP at Ramnagar of 14mld capacity with Activated Sludge based MLE Process
Total	Complete sewerage network in the Project Area with sewage pumping stations	3 new STPs of 6.5mld, 18mld and 14mld capacities

Source: DPRs given to the Preparatory Survey Team

The information from the above tables is compiled below to compare the existing assets vs the assets after completion of the ongoing GAP II Project and after completion of the assets being proposed under the current study.

~~Table 10.3.4 Comparison of Existing and Total Future Sewerage Assets the Project Area~~

~~Project Area~~	~~Existing Sewerage Assets~~	~~Total Future Sewerage Assets~~
~~Chunar, Mirzapur, Saidpur, Ghazipur, Varanasi, Ramnagar~~	~~Partial sewerage network~~ ~~With sewage pumping stations~~ ~~7 STPs~~	~~Complete sewerage network~~ ~~With sewage pumping stations~~ ~~12 STPs~~

10.4 Performance Monitoring of the Sewerage Facilities during O&M

The sewer network is designed to convey the entire sewage generated in the coverage area to sewage treatment plants that then treat the sewage to required discharge norms. Therefore, the performance indicators for sewer network are typically associated with conveyance of 100% sewage volume, and as the network has interface with the house connections, the service levels are related to addressing complaints such as blockages and overflows. The performance indicators for treatment plants are specific to volume being treated and the effluent quality to be achieved. These are noted below.

10.4.1 Suggested Performance Indicators for the Sewerage Network

The recommended performance indicators were formulated after considering the objectives of NGRBA that required no untreated sewage to flow into the Ganga River, meaning 100% coverage. The suggested criteria are also in line with the objectives of the AMRUT scheme, in view that the Varanasi City, the largest populated city in the Project Area is one of the 100 SMART Cities in the AMRUT program. The recommended performance indicators are given below:

- Coverage of latrines : 100%
- Collection of sewage : 100%
- Complaint resolution in 24hrs : 80%

10.4.2 Suggested Performance Indicators for the Sewage Treatment Plants

The sewage treatment plants should treat the entire volume of incoming sewage flow, without any bypass, and produce treated flow meeting the water quality specified by the NGRBA for discharging to Ganga River or by CPHEEO for discharging into Surface Water bodies that are used a source of drinking water. The suggested performance criteria are given below:

- Sewage treatment capacity : 100% of inflow to be treated without bypass

- Treated sewage quality : Give below (from CPHEEO Manual 2015)

  BOD : < 10mg/L

  TSS : < 10mg/L

  TN : < 10mg/L

  TP : < 2mg/L

  F. Coli : < 230 MPN/100mL

It is recommended that following measures be taken to ensure proper O&M of the STPs. During the first two years of the O&M Contract (1 year of defect liability period + 1 year of O&M), the STP influent and effluent shall be sampled as scheduled in Table 10.4.1 and analysed in the laboratory (in-house) at the STP.

Table 10.4.1 Sampling/Analysis Locations and Frequencies

Parameter	Sampling Frequency	Sampling Method	Sampling points/location
pH	1.Daily	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	2. Three times per week	Grab	Aeration Basin Zones a) Anaerobic (if applicable) b) Anoxic c) Aerobic
Turbidity	1. Daily	Flow-weighted 24-hour composite	Effluent from secondary clarifiers or from SBR basin
	2. Continuous	On-line	Effluent from secondary clarifiers or from SBR basin
COD	1. Daily	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	Weekly	Influent	Influent sewage after grit chamber
TSS	1. Daily	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	2. Twice a week	Grab	Waste activated sludge (WAS)

VSS	1. Daily	Flow-weighted 24-hour composite	Raw Sewage
	2. Twice a week (Tue, Thu)	Grab	Waste activated sludge (WAS)
Residual chlorine (if applicable)	1. Daily	Grab	Plant Effluent
	2. Continuous	On-line	Plant Effluent
BOD	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage Influent b) Plant Effluent
TKN	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
Ammonia-N	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	2. Three times per week	Grab	Aeration Basin Zones (as designed) a) Anaerobic (if applicable) b) Anoxic c) Aerobic
Nitrate-N	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	2. Three times per week	Grab	Aeration Basin Zones a) Anaerobic (if applicable) b) Anoxic c) Aerobic
Alkalinity	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
	2. Three times per week	Grab	Aeration Basin Zones a) Anaerobic (if applicable) b) Anoxic c) Aerobic
Total phosphorous	1. Three times per week	Flow-weighted 24-hour composite	Raw Sewage and Plant Effluent

Soluble phosphorous	1. Three times per week	Flow-weighted 24-hour composite	Raw Sewage and Plant Effluent
	2. Three times per week	Grab	Aeration Basin Zones a) Anaerobic (if applicable) b) Anoxic c) Aerobic
Faecal coliform	1. Three times per week	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
VFAs	1. Three times per week	Grab	a) Raw Sewage b) Anaerobic zone c) Anaerobic Digester – if provided
MLSS	1.Twice a week	Grab	Aerobic zone
MLVSS	1.Twice a week	Grab	Aerobic zone
Flow rate	1.Continuous	On-line flowmeter	a) Raw Sewage (Plant Effluent) b) Plant Effluent c) RAS d) WAS e) Sludge
Temperature	1. Daily	Flow-weighted 24-hour composite	a) Raw Sewage b) Plant Effluent
Specific gravity and concentration	1. Three times per week	Grab	Chemicals Sludge for consistency
Volume	1. Three times per week	Grab	Chemicals/Screenings/Grit/ Gas generation if applicable
Electricity Generation	Daily	On-line	Gas Quality, Volume, Engine running and Electricity Generation.

10.5 Suggested Responsibilities of the O&M Contractor and the Supervising Agency (Nagar Nigam)

It is presumed that necessary modifications will be made to the current O&M practice as per the guidelines of NGRBA and AMRUT so that the O&M will be performed by the Contractor for the first five years, and then on it will be outsourced a natural continuation of the process. Thereby, the Nagar Nigam will need to perform only a supervisory role, and will need to build its capacity appropriately, or can outsource the supervision task to UP Jal Nigam.

The analysis requirements for the first two years are noted in the previous section, and for the subsequent three years of the O&M period included in the contract, the sampling and analysis shall be conducted (on 24 hours-composite sample) once every week and shall cover all the days of the week during a seven week period. In addition, the Contractor shall be required to validate its analysis of effluent samples up to four times in a month from an approved laboratory (by Bureau of India Standards), which is not connected with the Project. The validation sampling shall be randomly selected based on Supervising Agency's decision and the cost of validation/analysis shall be borne by the Contractor. The Contractor shall then provide the influent and effluent water quality information tabular and graphical form to illustrate trends in water quality parameters.

The Supervising Agency shall check the treated effluent quality trends and ask the Contractor to undertake appropriate remedial actions, if the performance of the plant is observed as not satisfactory i.e., non-meeting the functional guarantees or drifting away from the desired performance levels.

It is further recommended that the Supervising Agency shall engage an approved (or Bureau of Indian Standards Certified) laboratory for assessing the effluent water quality indices, for which the samples shall be jointly collected by the Supervising Agency and Contractor. The selection of sample locations and number of samples shall be developed during the first year of defect liability period.

During the entire operation and maintenance period, Supervising Agency shall nominate their official/counterparts for the inspection of specific STPs on weekly basis. Supervising Agency shall also nominate a qualified person to carry out periodical inspection of the STPs and to conduct surprise checks, without prior notice to the Contractor. This policy is required to ensure proper O&M of the STPs.

During the Defect Liability Period (DLP) the Supervising Agency shall carryout monthly, quarterly, half yearly and annual inspection of the treatment plant through its designated personnel as well as with the assistance of project management consultants and based on their suggestions, the Supervising Agency shall suggest necessary improvements to the Contractor for efficient O&M of the STP

10.6 Operation & Maintenance Costs

The O&M cost is based on the NGRBA guidelines. The O&M cost for sewage facilities includes the following items:

1) Repair cost
2) Staff cost
3) Energy charges cost
4) Residual disposal cost (for STP)
5) Chemicals cost (for STP)

Under the NGRBA Guidelines, the Annual O&M cost of sewers is calculated as 0.25% of construction cost using NGRBA guidelines, same as the DPR. For STPs and Pump Stations, the methodology given in Annexure 7 of the NGRBA Guidelines that are summarized below.

Annual O&M cost of the Pump Station is calculated by the following conditions

- Civil works: 1.5% of cost
- Mechanical and Electrical works: 3.0% of cost
- Staff and Power works: As detailed in the DPR.

It is noted that this methodology has been followed in the DPRs given to the Preparatory Survey team, and the O&M costs compiled from those DPRs are given below in Table 10.6.1.

Total annual O&M cost for sewerage for five years is estimated at approximately 23,690.4 Lakhs INR excluding Saidpur.

Table 10.6.1 Estimated O&M Cost of Proposed Sewerage Works (INR Lacs)

Town	Sewerage Network Construction Cost	Sewage Treatment Plant Construction Cost	Sewage Pump Stations Construction Cost	Sewerage O&M Cost for 5 years
Chunar	8163.01	638.70	1132.54	905.16
Mirzapur	21455.25	3683.41	2078.80	2958.28
Saidpur	No recent DPR	No recent DPR	No recent DPR	No recent DPR
Ghazipur	9941.70	3664.49	1479.85	2803.27
Varanasi Dist I	28027.29	No STP in DPR	No PS in DPR	948.84
Varanasi Dist II	42050.79	6703.39	No PS in DPR	6765.58
Varanasi Dist III	15045.98	10301.90	No PS in DPR	3754.60
Ramnagar	8860.92	2233.62	1477.32	5554.67

CHAPTER 11 Environmental and Social Considerations

<Objective of the Study>

According to the JICA's TOR (Terms of References) for the preparatory survey, the proposed projects have been classified as Category B as per the JICA's Guideline for Environmental and Social Considerations by the reasons that the projects may affect less significant impacts compared to than those of Category A projects which are likely to have significantly adverse impacts on the environment or society since they have a wide range of impacts, impacts that are irreversible, complicated, or unprecedented, and impacts that are difficult to assess, or, project for a sector that requires special attention (e.g., a sector that involves large-scale infrastructure development), involves activity that requires careful consideration (e.g., large-scale involuntary resettlement), or takes place inside or adjacent to a sensitive area (e.g., protected natural habitat).

Therefore, the study for the ESCs (Environmental and Social Considerations) was carried out for the following issues based on the "JICA's Guideline for Preparation of the Reports for Environmental and Social Considerations for Category B Projects".

<Result of the Study>

The following results were obtained in the ESCs;

- *The proposed project will not require EIA as per Indian regulation of EIA Notification 2006.*
- *Estimated impact on pollution aspect: air, water pollution waste, noise, offensive odor*
- *Natural environment: there will be no adverse impact on protected area or important species since such national parks or protected area or such species has not been identified at the project sites, while some impact for hydrology was estimated at construction phase*
- *Social environment: some impacts on land issue (land acquisition for STP and pumping station sites), social infrastructure (traffic, underground utilities), infectious diseases, working environment and safety and accidents were identified*
- *Environmental monitoring was established as mitigation measures for the potential adverse impacts*

The project scope and component for actual implementation have not been approved by the project proponent (NMCG) at the JICA survey. However, additional action will be necessary for the issues as listed below;

- *Clarification of implementation structure for the mitigation measures and environmental* *monitoring*

- *Resettlement and acquisition plan for the STP sites and pumping stations*
- *Holding SHMs (Stakeholder Meetings)*

11.1 Project Component for Environmental and Social Considerations

The project component of each project site is summarized in **Table 11.1.1**.

The objectives of the project particularly for the improvement of the environmental are the following:

- Improvement in sewage collection and treatment;
- Prevention of ground water and soil pollution due to infiltration of untreated sewage;
- Prevention of discharge of untreated sewage into River Ganga;
- Improvement in water quality of River Ganga;
- Improvement in environmental sanitation health and reduction in associated health hazards, within the city; and
- Improvement in quality of life, human dignity and increase productivity.

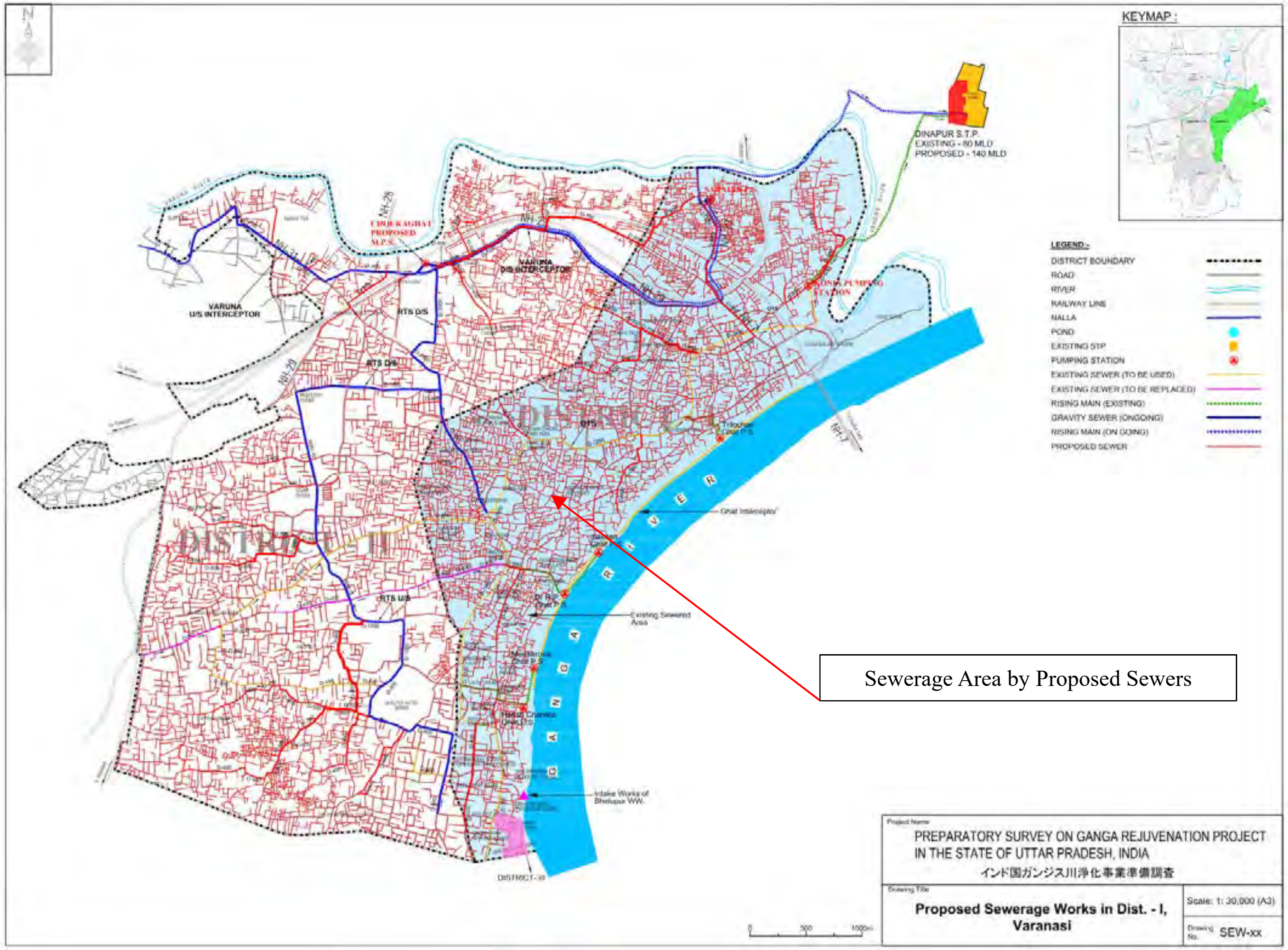
The project component in **Table 11.1.1** has not been approved by the project proponent (NMCG) including selection of the sewage collection method of ID & T (Interception, Diversion and Treatment) or Comprehensive (sewer networks) methods. The location map of the project site is shown in . The detail of the project sites for the project component at each city is shown in **Figure 11.1.2** to **Figure 11.1.8**.

Figure 11.1.1 Location Map of Project Sites

Table 11.1.1 Summary of Project Component

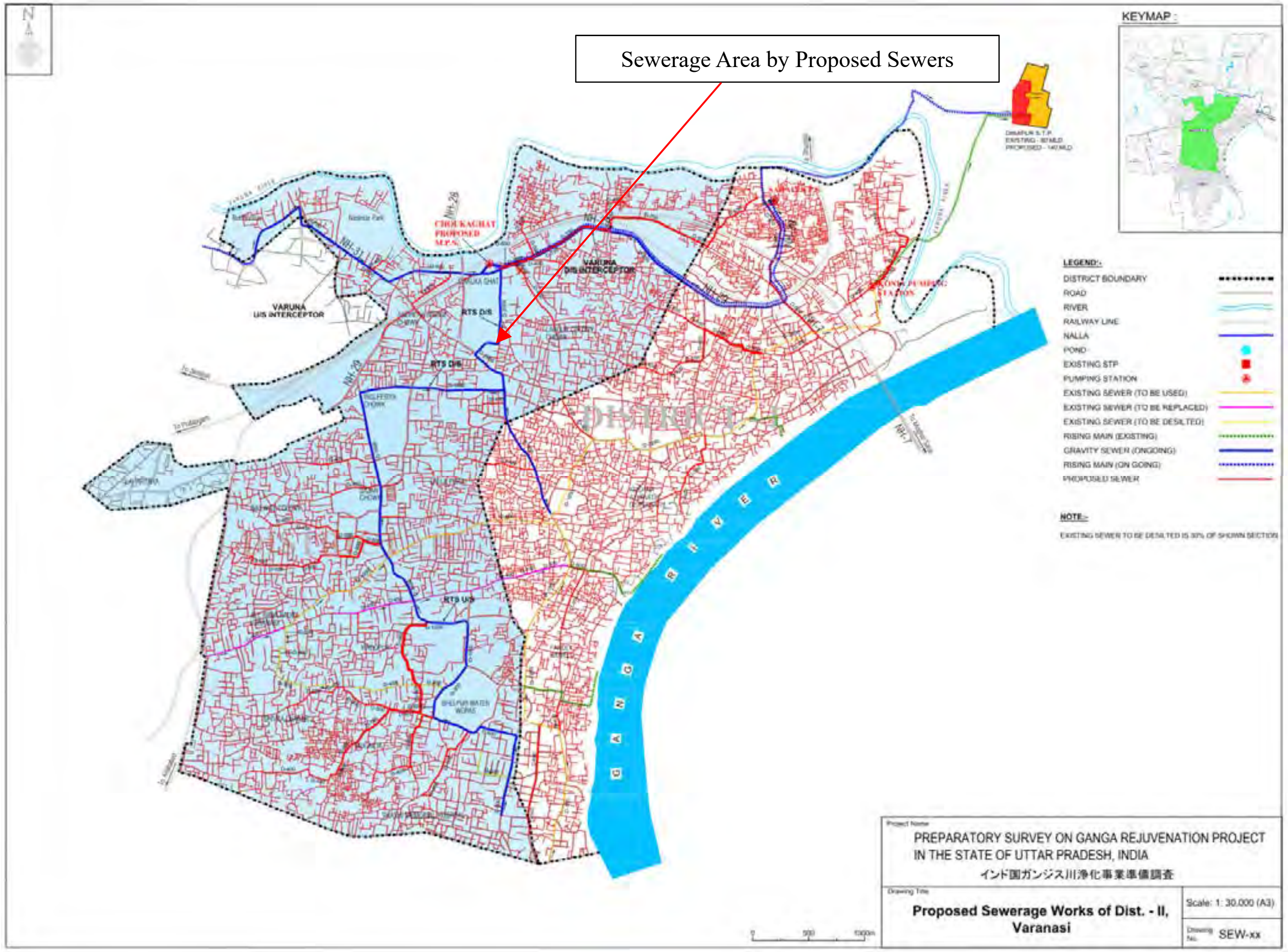
City	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar
District	Varanasi	Mirzapur	Ghazipur	Varanasi	Mirzapur
Component	(1) District - I 1) Sewer • Dia.: 200 to 900 mm • Length: 217,772 m (Open) , 1,876 m (Micro Tunnelling) • Manhole: 10,925 nos. • House connection: 9,804 nos 2) Pumping Station: None 3) STP: None (2) District - II 1) Sewer • Dia.: 200 to 900 mm • Length: 272,096 m (Open) , 3,911 m (Micro Tunnelling) • Manhole: 13,128 nos. • House connection: 34,216 nos. 2) Pumping Station: None 3) STP: None (3) District - III 1) Sewer • Dia.: 400 to 600 mm • Length: 807 m 2) Pumping Station: • Location: Sarai Nandan • Unit: 6 (Duty: 4, d: 2) • Capacity: 400 m3/hr 3) STP: Ramna STP Capacity: 50 MLD • Sewage treatment: Single stage CND • Sludge treatment: Thickener Digestion SDB	1) Sewer: • Dia.: 200 to 900 mm • Length: 8,835 m (Open) , 5,340 m (Rising Main), 7,000 m (Reuse Line) • Manhole: 344 nos. • Interception structure: 17 nos. (new), 9 nos. (Revamping) • House connection: 9,804 nos. 2) Pumping Station • Proposed: 3 (IPS), 1 (MPS) • Rehabilitation: 2 (IPS), 2 (MPS) 3) STP Mirzapur STP • Capacity: 32 MLD • Sewage treatment: USAB + SBR (14 MLD), SBR (18 MLD) • Sludge treatment: Thickening by gravity, Mechanical dewatering Vindhyachal STP • Capacity: 6 MLD • Sewage treatment: SBR • Sludge treatment: Thickening by gravity, Sludge drying bed	1) Sewer: • Dia.: 350 to 1,200 mm • Length: 8,335 m (Open) , 25 m (Rising Main) • Manhole: 284 nos. • Interception structure: 17 nos. (new) • House connection: 9,804 nos. 2) Pumping Station: N/A 3) STP Ghazipur STP • Capacity: 18 MLD • Sewage treatment: SBR • Sludge treatment: Thickening by gravity, Mechanical dewatering	1) Sewer: • Dia.: 350 to 900 mm • Length: 3,080 m (Open) • Manhole: 10 nos. • Interception structure: 4 nos. (new) • House connection: None. 2) Pumping Station • Proposed: 1 (IPS) 3) STP Ramnagar STP • Capacity: 14 MLD • Sewage treatment: Single stage CND (Circulated Nitrification / Denitrification) method • Sludge treatment: Thickening by gravity, Mechanical dewatering	1) Sewer: • Dia.: 350 to 700 mm • Length: 4,308 m (Open) 2,160 m (Rising Main), 3,695 m (Reuse Line) • Manhole: 149 nos. • Interception structure: 22 nos. (new) • House connection: None. 2) Pumping Station • Proposed: 1(IPS), 1 (MPS) 3) STP Chunar STP • Capacity: 6.5 MLD • Sewage treatment: SBR method • Sludge treatment: Thickening by gravity, Mechanical dewatering

Notes;
HAM (Hybrid Annuity Model)-PPP scheme will be applied for Ramna STP in Varanasi, Mirzapur, Ghazipur and Chunar cities.
Source: JICA Survey Team



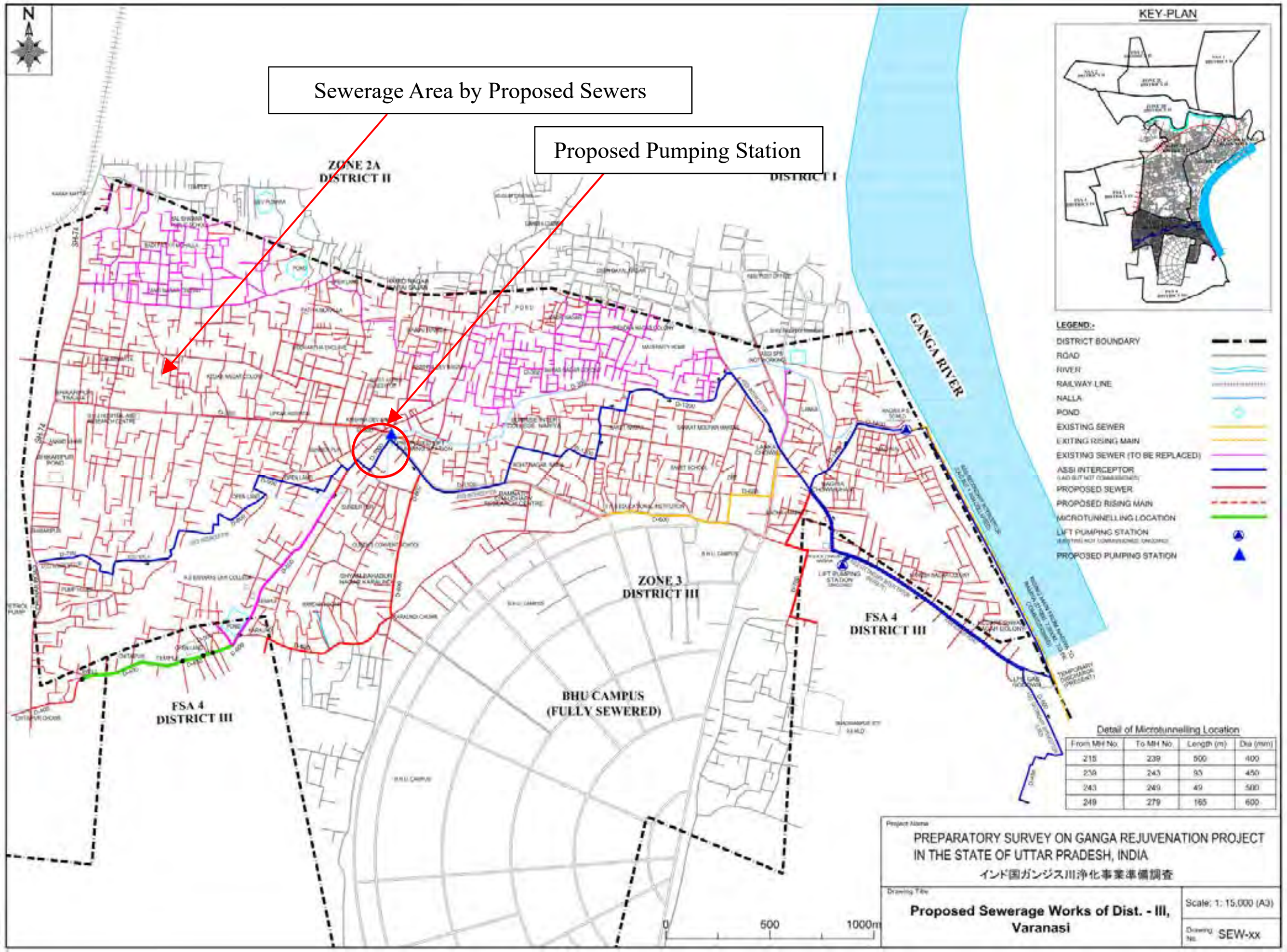
Source: JICA Survey Team

Figure 11.1.2 Location Map of Proposed Project in District I, Varanasi City



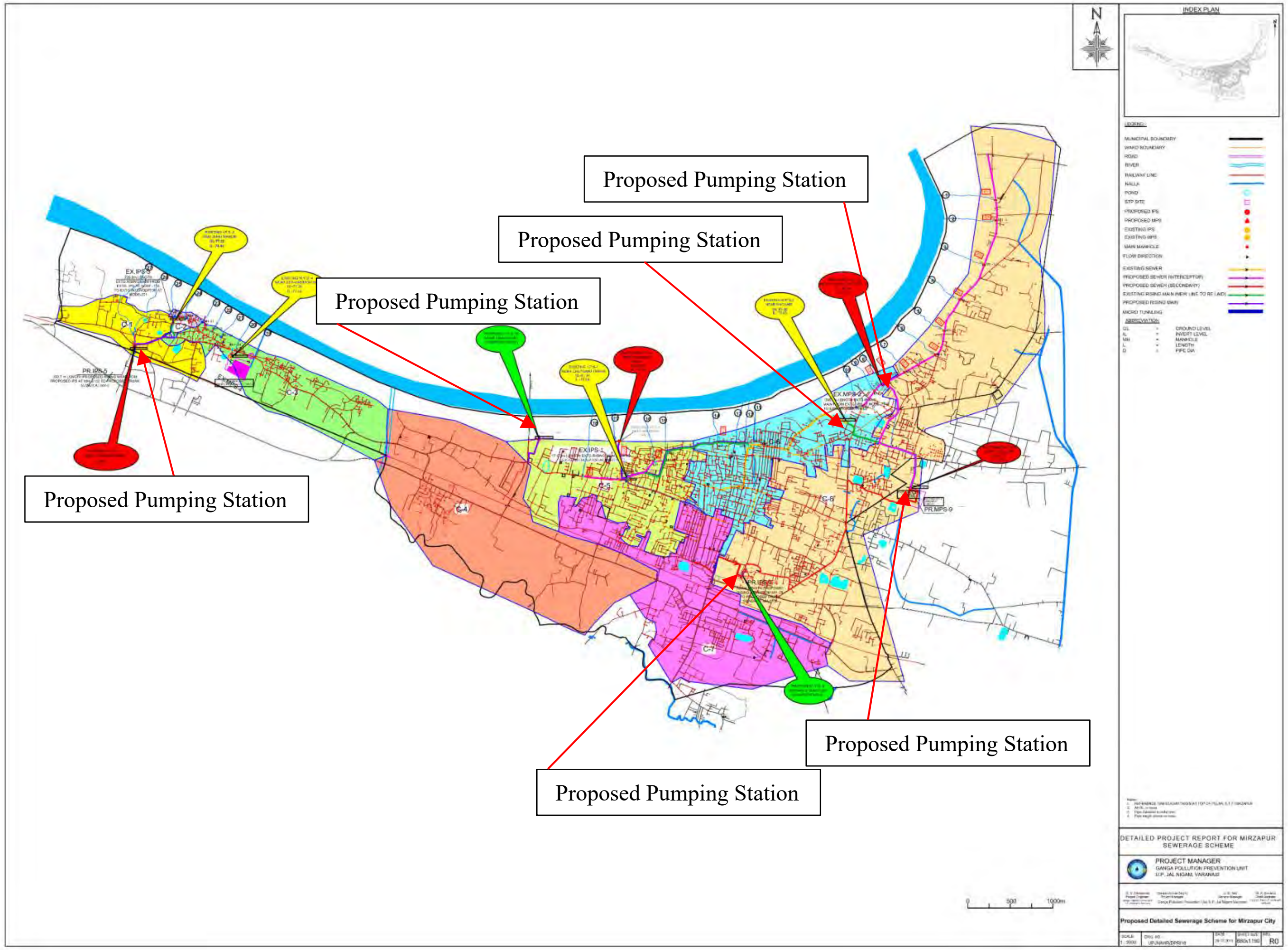
Source: JICA Survey Team

Figure 11.1.3 Location Map of Proposed Project in District II, Varanasi City



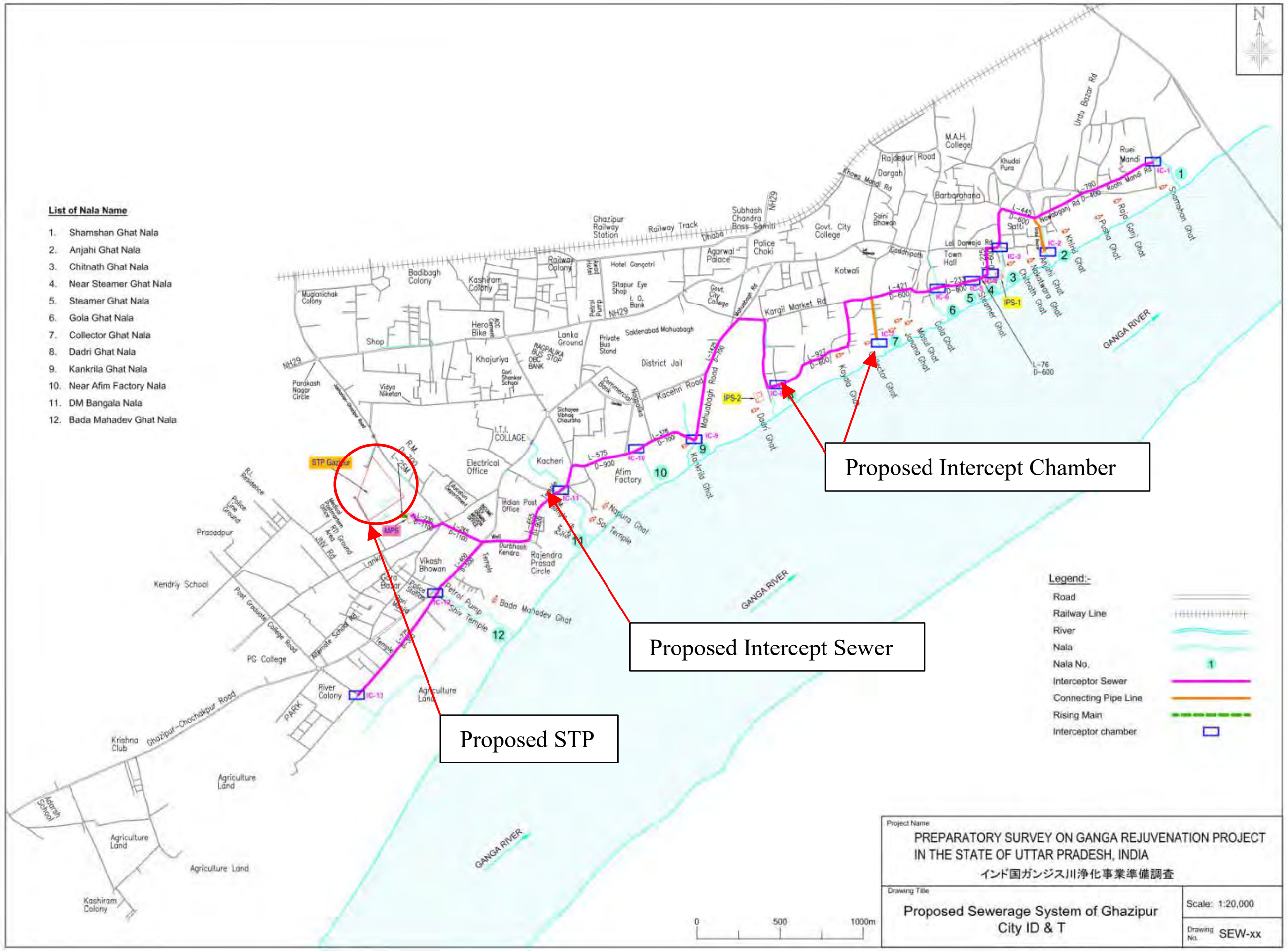
Source: JICA Survey Team

Figure 11.1.4 Location Map of Proposed Project in District III, Varanasi City



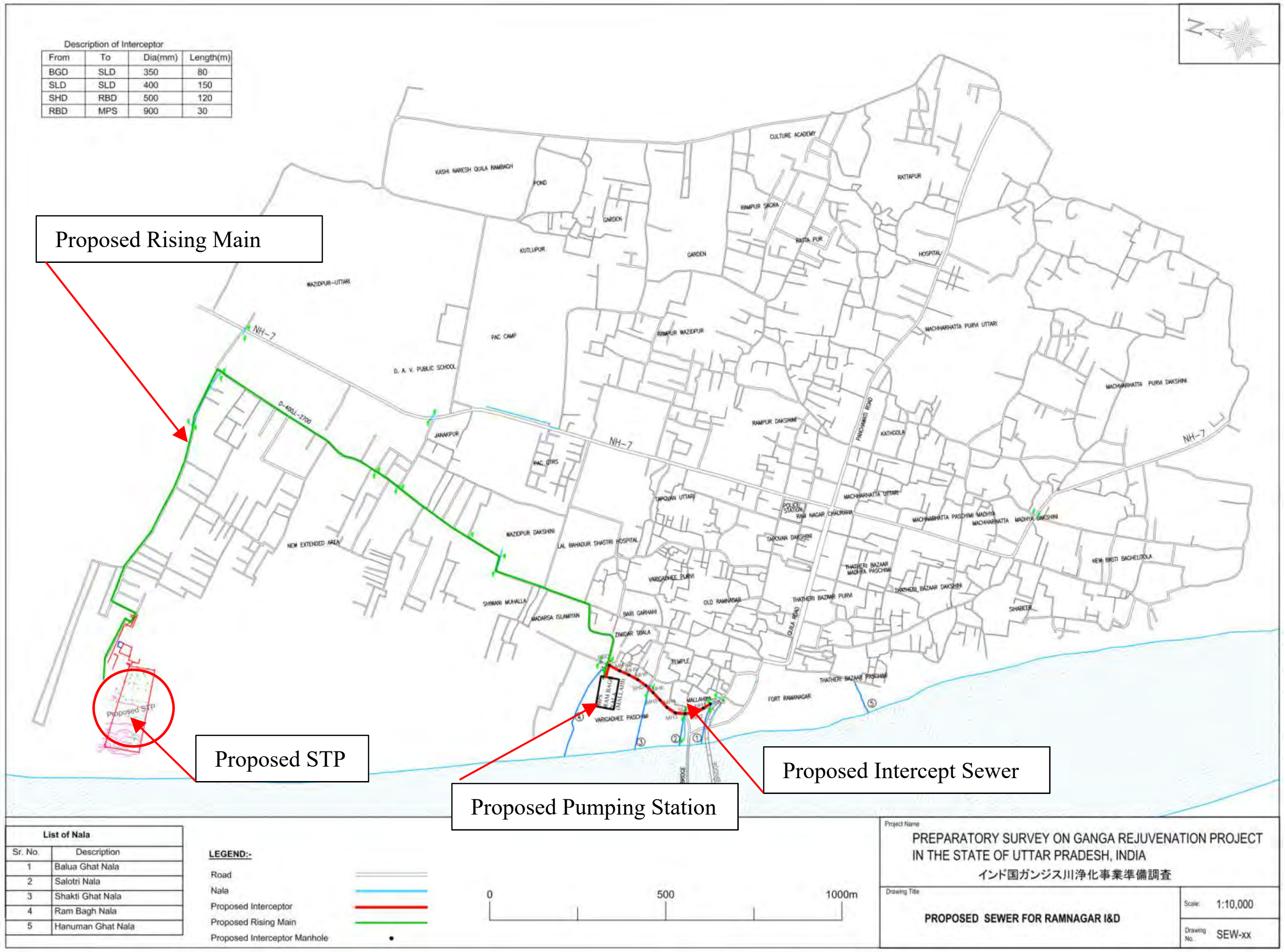
Source: JICA Survey Team

Figure 11.1.5 Location Map of Proposed Project in Mirzapur City



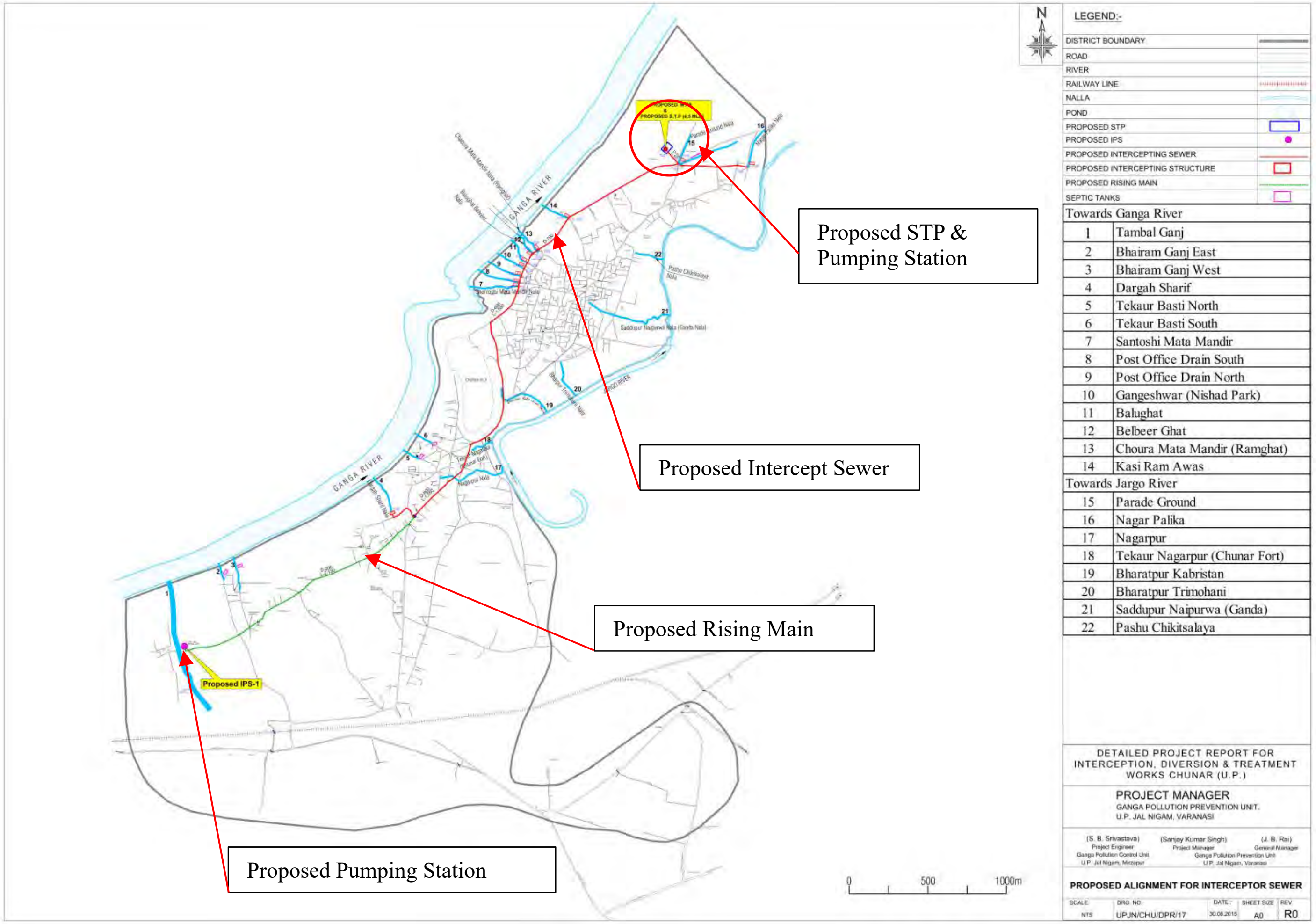
Source: JICA Survey Team

Figure 11.1.6 Location Map of Proposed Project in Ghazipur City



Source: JICA Survey Team

Figure 11.1.7 Location Map of Proposed Project in Ramnagar City



Source: JICA Survey Team

Figure 11.1.8 Location Map of Proposed Project in Chunar City

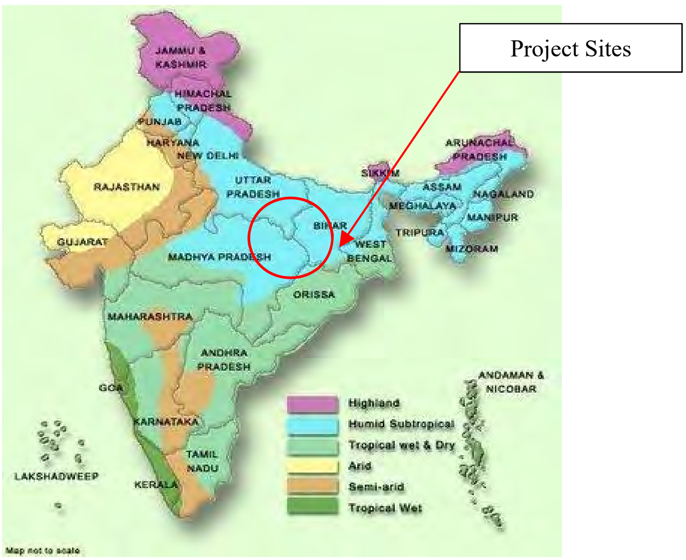
11.2 Environmental and Social Baseline of Project Sites

This section comprises the descriptions of the environmental and social baseline of the project sites and surrounding area. The physical, biological and socio-economic environments are considered in the discussions. Most of information is addressed to Varanasi since the place is famous and more documents are available.

11.2.1 Natural Environment

(1) Meteorology / Climatology

The climate status of the UP state is subtropical and congenial for agriculture. In winter the average minimum temperature ranges from 25 °C in northern part of the plains to 15 °C in eastern part of the state. The maximum temperature during hot season varies from 32 °C in Northern part to 46°C in South Western part of the state. The annual relative humidity ranges from 60 to 70% in North Eastern Tarai region to 30 to 40% in South Western areas. The normal annual rainfall of the state is 947.4 mm and it ranges from 710 mm to 1,750 mm during for the past 40 years. As regards the precipitation trend in the South West and South Eastern part of the state, it ranges from 672 to 1,381 mm. The target five (5) cities belong to above sub-tropical climate as shown in Figure 11.2.1. Their temperature ranges 22°C in winter to 44°C in summer. Their annual average rainfall of the target cities is about 1,100 mm.



Source: "Impact of Climate Change of Indian Agriculture & Its Mitigation Priorities", Manas Ranjan Senapati et al., 2013

Figure 11.2.1 Climate Map of the Project Sites

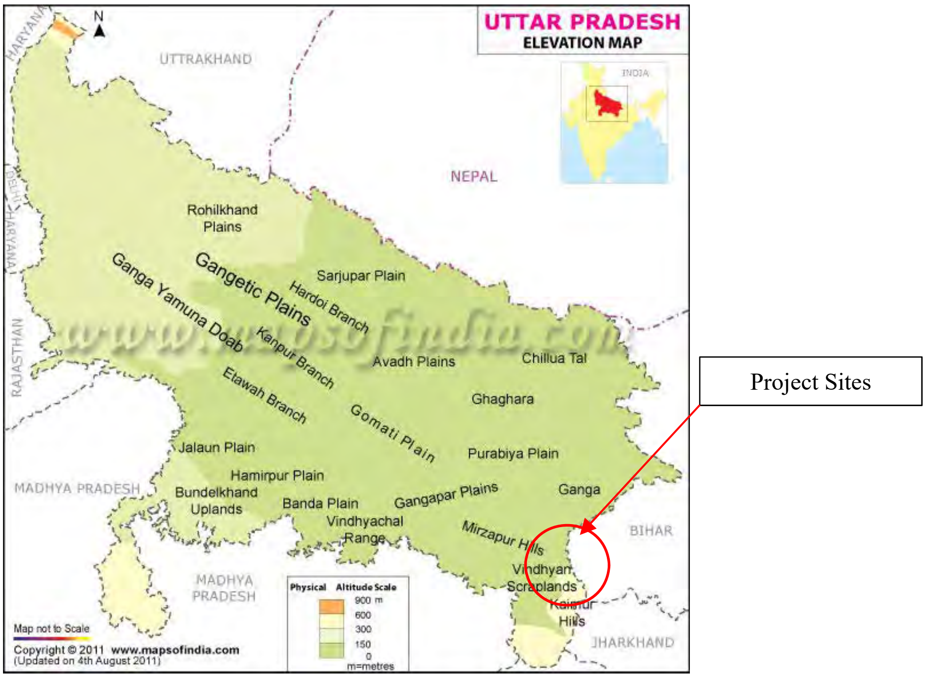
(2) Geographical / Topographical Situation

The geographical situation of the cities is shown in **Table 11.2.1**. The topographical map is shown in **Figure 11.2.2**. All the cities are situated in the South-East edge of the state of UP with their geographical locations of 82°30'E to 83° and 23°N to 25°N. All the cities belong to the Indo-Gangetic Plains of North India and face the river Ganga. The target cities are stretched along the river Ganga with their altitude of 85 m above sea level in Mirzapur to 65 m in Ghazipur city.

Table 11.2.1 Geographical Situation of Target Cities

	Varanasi	**Mirzapur**	**Ghazipur**	**Ramnagar**	**Chunar**
Area (km^2)	Over 1,535 km^2	20.88 km^2	N/A	N/A	8.31 km^2
Stretch	• 82° 56'E to 83° 03'E • 25° 14'N to 25° 23.5'N	• 82º 72' to 83ºE • 23º 52' to 23º 32'N	• 83° 4' and 83° 58' E • 25° 19' and 25° 54'N	• 83° 1'50'' E • 25°16'22''N	82° 45' E and 35° N
Location	It is situated on the bank of river Ganga of State of UP. It is located between the confluences of river Ganga and Varuna and river Ganga and Assi rivulet.	It is surrounded by Varanasi and Sant Ravidas Nagar on the north, Allahabad on the west, and towards south east its boundaries are contiguous with district, Sonebhadra and the state of Madhya Pradesh.	Ghazipur district forms the eastern part of the Varanasi Division. It lies to the east and north of the Jaunpur and Varanasi district respectively. The River Ganges from one side and Karmnasa from other side divided it from Bihar State.	Ram Nagar is situated near the Ganga River on its eastern bank, opposite to the Tulsi Ghat.	It is situated at south of the river Ganga.

Source: JICA Survey Team

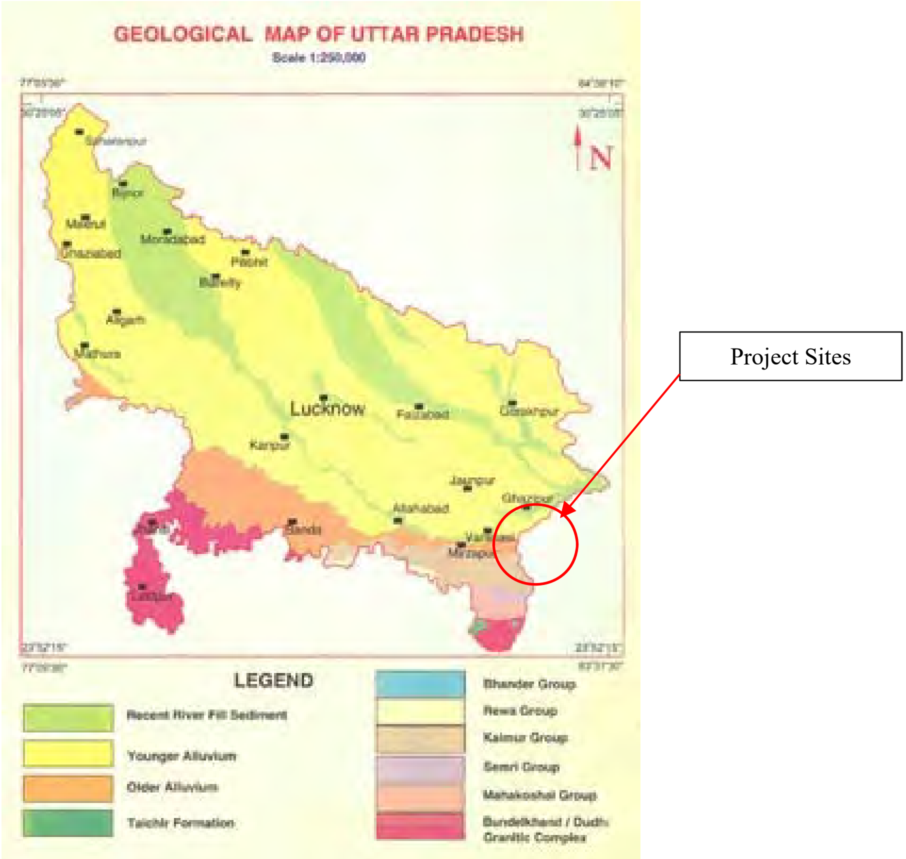


Source: www.mapof india.com

Figure 11.2.2 Topographic Map of the Project Sites

(3) Geology

The geological map of the project sites is shown in **Figure 11.2.3**.The Ganga plain which dominates the landscape and nearly covers three fourth of the geographical area of the State of UP, lies between the rocky Himalayan belt in the north and the southern hilly tract comprised of mainly Pre-Cambrian rocks. The Ganga plain is filled with recent alluvial sediments which are at places more than 1,000 m. thick and an amalgam of sand, silt, clay in varying proportions. As shown in **Figure 11.2.3**, Varanasi and Ramnagar Districts falls under the Younger Alluvium classification and same with Ghazipur District which also covers Saidpur. For Mirzapur District which includes Chunar, two (2) classifications covered, namely: Mahakoshal Group and Kaimur Group. Younger Alluvium - Younger alluvium (Qal) is underlying geologic unit. This is an unconsolidated, poor to well graded mass consisting of sand, gravel, and cobbles. Surface soils are well drained, with moderately rapid permeability, slow runoff, and slight erosion hazard.



Source: Department of Mines and Geology, State of UP

Figure 11.2.3 Geological Map of Project Sites

(4) Land Use

Table 11.2.2 shows the land use classification of each district covered by the project areas. Varanasi and Ghazipur district is the most developed area among all districts because of their highest percentage of net sown land.

Table 11.2.2 Land Use Classification of the Project Area

Type	Varanasi District (incl. Varanasi & Ramnagar)		Mirzapur District (incl. Mirzapur & Chunar)		Ghazipur District (incl. Ghazipur)	
	Area in Hectare	Percentage	Area in Hectare	Percentage	Area in Hectare	Percentage
Forest	0	0.0	109,236	25.9	121	0.0
Cultivable Wasteland	2,153	1.4	13,693	3.2	3,557	1.1
Fallow Land	22,182	14.8	10,197	2.4	15,558	4.7
Non-Cultivable Land	2,247	1.5	9,166	2.2	3,007	0.9
Other Land Excluding Agriculture	26,097	17.4	49,589	11.8	48,797	14.8

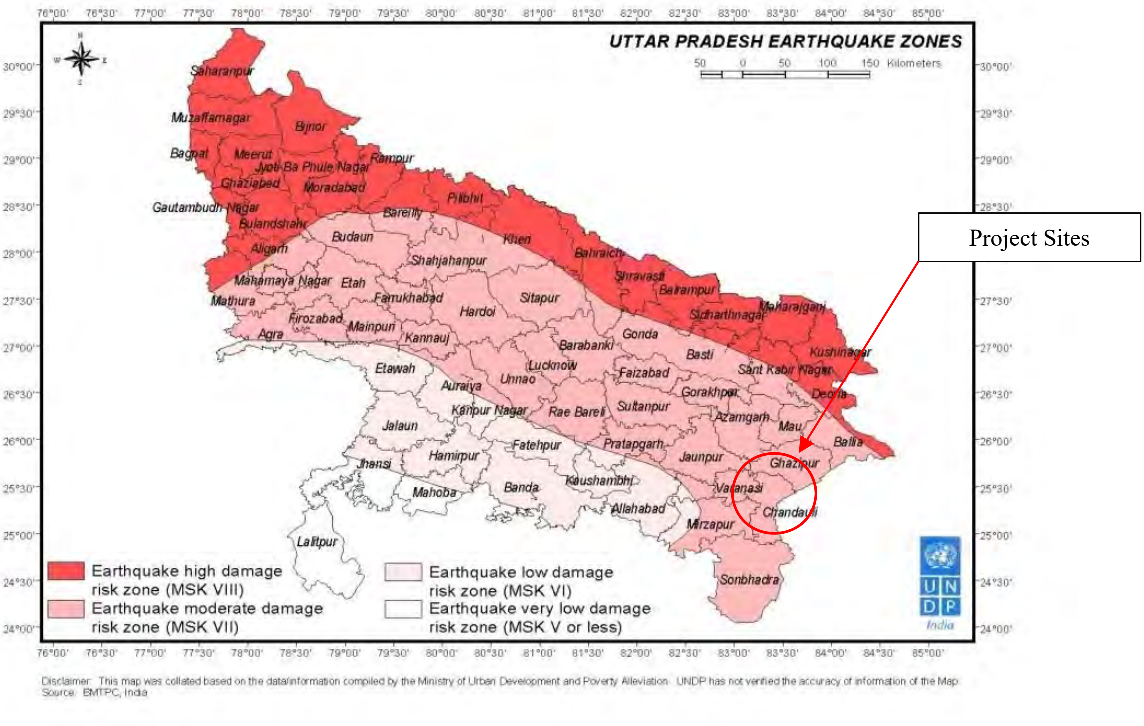
Type	Varanasi District (incl. Varanasi & Ramnagar)		Mirzapur District (incl. Mirzapur & Chunar)		Ghazipur District (incl. Ghazipur)	
Pasture Land	23	0.0	514	0.1	806	0.2
Groves and Gardens	2,961	2.0	29,093	6.9	3,405	1.0
Net Sown Land	94,605	63.0	200,190	47.5	254,512	77.2
Total	150,268	100	421,678	100	329,763	100

Source: Land Use Pattern in Eastern Uttar Pradesh, 2010

(5) Natural Disaster

Natural disasters that are of significance in Uttar Pradesh are: floods, droughts, fires and earthquakes as characterized as below. UP is also vulnerable from the aspect of manmade hazards such as stampede, chemical, radiological and other hazards.

- Eastern part of the state is historically flood prone but since last few years western UP region has also experienced massive flood disaster.
- Drought is another major natural hazard affecting UP state. The recurrence of highly deficient rainfall in East U.P. occurs approximately every 6 to 8 years whereas in West U.P. it is 10 years.
- Moderate damage risk of earthquake: The type of earthquake that covers all project sites belong to Moderate Damage Risk Zone of MSK VII (MSK: Medevedev – Sponheuer – Karnik. MSK VI (or less), VII and VIII (or above) corresponds to Zones 2, 3, 4 and 5 of MCE (Maximum Considered Earthquake)) as shown in **Figure 11.2.4** for the Disaster Earthquake Zone Map.



Source: Status of Environment and Related Issues (ENVIS Centre: Govt. of Uttar Pradesh)

Figure 11.2.4 Earthquake Zone Map

(6) Hydrology

Rainfall, subsurface flows and snow melt from glaciers are the main sources of water in river Ganga. Surface water resources of Ganga have been assessed at 525 billion cubic meters (BCM). Out of its 17 main tributaries Yamuna, Sone, Ghagra and Kosi contribute over half of the annual water yield of the Ganga. These tributaries meet the Ganga at Allahabad and further downstream.

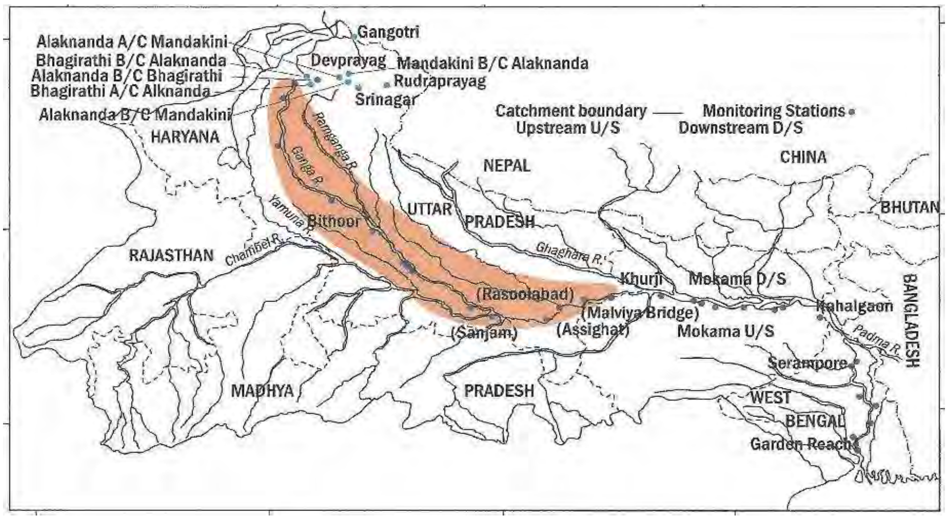
The river has a problem of low flows between the Haridwar - Allahabad stretch. December to May is the months of low flow in the Ganga. On an average, each square km of the Ganga basin receives a million cubic meters (MCM) of water as rainfall. 30% of this is lost as evaporation, 20% seeps to the subsurface and the remaining 50% is available as surface runoff. The deep channel of the river bounded by high banks facilitates the passage of ground water as base flow. Annual flooding is the characteristic of all rivers in the Ganga basin. The Ganga rises during the monsoon but the high banks restrict the flood water from spreading. The flood plain is usually 0.5 to 2 km wide. This active flood plain is flooded every year.

The project sites of the target five (5) cities are located at the middle reach of the Gange river.

11.2.2 Pollution

(1) Surface Water Quality

The Uttar Pradesh Pollution Control Board (UPPCB) is an organization authorized by the Government of India to conduct monitoring of the river water quality within the State. There are total of fifty-three (53) monitoring stations in the State of UP and eight (8) monitoring points are within and near the project sites. **Figure 11.2.5** shows the location of the monitoring stations in the State.



Source: UPPCB

Figure 11.2.5 Location Map of Monitoring Stations in River Ganga in Uttar Pradesh

Table 11.2.3 shows the tabulated results of the river water analysis from October to December 2015 for the eight (8) monitoring stations at the vicinity area of the project sites. The descriptions of the sampling points are the following. Among the monitoring stations, the worst water quality was measured at Station 7. All parameters did not meet the national standards. The results show that River Ganga is really polluted that needs immediate action to rejuvenate.

Table 11.2.3 River Water Quality Analysis Results (October to December 2015)

Date/Parameter	Sampling Stations								Standard
	Sta. 1	Sta. 2	Sta. 3	Sta. 4	Sta. 5	Sta. 6	Sta. 7	Sta. 8	
October 2015									
DO, mg/L	7.60	8.10	8.70	7.80	8.00	8.20	3.50	8.20	5
BOD, mg/L	2.30	2.50	2.80	5.00	3.80	2.60	26.40	3.30	3
Total Coliform, MPN/100ml	2,100	2,500	2,700	43,000	34,000	11,000	240,000	14,000	500
November 2015									
DO, mg/L	7.90	8.20	8.80	7.60	8.00	8.50	3.20	8.40	5
BOD, mg/L	2.20	2.40	3.00	5.20	4.00	2.80	27.60	3.20	3
Total Coliform, MPN/100ml	32,000	2,000	3,100	49,000	34,000	8,000	240,000	17,000	500
December 2015									
DO, mg/L	8.00	8.30	8.60	7.50	7.80	8.60	3.00	8.50	5
BOD, mg/L	2.30	2.50	2.50	5.30	4.30	3.00	25.60	3.30	3
Total Coliform, MPN/100ml	2,500	2,100	2,100	49,000	34,000	8,000	220,000	17,000	500
Average									
DO, mg/L	7.83	8.20	8.70	7.63	7.93	8.43	3.23	8.37	5
BOD, mg/L	2.27	2.47	2.77	5.17	4.03	2.8	26.53	3.27	3
Total Coliform, MPN/100ml	12,200	2,200	2,633	47,000	34,000	9,000	233,333	16,000	500

Notes ;

1) *Monitoring stations*
   - Sta. 1: Upstream point of River Ganga in Vindhayachal, Mirzapur;
   - Sta. 2: Downstream point of River Ganga in Mirzapur;
   - Sta. 3: Upstream point of River Ganga in Varanasi;
   - Sta. 4: Downstream point of River Ganga in Varanasi;
   - Sta. 5: Downstream point of River Ganga in Tarighat, Varanasi;
   - Sta. 6: At River Varuna in Rameshwar, Varanasi;
   - Sta. 7: At River Varuna contact before River Ganga; and
   - Sta. 8: At Gomati River contact before River Gomati in Rajwari, Varanasi
2) *Indian Standard for Class B Surface Water: DO – 5 mg/L or more; BOD – 3 mg/L or less, Total Coliform – 500 MPN/100 ml or less*

Source: http://www.uppcb.com/river_quality.htm

(2) Groundwater Quality

A study was done in 2010 by RWTH Aachen University. They surveyed tube wells from Ghazipur, Varanasi and Mirzapur districts of Uttar Pradesh. The survey results show that 60% of the samples were beyond ≥ 10 μg/L and 20% had ≥ 50 μg/L regarding Arsenic contamination. Arsenic was detected from the tube wells with the depths ranging from 25 to 45 m. The contaminated wells are mainly located in Holocene Newer Alluvium which is characterized by grey to black coloured organic-rich argillaceous sediments. They concluded that the arsenic in groundwater of this area was released from the associated sediments which were mainly deposited from the Himalayan hill ranges and very little inputs from peninsular India. (Source: www.waterandmegacities.org)

Other information regarding the groundwater quality in the project areas are:

- Varanasi District has fallen into water shortage. The district takes a total of 270 million liters water from the river Ganga and tube wells. Yet the citizens lack drinking water. The groundwater is polluted due to nitrate and faecal coliform. There is no proper management of groundwater recharging in the area.
- In Mirzapur district, tube wells in Mirzapur and Chunar towns have low concentrations of Arsenic (As) in groundwater (As <10 μg/l) because of their locations on the Pleistocene Older Alluvium upland surfaces. Most of the contaminated villages in Mirzapur district are located close to abandoned or present meander channels and floodplains of the Ganga River.
- The groundwater in Ghazipur district is not suitable for its potability because most of the parameters were beyond the acceptable limits as prescribed by WHO (2004) and ICMR. The parameters exceeding the limits are total dissolve solid, total hardness, chloride, calcium, electrical conductivity, total alkalinity and phosphate. However, the parameters were not too high to pose any serious health hazard.

(3) Water Quality at STPs, Canal, Ghat and Varuna River

On December 8-10, 2015, the JICA Study Team conducted water samples from the existing Dinapur and Bhagwanpur Sewage Treatment Plants (STPs) in Varanasi district. This is to determine the current water quality from the source passing through the canal to the riverside down to the main river. The location of the sampling points is shown in **Figure 11.2.6** (For details, refer to **Chapter 6**).

There were 25 sampling points taken the water samples in Varanasi city. The parameters considered in the analyses are temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Free Ammonia (NH_3), Ammonia Nitrogen (NH_4-N), Total Kjeldahl Nitrogen (TKN), Nitrate (NO_3^-), Total Phosphorus (T-P) and Faecal Coliform. Samples were analyzed by SAI International.

Source: JICA Survey Team

Figure 11.2.6 Location of Water Sampling Stations

Among the parameters, faecal coliform had extreme value in all sampling points except for the upstream and downstream location of Bhagwanpur STP. Half numbers of the total samples have high NH_4-N, and few samples exceeded BOD and TSS values. Only sample taken from the shorefront of Dinapur STP is beyond the pH limit. The rest of the samples are within the national standard limit. For the purpose of the design and monitoring during construction and operation, a new guideline on effluent standards for STPs (New Effluent Water Quality Standard by CPHCCO, 2017) is being implemented. The tabulated results for Varanasi city are shown in **Table 11.2.4**. For the results for Ram nagar, Mirzapur, Saidpur and Ghazipur cities, refer to Chapter 6.

Table 11.2.4 Water Quality Results of Samples of STPs, Canal, Ghat and River

Location	Parameters											
	Temp., ºC	pH	DO, mg/L	BOD_5, mg/L	COD, mg/L	TSS, mg/L	TDS, mg/L	NH_3, mg/L	NH_4-N, mg/L	TKN, mg/L	NO_3, mg/L	T-P, mg/L	Faecal Coliform
V-1	23.1	8.4	5.2	11.0	29.2	8.0	512	1.84	*13.0*	15.6	20.7	1.96	*22,000*
V-2	21.8	*9.5*	4.3	17.0	44.0	16.0	436	<1.0	*7.81*	11.3	5.56	1.48	*25,000*
V-3	24.2	8.2	0.8	*72.0*	174	*102*	428	2.38	*23.4*	46.0	0.81	2.28	*26,000*
V-4	24.9	8.1	4.8	13.0	34.0	<5.0	522	2.14	*18.2*	22.6	8.49	1.86	*22,000*
V-5	21.9	8.3	7.0	<2.0	<4.0	6.0	202	<1.0	<1.0	3.47	4.85	<0.1	*8,000*
V-6	22.1	8.2	6.3	<2.0	<4.0	10.0	216	<1.0	<1.0	3.47	6.65	0.11	*6,000*
V-7	24.7	7.6	1.0	*62.0*	143	*66.0*	410	2.46	*21.7*	31.2	1.90	3.00	*46,000*
V-8	23.9	7.9	5.4	8.2	23.5	<5.0	318	<1.0	*9.54*	13.0	10.7	1.82	*39,000*
V-9	22.3	7.5	1.5	*42.0*	102	60.0	548	6.28	*27.8*	38.2	1.85	3.92	*27,000*
V-10	23.0	8.0	0.8	*83.0*	196	*126*	534	5.26	*26.9*	36.5	1.38	3.26	*41,000*
V-11	20.8	7.8	4.2	8.4	32.8	28.0	550	2.18	*17.4*	21.7	1.44	1.80	*33,000*
V-12	23.4	8.1	4.7	6.8	24.0	26.0	556	2.47	*19.9*	24.3	1.38	1.83	*27,000*
V-13	23.3	7.6	3.4	*28.0*	76.8	*56.0*	368	3.24	*15.6*	19.9	<0.5	2.03	*36,000*
V-14	21.6	8.3	6.3	<2.0	<4.0	10.0	216	<1.0	<1.0	2.60	3.12	<0.1	*11,000*
V-15	21.7	8.2	6.5	<2.0	<4.0	6.0	236	<1.0	<1.0	3.47	6.88	0.13	*8,000*
V-16	22.1	7.9	5.6	2.4	12.8	10.0	264	<1.0	3.47	6.07	<0.5	0.50	*14,000*
V-17	21.7	8.2	6.1	<2.0	<4.0	12.0	206	<1.0	<1.0	2.60	2.71	<0.1	*9,000*
V-18	21.9	8.1	6.2	<2.0	<4.0	10.0	244	<1.0	<1.0	3.47	5.43	0.21	*13,000*
V-19	21.7	8.3	7.1	<2.0	<4.0	6.0	228	<1.0	<1.0	3.98	4.50	<0.1	*12,000*
V-20	21.8	8.3	6.9	<2.0	<4.0	8.0	218	<1.0	<1.0	3.47	4.39	<0.1	*10,000*
V-21	23.1	7.9	5.3	7.4	36.8	*32.0*	548	2.64	*20.8*	21.7	0.69	1.76	*14,000*
V-22	21.7	8.4	6.8	<2.0	7.2	<5.0	216	<1.0	1.73	4.37	2.65	<0.1	*11,000*
V-23	21.6	8.3	6.5	<2.0	8.0	<5.0	206	<1.0	<1.0	2.60	3.52	<0.1	*13,000*
V-24	22.3	7.9	5.9	4.3	20.0	6.0	346	<1.0	*8.68*	11.3	0.75	1.32	*17,000*
V-25	21.5	8.34	7.0	<2.0	5.6	8.0	196	<1.0	1.73	4.34	3.12	0.68	*12,000*
Effluent Discharge Standards												
NGRBA Guidelines (2010)	-	5.5 – 9.0	-	20	-	30	-	-	-	-	-	-	D – 1,000 P -10,000
Sewage Manual (2013)	-	-	-	<10	-	<10	-	<10	-	-	-	<2	<230
New Guideline (plan	-	6.5 – 9.0	-	≤10	≤50	≤20	-	≤10	≤5	-	-	-	<100

Note:
1) *Values in italic were exceeded the allowable limits.*
2) Location of sampling:
   - V-1: Upstream of Dinapur STP
   - V-2: Shorefront of Dinapur STP
   - V-3: Raw Sewage from Dinapur STP
   - V-4: Treated Sewage from Dinapur STP
   - V-5: Upstream of Bhagwanpur STP
   - V-6: Downstream of Bhagwanpur STP
   - V-7: Raw Sewage from Bhagwanpur STP

V-8:		Treated Sewage from Bhagwanpur STP
V-9:	:	Upstream of Assi Nala
V-10:		Mount of Assi Nala
V-11:		Upstream of Varuna River
V-12:		Mouth of Varuna River
V-13:		Mouth of Assi Nala (Shorefront)
V-14:		Upstream of the Mouth of Assi Nala (Centre)
V-15:		Upstream of the Mouth of Assi Nala (Shorefront)
V-16:		Downstream of the Mouth of Assi Nala (Shorefront)
V-17:		Downstream of the Mouth of Assi Nala (Centre)
V-18:		Intake Tower (Shorefront)
V-19:		Assi Ghat (Shorefront)
V-20:		Assi Ghat (Centre)
V-21:		Mouth Varuna River (Shorefront)
V-22:		Upstream of the Mouth of Varuna River (Shorefront)
V-23:		Upstream of the Mouth of Varuna River (Centre)
V-24:		Downstream of the Mouth of Varuna River (Shorefront)
V-25:		Downstream of the Mouth of Varuna River (Centre)

Source: JICA Survey Team

(4) Air and Noise Quality

Air Quality

The ambient air quality used was acquired from the monitoring data results conducted by UPPCB. Monthly monitoring is being conducted and the nearest sampling points were taken in Varanasi city. **Table 11.2.5** shows the laboratory results of the air quality. Based on the table, SO_2 and NO_2 were within the limits set by the Indian government while PM-10 was beyond the standard. This is potentially caused by too much matters which are dusts circulating within the area.

Table 11.2.5 Air Quality Analysis Results (October to December 2015)

Date/Parameter	Sampling Stations in Varanasi		Standard
	Residential (Jawahar Nagar)	Commercial (Sigra)	
October 2015			
PM-10, µg/m³	146.9	147.3	100
SO_2, µg/m³	19.5	19.3	80
NO_2, µg/m³	33.5	34.1	80
November 2015			
PM-10, µg/m³	143.7	148.6	100
SO_2, µg/m³	19.0	19.7	80
NO_2, µg/m³	33.0	33.7	80
December 2015			
PM-10, µg/m³	147.7	153.3	100
SO_2, µg/m³	19.9	20.5	80
NO_2, µg/m³	34.9	34.1	80
Average			
PM-10, µg/m³	**146.1**	**149.7**	100
SO_2, µg/m³	19.5	19.8	80
NO_2, µg/m³	33.8	34.0	80

Indian Standard for Residential and Commercial: PM-10 – 100 µg/m³; NO_2 – 80 µg/m³; SO_2 – 80 µg/m³
Source: http://www.uppcb.com/air_quality.htm

Ambient Noise

A study was carried out in 2005 by CPCB to acquire the noise levels in different parts of Varanasi city. Noise pollution affects the millions of people in all parts of the world, especially those who live in large cities, due to heavy vehicular traffic. The study had been performed in Varanasi city to assess the noise levels at selected locations with heavy traffic. The data were compared with standards and recommendations made to overcome the noise pollution in urban areas. Noise levels have been estimated at six sites in Varanasi city, representing various zones like residential, commercial, silence and traffic crossings. Noise level at all the sites of these zones during day hours has been observed to be far exceeded than the prescribed limit. Main source of noise was vehicular traffic. The survey also revealed that the afternoon hours are the noisiest. The noise level ranged from 46.3 (dBA) to 88.5 (dBA). Lahartara crossing (at G.T. Road) was highly noisy (Leq about 76 dBA).The noise pollution parameter (LnP) values ranged in between 76.37(dBA) to 99.44 (dBA). The TNI values were recorded in between 70.80 to I 13.20. The noise levels recorded at all the six sites far exceed the prescribed limits. (Source: www.envirobiotechjournals.com)

11.2.3 Biological Environment

(1) Flora

The flora of a region includes all the varieties of plants which grow there. The plains of Uttar Pradesh have been very rich in natural vegetation which has, however, diminished due to wide-ranging needs of the people. The project sites are public roads, vacant lands or facility areas of sewerage systems where some shrubs or scrubs are growing. The project sites are public roads, vacant lands or facility areas of sewerage systems where some shrubs or scrubs are growing where common species inhabits, and will not affect above important species.

(2) Fauna

For fauna, animal depends on forest not only of food but also for habitat. The diversity of fauna living in water and terrestrial environment in the air are found in the UP State. The Project may affect to local fauna during construction. Since their list is long, mention shall be made here only of important species mainly found in the State:

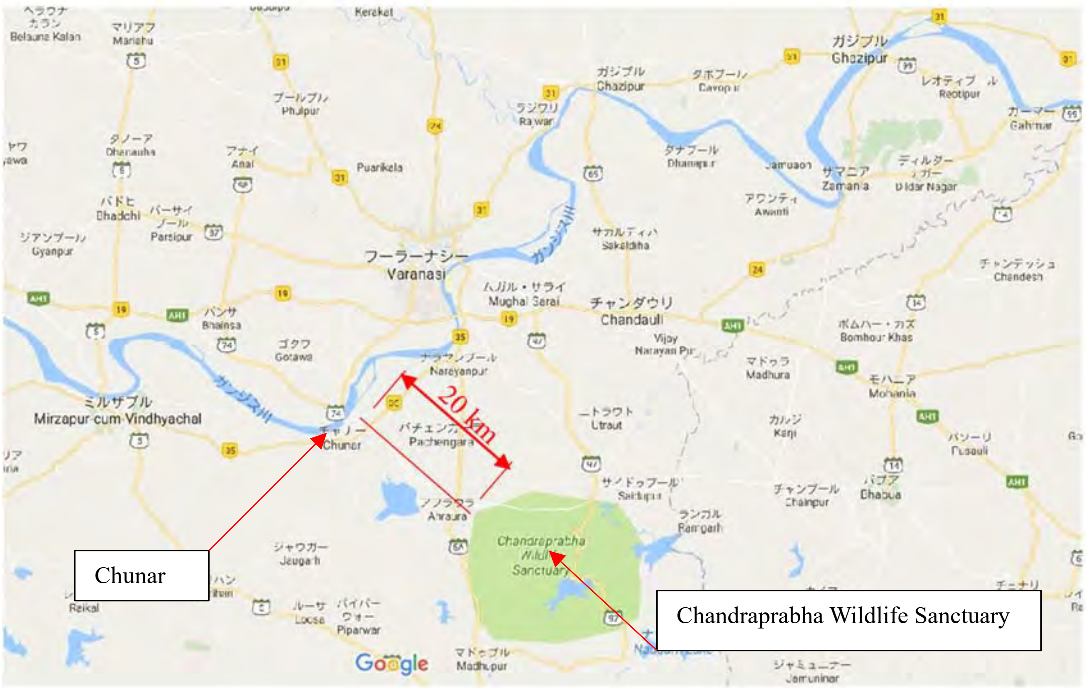
- Fish - Mahaser, Hilsa, Saul, Tengan, Parthan, Rasela, Vittal, Rohu, Mirgal,Kata, Labi, Mangur, Cuchia, Eel, Einghi, Mirror Carp, Trout;

- Amphibia - Frog and Toad;
- Reptiles - Bamania, Pit-viper, Lizard, Goh, Cobra, Tortoise, Krait, Dhaman and Crocodile;
- Aves - Cheel, Vulture, Peacock, Nightingale, Pigeon, Parrot, Owl, Nilkanth and Sparrow;
- Mammals - Shrew, Porcupine, Sqirrel, Hare, Mongoose, Cow, Buffalo and Mouse; and
- Other common species found here are Tiger, Panther, Snow Leopard, Sambhar, Cheetal, Kastura, Chinkara, Black Deer, Nilgai, Back-brown Bear, Mountain Goat, Hyena, Hill Dog, Elephant etc. Among the birds Fowl, Pheasant, Partridge, Florican, Duck, Goose and Wader are common.

The project sites are public roads, vacant lands or facility areas of sewerage systems where some shrubs or scrubs are growing where common species inhabits, and will not affect above important species.

(3) Protected Area

Chandraprabha Wildlife Sanctuary that is endowed with beautiful picnic spots, dense forests, and scenic waterfalls to its vicinity is located at about 20 km from the project site of Chunar as a closest distance as shown in **Figure 11.2.7**. It is assumed that the project may not influence anything to the Sanctuary since it is enough too far.



Source: JICA Survey Team

Figure 11.2.7 Location Map of Chandraprabha Wildlife Sanctuary

11.2.4 Socio-Economic Environment

(1) Socio-Economic Profile

Uttar Pradesh is the most populous state in the country accounting for 16.4 per cent of the country's population. It is also the fourth largest state in geographical area covering 9.0 per cent of the country's geographical area, encompassing 294,411 km^2 and comprising of 83 districts, 901 development blocks and 112,804 inhabited villages. The density of population in the state is 473 persons per square km^2 as against 274 for the country. The population, population growth from 2001 to 2011, employment rate and industries of the target cities is shown in **Table 11.2.6**.

Table 11.2.6 Socio-Economic Profile of Target Cities

	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar
Population	3,676,841 (Male: 1,921,857, Female: 1,754,984)	2,496,970 (Male: 1,312,302, Female: 1,184,668)	3,620,268 (Male: 1,855,075, Female: 1,765,193)	49,132 (Male: 26,071, Female: 23,061)	37,185 (Male: 19,647, Female: 17,538)
Population growth (%)	17.15	18.00	19.18	N/A	N/A
Employment rate	29%	N/A	N/A	N/A	N/A
Industry	• Spinning • Weaving • Metal • printing and publishing • electrical machinery,	• Carpet manufacturing.	N/A	No major industries. Some micro & small enterprises	• Agriculture • Agri-based business.

Source: Census India 2011.

(2) Indigenous Groups

Regarding "Indigenous Groups" as per the world bank's OP 4.10, SCs (Scheduled Casts) and STs (Scheduled Tribes) are regarded as indigenous group by the Indian Government. In UP state, the tribes of Baiga, Agaria, Aheria, Baiga、Belder and Buksh have been recognized as STs by the Indian Government. Among them, only Agariya has been inhabited in Mirzapur of the target cities. However, the location of the inhabitant cannot be identified. The proposed sites are public roads and vacant lands, which will not include the tribe and may not affect these groups even if they are identified. In addition, the project sites are not mountainous area will not include "Forest Dweller".

11.2.5 Baseline Data which was not available

Some data was available only for UP state and Varanasi city. The data in other cities which was not available in the survey will be a pending issue.

11.3 Indian Legislative and Institutional Framework on Environmental and Social Considerations

11.3.1 Legal Framework of the Government of India

The Government of India has laid various policy guidelines, acts and regulations pertaining to the environment. The Environment (Protection) Act, 1986 is the umbrella legislation for the protection of environment. As per this Act, the responsibility to administer the legislation has been jointly entrusted to the Ministry of Environment and Forests (MoEF) and the Central Pollution Control Board (CPCB)/State Pollution Control Boards (SPCBs).

11.3.2 Key Environmental Laws and Regulations

The key environmental laws and regulations relevant to the projects are shown in **Table 11.3.1**. The complete lists are shown as well as the applicability in the projects.

Table 11.3.1 Environmental Regulations and Legislations

No.	Act/Rules	Purpose	Applicable (Yes/No)	Reason for Applicability	Authority
1	The Environment Protection Act, 1986	To protect and improve overall environment	Yes	As all environmental notifications, rules and schedules are issued under this act.	MoEF, CPCB, SPCB
2	Environmental Impact Assessment Notification, 14th Sep-2006	To provide environmental clearance to new development activities following environmental impact assessment	No	This notification is applicable only to the identified 29 projects that need an EC posted at UPPCB website	MoEF
3	Municipal Wastes (Management and Handling) Rules, 2000	To manage the collection, transportation, segregation, treatment and disposal of municipal solid wastes	No	This notification is applicable to municipal solid waste treatment facility projects	MoEF, CPCB, SPCB
4	Notification for Use of Fly Ash	Reuse large quantity of fly ash discharged from thermal power plant to minimize land use for disposal	No	If thermal plant is within 100 km from any sewerage treatment facility projects	
5	National Environment Appellate Authority Act (NEAA) 1997	Address grievances regarding the process of environmental clearance	No	If EC is issued but for NOC, not applicable	NEAA (National Environment Appellate Authority)
6	The RFCT in LARR (Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act), 2013	Set out for acquisition of land by government	Yes	This act will be applicable to as there will be acquisition of land for the projects.	Revenue Department State Government
7	The Forest (Conservation) Act 1980	To check deforestation by restricting	No	This act is applicable if there is diversion of	Forest Department, State

No.	Act/Rules	Purpose	Applicable (Yes/No)	Reason for Applicability	Authority
		conversion of forested areas into non-forested areas		forest land for non-forest activities for any of the projects	Government and MoEF
8	MoEF circular (1998) on linear plantation on roadside, canals and railway lines modifying	Protection/planting roadside strip as avenue/strip plantation	Yes	This act will be applicable if sewers are to be laid along roadside, wherein roadside tree plantation exists, irrespective of whether tree felling is involved or not	Forest Department, State Government and MoEF
9	Wild Life Protection Act 1972	To protect wildlife through certain of National Parks and Sanctuaries	No	This act is will be applicable, if there are any points of wildlife crossings in proximity to project locations	Chief Conservator Wildlife, Wildlife Wings, State Forest Department and MoEF
10	Air (Prevention and Control of Pollution) Act, 1981	To control air pollution from transport and controlling emission of air pollutants as per prescribed standards	Yes	This act will be applicable during construction for obtaining NOC for establishment of workers' camp, construction camp, etc.	SPCB
11	Water Prevention and Control of Pollution Act, 1974	To control water pollution by controlling discharge of pollutants as per prescribed standards	Yes	This act will be applicable during construction for obtaining NOC for establishment of workers' camp, construction camp, etc.	SPCB
12	The Noise Pollution (Regulation Control) Rules, 2000	The standards for noise for day and night have been promulgated by MoEF for various land uses	Yes	This act will be applicable for all construction equipment deployed at the worksite	SPCB
13	Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains found in India	No	This act will be applicable only if any of the projects is in proximity to any ancient monuments, declared protected under the act	Archaeological Dept. GoI, Indian Heritage and Indian National Trust for Art and Culture Heritage (INTACH)
14	Public Liability Act, 1984	Protection from hazardous materials and accidents	Yes	Contractor need to stock hazardous material like diesel, bitumen, emulsions, etc.	SPCB
15	Explosive Act, 1984	Safe transportation, storage and use of explosive material	Yes	For transporting and storing diesel, oil and lubricants, etc.	Chief Controller of Explosives
16	Central Motor Vehicle Act 1988 and Central Motor Vehicle Rules 1989	To check vehicular air and noise pollution	Yes	This rule will be applicable to vehicles deployed for construction activities and construction machinery.	Motor Vehicles Department

Source: JICA Survey Team

11.3.3 Environmental Clearance

(1) Legal Basis for Environmental Clearance

EIA Notification 2006 is a legal basis which stipulates environmental clearance for development of projects. There are the following four (4) stages in the environmental clearance process as per the notification.

- Stage 1: Screening
- Stage 2: Scoping
- Stage 3: Public Consultation
- Stage 4: Appraisal

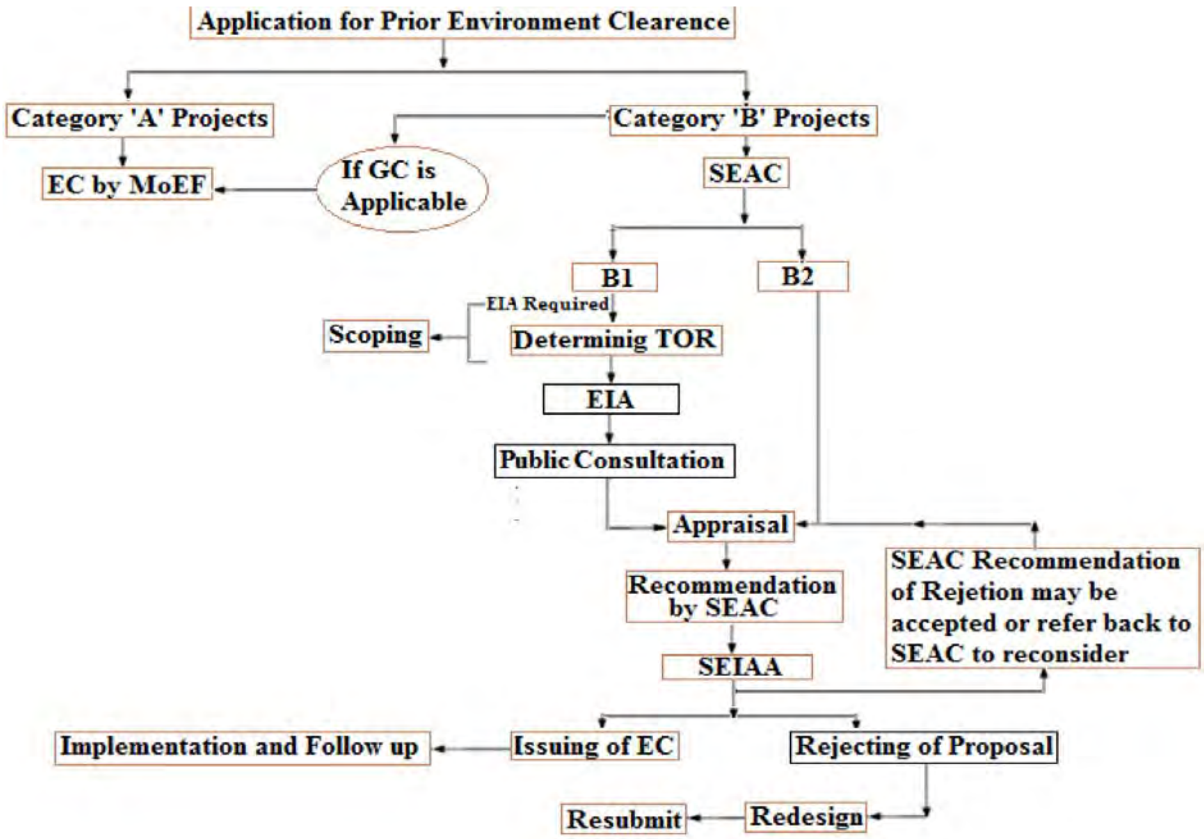
(2) Stage 1: Screening

According to the notification, projects are classified either Category A or Category B depending on the types, scales of the projects and potential impact level to be caused by them. For Category A projects which have large scales and cause potential significant impact, EC (Environmental Clearance) shall be obtained from the EAC (Expert Appraisal Committee) of MoEF (Ministry of the Environment and Forests). For Category B project which have less scales comparing to category-A projects and may have less impact level, on one hand, an EC shall be obtained from the SEAC (State Level Expert Appraisal Committee).

In the case of Category B projects, this stage will entail the scrutiny of an application seeing prior environmental clearance made in Form 1 by the concerned State Level Expert Appraisal Committee (SEAC) for determining whether the project requires further environmental studies for preparation of an Environmental Impact Assessment (EIA).

The projects requiring an EIA report shall be termed Category B1. Projects of Category B2 are not required to prepare an EIA report. In projects of Category B, Category B is applied only for the project of" Townships and Area Development projects", while other projects are categorized as B2.

The general process flow of the prior EC in India is shown in **Figure 11.3.1.**



Source: "Public Involvement in Environmental Impact Assessment: A Study of Sorang Hydroelectric Power Project in District Kinnaur, Himachal Pradesh, India", Lata R et.al, 2015

Figure 11.3.1 Prior Environmental Clearance Process Flow in India

(3) Scoping

Scoping refers to the process by which a review is undertaken by the EAC (Expert Appraisal Committee) in the case of Category A projects, and SEAC (State level Expert Appraisal Committee) in the case of Category B1 projects. All projects of Category B require scoping. The projects for construction, township, commercial complex and housing including sewerage projects shall not require scoping and will be appraised based on Form 1and a conceptual plan.

(4) Public Consultation

Public Consultation refers to the process by which the concerns of local affected persons and others who have a plausible stake in the environmental impacts of the projects are ascertained with a view to considering all the material concerns regarding the project or activity design as appropriate. All Category A and Category B1 projects or activities shall undertake public consultation, except a) Irrigation projects, b) all projects located within industrial estates or parks, c) expansion of roads, d) all building / construction projects, e) all projects as determined by the Central Government.

(5) Appraisal

Applicants shall submit the final EIA report and outcome of the public consultations including public hearing proceedings to the regulatory authority concerned (EAC or SEAC) for obtaining the EC. The appraisal of all projects which are not required to submit an Environmental Impact Assessment report shall be carried out based on the prescribed application Form 1 and Form1A as applicable. After the final EIA report is received by the EAC or SEAC, it takes 60 days to approve the report.

(6) EIA Requirement for Proposed Projects

According to EIA Notification 2006, water supply and sewerage projects is categorized as Category B2 and will not require conducting EIA (Environmental Impact Assessment) nor information disclosure.

(7) Comparison of India EIA System and JICA Guideline

The comparison on the requirements in between Indian EIA system which is mainly regulated in EIA Notification 2006 and JICA guideline (JICA Guideline for Environmental and Social Considerations 2010) is summarized in **Table 11.3.2**.

Table 11.3.2 Comparison between Indian EIA System and JICA Guideline

JICA Guideline	Indian EIA System as per EIA Notification 2006 or other Relevant Legislation / Regulation	Gap between JICA Guideline and India EIA System	Action to fill Gap by the Project
1. Information Disclosure			
• Important Principles, 5. JICA discloses information: JICA itself discloses information on environmental and social considerations in collaboration with project proponents etc., in order to ensure accountability and to promote the participation of various stakeholders. • 2.1 Information Disclosure: In principle, project proponents etc. disclose information about the environmental and social considerations of their projects. JICA assists project proponents etc. by	• The approved TOR (Terms of Reference) by the Expert Appraisal Committee or State Level Expert Appraisal Committee for EIA study shall be published on the website of the Ministry of Environment and Forests and the concerned State Level Environment Impact Assessment Authority. • For obtaining responses in writing from other concerned persons having a plausible stake in the	Yes.	Project proponent is recommended to disclose the results on ESCs various stakeholder as much as possible.

JICA Guideline	Indian EIA System as per EIA Notification 2006 or other Relevant Legislation / Regulation	Gap between JICA Guideline and India EIA System	Action to fill Gap by the Project
implementing cooperation projects as needed.	environmental aspects of the project or activity, the concerned regulatory authority and the State Pollution Control Board (SPCB) or the Union Territory Pollution Control Committee(UTPCC) shall invite responses from concerned persons by publishing draft Summary EIA report on their websites		
2. Screening			
JICA classifies projects into four (4) categories according to the extent of environmental and social impacts, taking into account an outline of project, scale, site condition, etc. • Category A: Proposed projects which are likely to have significant adverse impacts on the environment and society. • Category B: Proposed projects whose potential adverse impacts on the environment and society are less adverse than those of Category A projects. • Category C: Proposed projects which are likely to have minimal or little adverse impact on the environment and society. • Category FI: Proposed projects which satisfy the following requirements: - JICA's funding of projects is provided to a	• All projects and activities are broadly categorized into two categories - Category A and Category B based on the spatial extent of potential impacts and potential impacts on human health and natural and man-made resources. • The projects requiring an Environmental Impact Assessment report shall be termed Category 'B1' and remaining projects shall be termed Category 'B2' and will not require an Environment Impact Assessment report • For Category A projects, EC shall be obtained from the EAC (Expert Appraisal Committee) of the central MoEF (Ministry of	Yes. There is no Category for F1 in Indian EIA system.	Not applicable.

JICA Guideline	Indian EIA System as per EIA Notification 2006 or other Relevant Legislation / Regulation	Gap between JICA Guideline and India EIA System	Action to fill Gap by the Project
financial intermediary or executing agency - the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal) - those sub-projects are expected to have a potential impact on the environment	Environment and Forestry) • For Category B projects, EC shall be obtained from state level EAC, where B1 projects require EIA and B2 projects do not require EIA		
1. Environmental and Social Elements to be Assessed			
• Impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. • Impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social	At the screening based on Form 1, the current status and potential impacts on the following environmental and social aspects shall be examined in combination with EMMP (Environmental management and Monitoring Plan). • Land environment • Water environment • Vegetation • Fauna • Air environment • Aesthetics • Socio-economic aspects	Yes. There are no environmental and social elements for the following to be assessed in Indian EIA system. • social capital and local decision-making institutions • existing social infrastructures and services • vulnerable social groups such as poor and indigenous peoples • equality of benefits and losses and equality in the development process • gender, children's rights • local conflicts of interest • infectious	The project needs to encourage the project proponent to take the JICA requirement as much as possible.

JICA Guideline	Indian EIA System as per EIA Notification 2006 or other Relevant Legislation / Regulation	Gap between JICA Guideline and India EIA System	Action to fill Gap by the Project
groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.		diseases such as HIV/AIDS,	
2. Consultation with Local Stakeholders			
• In principle, project proponents etc. consult with local stakeholders through means that induce broad public participation to a reasonable extent, in order to take into consideration the environmental and social factors in a way that is most suitable to local situations, and in order to reach an appropriate consensus. • Category A projects, JICA encourages project proponents etc. to consult with local stakeholders about their understanding of development needs, the likely adverse impacts on the environment and society, and the analysis of alternatives at an early stage of the project, and assists project proponents as needed.	All Category 'A' and Category B1 projects or activities shall undertake public consultation, except the following: • Modernization of irrigation projects • All projects or activities located within industrial estates or parks approved by the concerned authorities • Expansion of roads and highways) which do not involve any further acquisition of lands • All building / construction projects/ area development projects and townships • All Category 'B2' projects and activities. • All projects or activities concerning national defence and security or involving other strategic considerations as determined by the Central Government.	Yes.	The project proponent needs to hold stakeholder meetings as much as possible.

JICA Guideline	Indian EIA System as per EIA Notification 2006 or other Relevant Legislation / Regulation	Gap between JICA Guideline and India EIA System	Action to fill Gap by the Project
5.Others (Involuntary Resettlement)			
• Involuntary Resettlement: Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. • When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.	EIA Notification does not mention involuntary resettlement. However, in case of the project which includes resettlement or land acquisition of private lands including compensation or rehabilitation measures, the project shall follow the provisions of the LARR (Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act), 2013 which provides fair compensation policies for PAPs (Project Affected Persons) corresponding to the requirements of international cooperation agencies..	No	

Source: JICA Survey Team

11.3.4 Relevant Clearance / Permissions other than Environmental Clearance

The major relevant clearances / permissions other than EC (Environmental Clearance) for implementation of the proposed projects and relevant information regarding the process details are shown in **Table 11.3.3**.

Table 11.3.3 Relevant Clearance / Permissions other than Environmental Clearance

No.	Action by Project	Authority for Granting Permission	Process to be Required
1	Crossing of Railways	Indian Railways	• Basis for legal or regulations: Guideline on Pipeline Crossing under Railway Track, 2009 • Responsible agency who shall grant a permission: Ministry of Railways • Approximate period from application to final permission for construction: 4 months • Required condition for permission: UPJN has to pay a charge depending the size of R/W to Indian Railways
2	Excavation of underground road area (highway, district roads, village roads, municipality roads)	PWD (Public Works Department)	• Basis for legal or regulations: The U.P. Roadside Land Control Rules, 1964 • Responsible Agency who shall grant the permissions: PWD • Approximate Period from Application to final approval: 1 to 2 month • UPJN has to prepare an application document and submit it to PWD
3	Discharge of treated wastewater	UPPCB	• Basis for legal or regulations: Guideline of MOEF / CPCB (Central Pollution Control Board) • Responsible Agency who shall grant the permissions: UPPCB (Uttar Pradesh State Pollution Control Board) • Approximate Period from Application to Final approval.: 1month • Concerned Executive Engineer of UPJN has to prepare an application document.
4	Permission for tree cutting	Forest Department (State Government of U.P.)	• Basis for legal or regulations: U.P. Transit Timber and Other Forest Produce Rules, 1978 • Responsible Agency who shall grant the permissions: Forest Department • Approximate Period from Application to Final approval: 2 months at maximum • Concerned department to prepare and apply document to each municipality
5	Power Receiving	PuVVNL (Purvanchal Vidynt Vitran Nigam Limited)	• Basis for legal or regulations: N/A • Responsible Agency who shall grant the permissions: PuVVNL • Approximate Period from Application to Final approval: 15 days • Concerned Executive Engineer to prepare and submit to PuVVNL

Source: JICA Survey Team

11.4 Project Alternatives Analysis

11.4.1 Zero Option

Zero option is the current sewerage system which does not implement projects. Generally, periodical maintenance has not been carried out for the drainages and the drainage channel has been filled with lots of garbage and causing worsened drainage to flow due to its clogging at the channels. Water quality observed in the drainages was almost raw sewage since sewerage system has not been developed. **Table 11.4.1** summarizes the comparison of potential negative and positive impacts against the zero option (without implementing projects) and the project scenario (with projects implementation).

Table 11.4.1 Summary of Major Potential Impacts by Zero Option and Project Scenario

	Zero Option	Project Scenario
Negative Impact	• Worsened water pollution of the Ganga river due to untreated sewage flow-in • Increased infectious risks due to worsened hygine status due to untreated sewage discharge • Decreased opportunities for local economy due to no construction works • Decresed value of estates	• Temoprary impact on social infrasturucture such as roads, railways and utilities at construction phase • Temporary impact of dust and noise at construction sites at construction phase • Increased social unrest against future potential tariff increase
Positive Impact	• Less risks of accicendents and third parties because of no construction works • No disturbance or destruction of ecosystem in case of sites with higer rich of flora and fauna species	• Increased opportunities for local economy due to employment of construction workers at local level • Improved water water quality of the Ganga river due to reduced pollutant loads by treatment of sewage at pollutant source • Decreased infectious risks due to improved hygine status through treatment of sewage • Increased values of estate

Source: JICA Survey Team

11.4.2 Selection of Location of Target Catchment Area

The target catchment area of the sewage and drainage for implementation of the projects is basically based on the DPRs. Through verification of the DPRs, the project sites in each catchment were selected in terms of current status of development of sewerage system, land availability for STP sites, pumping stations and project implementation / procurement method including fund allocation.

11.4.3 Selection of Treatment Method

(1) Sewage Treatment

Originally, the process of the sewage treatment of the STPs in each municipality was proposed in DPRs. Then, verification was made for the proposed process in the DPRs in the JICA study. Table 11.4.2 shows the treatment process of each STP which was finally selected by the JICA survey for the originally proposed treatment methods by DPRs through a comprehensive evaluation in terms of pollution control performance of nitrogen removal and effluent quality, cost (capital, operation and maintenance cost) and past record in India. Originally, advanced type SBR was adopted for the STPs for Chunar, Vindhyachal, Mirzapur, and Ghazipur, CND process for Ramnagar and Ramna. These treatment methods were adopted to meet more strict standards toward improved water environment.

Table 11.4.2 Comparison of Sewage Treatment Processes

Item			Varanasi	Mirzapur		Ghazipur	Ramnagar	Chunar	New Standard (Planned)
			Ramna STP	Mirzapur STP (new)	Vindhyachal STP (new)	Ghazipur STP	Ramnagar STP	Chunar STP	
Base Year		-	2020	2020	2020	2015	2020	2020	
Target Year		-	2050	2050	2050	2045	2050	2050	
Project Area		ha	-	1,795.44	292.82	2000	494.66	831.2	
Population Projection		no.	-	347,938	75,686	205,000	118,503	80,000	
Density of Population		no./ha	-	193.8	258.5	102.5	239.6	96.2	
Unit Rate of Water Consumption		lpcd	150	135	135	135	135	135	
Sewage Volume at Target Year (Daily Ave.)		MLD	-	41	9	24.36	14.06	9.48	
Design Sewage Volume	Existing	MLD	-	-	-	-	-	-	
	Future	MLD	50	18 (2030)	2 (2030)	18 (2025)	13 (2050)	6.5 (2030)	
Raw Sewage Quality	pH	-	7-8	7-8	-	6-8	7-7.5	7-8	
	BOD	mg/l	200	250	-	250	250	250	
	SS	mg/l	600	400	-	250	450	400	
	TK-N	mg/l	40	-	-	35	30	-	
	Fecal Coliform	MPN/100 ml	10^7	10^8	-	-	-	10^8	
Treated Effluent Quality	pH	-	10	6.5-8	-	6.5	7.5	6.5-8	6.5-9
	BOD	mg/l	10	10	10	10	10	≦10	≦10
	SS	mg/l	10	10	10	10	10	≦10	≦10
	T-N	mg/l	10	10	10	10	10	10	≦10
	Faecal Coliform	MPN/100 ml	230	230	230	230	230	230	<230
Sewage Treatment Process	Proposed by DPRs		CND (Single-stage)	SBR	SBR	Advanced SBR	CND (Single-stage)	SBR	
	Proposed by JICA Survey		Same as DPR	Advanced SBR	Same as DPR	Same as DPR	Same as DPR	Advanced SBR	
Disinfection Process		-	Chlorine Contact						
Sludge Treatment Process		-	Thickener Digestion SDB			Thickener Digestion Centrifuge	Thickener Digestion Centrifuge	Thickener Digestion Centrifuge	

Source: JICA Survey Team

(2) Sludge Treatment Process

Refer to Chapter 9 for details on the study on sludge treatment process.

(3) Sludge Disposal

As the sludge disposal process in the urban area in Japan, dewatered sludge is often treated furthermore for volume reduction to landfill or re-use by incineration. However, in case of the proposed project, the STPs are located near farmland, thus a final disposal of the dewatered sludge in farm lands was selected.

11.5 Scoping and Terms of References for Environmental and Social Considerations

11.5.1 Initial Scoping

An initial scoping for the proposed projects was made as shown in **Table 11.5.1**. The following adverse environmental and social impacts are estimated.

- At construction phase: hydrology, resettlement / land issues, social infrastructure, infectious diseases, working environment and safety, air pollution (dust) , waste, noise and accidents
- At operation phase: poverty, landscape, working environment and safety, water pollution, waste, soil contamination, noise, offensive odour, accident, climate change

Table 11.5.1 Results of Initial Scoping

Category	No.	Impact	Assessment		Reason for Assessment
			Const.	Oper.	
Natural Environment	1	Protected Area	D	D	The project site and surrounding area is not located in any national parks or nature reserves.
	2	Ecosystem	D	D	Most of the project sites are planned at built-up area.
	3	Hydrology	B-	D	At construction stage: Potential disturbance of natural drainage is estimated by the temporary storage of excavated soil and construction materials. At operation stage: The current sewage discharging in nallah and finally into rivers will be taken into the proposed sewerage system as a balance.
	4	Topography / Geology	D	D	At construction stage: The construction works will not cause a large-scaled topographical and geological alteration.
Social Environment	5	Resettlement / Land Issue	B-	D	The project will require land acquisition for the construction of STPs and pumping stations.
	6	Poverty	D	B-	At Operation stage: The increase of sewage tariff may affect the low-income households.
	7	Ethic Minority	D	D	There is no ethnic minorities nor indigenous people at the project sites.

Category	No.	Impact	Assessment		Reason for Assessment
			Const.	Oper.	
	8	Employment, sustenance and regional economy	B+	D	At Construction stage: An opportunity for employment of residents is expected by the construction works and may contribute to local economy.
	9	Land Use / Regional Resource	D	D	The project sites are the existing facility areas of sewerage treatment facilities and the vacant areas in the built-up area and the public roads.
	10	Water Use	D	D	The project does not relate to water use.
	11	Social Infrastructure / Service	B-	D	At Construction stage: The excavation / construction works at the construction sites may affect the traffic flow and existing public utilities such as water pipes, telephone cables.
	12	Local society for decision making	D	D	The project is to implement a public works by the government which aim to bring public benefit and will not affect local society.
	13	Unbalance of damages and benefits	D	D	The project is to provide improved sanitation system to the citizens equally.
	14	Local Conflicts of Interests	D	D	The project does not provide its improved sanitation system only to partial people or social structure, and it will not bring local conflicts.
	15	Heritage or Cultural Assets	D	D	The project sites are public roads or built-up areas which not encompass such historical or cultural assets.
	16	Landscape	D	B-	New appearance of facilities may affect surrounding landscape.
	17	Gender	D	D	The project is not related to gender issue.
	18	Right of Children	D	D	The project is not related to the issue of right of children. Child labor will be prohibited for implementation of the project by compliance with national laws or international guidelines.
	19	Infectious Diseases (e.g. HIV / AIDS)	B-	D	The inflow of construction workers may generate or expand infection diseases.
	20	Working Environment and Safety	B-	B-	At Construction stage: Care should be taken for the working environment of the construction workers At Operation stage: Care should be taken for the maintenance works of sewers for potential generation of toxic gases or handling of the chlorine gas at the disinfection process.
Pollution	21	Air Pollution	B-	D	The construction vehicles and equipment at construction stage will generate dust
	22	Water Pollution	D	B∓	At Construction stage: Turbid water will be generated temporarily at construction sites. However, its impact is minor. At Operation stage: Basically, the project will improve water quality. However, inappropriate operation or system dysfunction may cause water quality pollution.
	23	Waste	B-	B-	At Construction stage: Construction / demolition debris, excavation soil and the garbage at construction camps will be generated. At Operation stage: Sludge will be generated at the sewage and sludge treatment process.
	24	Soil Contamination	D	B-	The leakage of sewage at the sewers may pollute the surrounding ground.
	25	Noise / Vibration	B-	B-	At Construction stage: Noise will be generated by the operation of construction vehicles and equipment.

Category	No.	Impact	Assessment		Reason for Assessment
			Const.	Oper.	
					At Operation stage: Noise will be generated by the operation of blowers and pumping equipment at STPs and pumping stations
	26	Ground Subsidence	D	D	The project does not extract groundwater.
	27	Offensive Odour	D	B-	The project may generate odour at the treatment process of sludge.
	28	Sediments	D	D	The project does not include the activities which affect the sediments of the river bed.
Others	29	Accident	B-	B-	At Construction stage: Care should be taken for the accidents for construction workers and third parties which are estimated at the construction works. At Operation stage: Care should be taken for the accidents which are estimated at the operation and maintenance works.
	30	Climate Change	D	B-	At Operation stage: The operation of the equipment such as pumping units and blower at STPs and ISPSs will consume electricity and generate treated sludge which may cause GHGs.

Notes:
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Survey Team

11.5.2 Terms of References for IEE

The IEE (Initial Environment Examination) for the potential adverse impact was conducted through literature survey, interview with the C/P (Counter Parts), construction plan,future plan of the projects and legal and isnstitutional requirements.

11.5.3 Estimation of Potential Impacts and Assessment

The potential adverse impact by the proposed projects is shown in **Table 11.5.2**.

Table 11.5.2 Potential Adverse Impacts at Project Phase

Phase: Construction

No.	Impact	Potential Adverse Impact
1	Hydrology	At monsoon season, the stockpile of the excavated soil and construction materials may block the natural drainage flow by the placement at lower area or on the direct water course of the drainage flow.
2	Resettlement / Land Issue	The land of Ramnagar STP site has not been secured. The land acquisition process is currently under way. The impact of discontent will be generated for the PAPs (Project Affected Persons) in terms of compensation process and some risk will remain for the project implementation.
3	Social Infrastructure / Service	The excavation works and pipe laying works of the proposed sewer lines may cause traffic congestion and public utilities such as water pipes and telephone cables and power lines specially on the following areas which has currently large volume or densely areas ; • Varanasi city: All project sites of sewer lines • Mirzapur city: Jln Lohiya Talab Road, Rambagh Road, Railway

		• Chunar city: Dragh Sharif Station Road, Chunar Fort Road
4	Infectious Diseases (e.g. HIV / AIDS)	During the construction phase, risk of HIV/AIDS infection may increase among construction workers around construction sites due to the inflow of construction workers from various districts in India.
5	Working Environment and Safety	During construction stage, adverse impact of working environment and safety on construction workers is estimated by the inappropriate construction manners and unexpected emergent events and poor work environment.
6	Air (Dust)	At the construction phase, dust will be generated by the operation of construction vehicles and construction equipment at construction sites and surrounding areas. Some adverse impact is estimated.
7	Waste	The excavation works or demolition works at the proposed sewer lines, rising mains, MPS, IPS and STPs will generate excavated soil and demolition waste by their construction works. And, domestic garbage will be generated at the construction camps. The impact due to treatment and the final disposal of such waste is estimated.
8	Noise	Some impact of noise on the surrounding residential area by the travelling of construction vehicles and operation of construction machineries. Special care should be taken in case that vulnerable sound receptors such as schools and hospitals exist at the vicinity areas of the project sites.
9	Accident	The increase of vehicles for the construction works may cause traffic congestions on the local road network, and increase the risk of traffic accidents around the construction sites. A part of roads around the project sites may be temporarily blocked and cause traffic congestion at some sections. Traffic may be encroached due to the arrangement of the works such as scaffold, material yard and operation of construction equipment. The vehicles carrying the materials, wastes to and from the construction area may drop spoil or soil on the road surface which cause slippery condition and increases the risk of unsafe traffic.

Source: JICA Survey Team

Phase: Operation

No.	Impact	Potential Adverse Impact
1	Poverty	At the operation phase after the construction of the sewerage facilities, the sewage tariff will be increased to recover the future increase of the operation and maintenance cost. Therefore, future increase of sewage tariff may affect the household economy of the urban poor.
2	Landscape	The appearance of new facilities of STPs, MPSs and IPSs may affect the city scape of the project sites. However, the height of the proposed STPs which will be below 10 m may not damage the existing landscape
3	Working Environment and Safety	The sewers may generate hazardous gas H_2S (Hydrogen Sulfide) and CH_4 (Methane) at the maintenance works. In addition, the operation works of STPs will have to handle the hazardous gas of CH_4 and Chlorine gas. These O&M works may cause adverse impact.
4	Water Pollution	At operation stage, some impact on water pollution due to the malfunction or dysfunction of the STP process or defect of the maintenance works is estimated for the following STPs. • Varanasi city: Dinapur STP whose effluent will be discharged into Varuna river • Mirzapur city: Mirzapur STP and Vindhyachal STP • Ghazipur city: Ghazipur STP • Ramnagar city: Ramnagar STP • Chunar city: Chunar STP
5	Waste	Screen residues and sludge will be generated by the STP process. Some impact is estimated relating to the disposal of the sludge due to is inappropriate manners of disposal.
6	Soil contamination	Potential leakage of the sewage at the sewer lines and manholes may cause a risk of soil contamination of the surrounding ground at the operation and the maintenance stage.
7	Noise	Pumping unit, blower, emergency generator and dewatering centrifuge will be source of generating noise at the STPs, MPSs and IPSs especially on the following sites where some residential houses exist currently. • Varanasi city: Dinapur STP • Mirzapur city: Mirzapur and Vindhyachal STP • Ghazipur city: Ghazipur STP

8	Offensive Odour	Odour may be generated at the sludge treatment at the proposed STPs due to dysfunction of the operation of STPs. Some impact of odour on surrounding areas especially on the following STPs where more residential houses exist rather than other STPs; • Varanasi city: Dinapur STP • Mirzapur city: Mirzapur and Vindhyachal STP • Ghazipur city: Ghazipur STP
9	Accident	Some accidents are estimated due to the travelling of the trucks of conveying treated sludge and incoming of honey wagons. However, the impact level is less compared to the construction phase.
10	Climate change	The following GHGs are estimated at the proposed STPs and MPSs; (1) GHGs due to power consumption • Dinapur STP: 9,696 – 7,763 = 1,933 MWh/y (which is power consumption – power generation by biogas recovery) • Mirzapur STP: 2,151 MWh/y • Vindhyachal STP: 722 MWh/y • Mirzapur MPS: 629 MWh/y • Chunar STP: 769 MWh/y • Chunar MPS: 112 MWh/y • Ghazipur STP: 2,090 MWh/y • Ramnagar STP: 1,223 MWh/y • Ramnagar MPS: 335 MWh/y Total power consumption: 9,964 MWh/y Therefore, 9,964 MWh/y x 0.82 t-CO_2/MWh* = <u>8,170.5 t-CO_2/year</u> is estimated for GHGs generation by the power consumption. *: Source: "CO_2 Baseline Database for the Indian Power Sector", April 2016, Ministry of Power Central Electricity Authority, India (2) GHGs Emission due to disposal of sludge <u>Sludge generation in dry base*</u> • Mirzapur STP: 56.26 m^3/day • Vindhyachal STP: 9.31 m^3/day • Chunar STP: 10.1 m^3/day • Ghazipur STP: 16.0 m^3/day • Ramnagar STP: 17.57 m^3/day Total generation of treated sludge to be disposed: 109.24 m^3/day 0.0667 t- CH_4/ds-t is assumed as the emission factor for landfilling of sludge in semi-aerobic state.** 0.0667 x 109.24 m^3/day x 0.8 t/m^3 = 5.83 t-CH_4/day (= 2,128.0 t-CH_4/year) CH_4 converted to CO_2: 25 x 2,128.0 tCO_2e/year = <u>53,200 tCO_2e/year</u> Therefore, 53,200 tCO_2e/year of GHGs is estimated by the sludge disposal. Notes *: Biogas (GHGs) is recovered for power generation. **Source: Ministry of Land, Infrastructure, Transport and Tourism, Government of Japan (3) Potential Generation of GHGs The total generation of GHGs is <u>61,370.5 tCO_2e/year</u> is estimated by the operation of STPs and MPSs.

Source: JICA Survey Team

11.6 Assessment Results of Environmental and Social Impacts at Initial Scoping and IEE

The assessment result toward potential adverse impacts for the initial scoping and IEE is shown in **Table 11.6.1**.

Table 11.6.1 Assessment Results at Initial Scoping and IEE

Category	No.	Impact	Initial Scoping		IEE		Reasons for Assessment
			Const.	Oper.	Const.	Oper.	
Natural Environment	1	Protected Area	D	D	N/A	N/A	The project site and surrounding area is not located in any national parks or nature reserves.
	2	Ecosystem	D	D	N/A	N/A	Most of the project sites are planned at built-up area.
	3	Hydrology	B-	D	B-	N/A	At monsoon season, the stockpile of the excavated soil and construction materials may block the natural drainage flow.
	4	Topography / Geology	D	D	N/A	N/A	The project does not include large-scaled excavation works.
Social Environment	5	Resettlement / Land Issue	B-	D	B-	N/A	The land of Ramnagar STP site has not been secured. The land acquisition process is currently under way. The impact of discontent will be generated for the PAPs (Project Affected Persons) in terms of compensation process and some risk will remain for the project implementation.
	6	Poverty	D	B-	N/A	B-	Future increase of sewage tariff may affect the household economy of the urban poor.
	7	Ethic Minority	D	D	N/A	N/A	There is no ethnic minority nor indigenous people at the project sites.
	8	Employment, sustenance and regional economy	B+	D	N/A	N/A	An opportunity for employment of residents is expected by the construction works and may contribute to local economy.
	9	Land Use / Regional Resource	D	D	N/A	N/A	The project sites are the existing facility areas of the sewerage systems, vacant areas in the built-up area and the public roads which may not cause significant change the land use.
	10	Water Use	D	D	N/A	N/A	The project does not relate to water use.
	11	Social Infrastructure / Service	B-	D	B-	N/A	The construction works of the water pipelines at road areas and GLRs may affect the traffic flow and existing underground utilities.
	12	Local society for decision making	D	D	N/A	N/A	The project is to implement a public works by the government which aim to bring public benefit and will not affect local society.
	13	Unbalance of damages and benefits	D	D	N/A	N/A	The project is to develop water supply facilities of safe water to the 110 villages which are currently not served by BWSSB's water service and not bring unbalance damage and benefit.
	14	Local Conflicts of Interests	D	D	N/A	N/A	The project does not supply water to specific people or structure, and it will not bring local conflicts.
	15	Heritage or Cultural Assets	D	D	N/A	N/A	Historical/cultural assets are conserved by UP states. The project will not affect these issues since the project sites do not encompass such historical or cultural assets.
	16	Landscape	D	B-	N/A	D	The heights of buildings of the proposed STPs are below 10 meters; therefore it may not have impacts to local landscape.
	17	Gender	D	D	N/A	N/A	The project is not related to gender issue.
	18	Right of Children	D	D	N/A	N/A	Child labor will be prohibited for the implementation of the project.

Category	No.	Impact	Initial Scoping		IEE		Reasons for Assessment
			Const.	Oper.	Const.	Oper.	
	19	Infectious Diseases (e.g. HIV / AIDS)	B-	D	B-	N/A	A risk of HIV/AIDS infection may increase among construction workers around construction sites.
	20	Working Environment and Safety	B-	B-	B-	B-	At construction phase: Adverse impacts on construction workers, surrounding residents is estimated. At operation phase: Potential generation of hazardous gas H_2S and CH_4 may cause adverse impact on occupational health and safety.
Pollution	21	Air Pollution	B-	D	B-	N/A	At construction phase: Dust will be generated by the operation of construction vehicles and construction equipment at construction sites and surrounding areas.
	22	Water Pollution	D	B-	D	B-	At construction phase: Most of case, water quality problems caused by excavation works when the works are carried out in river crossing. In terms of water pollution, impact the project is low and temporary since he river water is already turbid in the project site. At operation phase: Some impact on water pollution due to the malfunction or dysfunction of the STP process or defect of the maintenance works is estimated.
	23	Waste	B-	B-	B-	B-	At construction phase: The excavation works or demolition works at the proposed sewer main, STPs and ISPSs will generate excavated soil and demolition waste by the construction works. At operation phase: Screen residues and treated sludge will be generated by the STP process. Appropriate treatment and disposal is necessary.
	24	Soil Contamination	D	B-	N/A	B-	At operation phase: Potential leakage of the sewage at the main sewer may cause a risk of soil contamination of the surrounding ground.
	25	Noise / Vibration	B-	B-	B-	B-	At construction phase: Some impact of noise on the surrounding residential area by the construction works at the areas close to residential areas. At operation phase: Some impact of noise by the operation of the equipment may affect the surrounding residential area by the operation of pump units.
	26	Ground Subsidence	D	D	N/A	N/A	The project does not extract groundwater.
	27	Offensive Odour	D	B-	N/A	B-	At operation phase: Odour may be generated at the sludge treatment at the proposed STPs.
	28	Sediments	D	D	N/A	N/A	There is no works affect the riverbed.
Others	29	Accident	B-	B-	B-	B-	At construction phase: The increase of vehicles for the construction

Category	No.	Impact	Initial Scoping		IEE		Reasons for Assessment
			Const.	Oper.	Const.	Oper.	
							works may increase the risk of traffic accidents around the construction sites. At operation phase: The sewers may generate hazardous gas H_2S (Hydrogen Sulphide) and CH_4 (Methane) at the maintenance works. In addition, the operation works of STPs will have to handle the hazardous gas of CH_4 and Chlorine gas.
	30	Climate Change	D	B-	N/A	B-	At operation phase: 61,370.5 ton GHGs amount converted as CO_2 equivalent is estimated per year by the consumption of electricity

Notes:
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
N/A: Not applicable for estimation for establishment for mitigation measures and environmental monitoring
Source: JICA Survey Team

11.7 Recommended Mitigation Measures toward Potential Adverse Impacts

The recommended mitigation measures toward the potential adverse impact are shown in **Table 11.7.1.**

Table 11.7.1 Mitigation Measures toward Potential Adverse Impacts

At Construction Phase

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
1	Hydrology	• Preparation of temporary construction plan to avoid blockage of natural drainage flow • Preparation of construction plan to avoid soil erosion at construction sites • Incorporation of above measures including indemnification into bidding and construction contract documents • Environmental monitoring of the contractor's drainage control	• Varanasi: EPC / SPC • Mirzapur, Chunar, Ghazipur: SPC • Ramnagar : EPC / SPC	UPPCB (Uttar Pradesh Pollution Control Board), UPJN, Consultant	To be covered in the project cost
2	Resettlement / Land Issue	• Preparation of appropriate compensation measures for PAPs (Project Affected Persons) • Compliance with legal requirement of LARR (Land Acquisition, Rehabilitation and Resettlement) Act, 2013 • Discussion among stakeholders	- Ditto -	UPPCB, Consultant	To be covered in UPJN budget

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
		up to final agreement			
3	Social Infrastructure / Service	• Prior notice to traffic police before the construction works • Prior acquisition of permissions / NOC (No Objection Certificate) from relevant authorities such as road, railway, drainage and rivers • Placement of traffic guides at each end of construction sections for smooth inducement of traffic • Setting detouring route if necessary. • Sufficient information disclosure such as construction period or work section to media such as television, radio, newspapers, etc. as well as utilization of internet media • Implementation of underground utility survey for existing water pipes, power lines, telephone lines and gas pipes not to cause damage on these utilities • Adoption of special construction method such as micro tunneling at crossing points of roads with heavy traffic and railways • Environmental monitoring • Incorporation of above measures including indemnification into bidding and contract documents	- Ditto -	UPPCB, UPJN, Consultant	Project Cost
4	Infectious Diseases (e.g. HIV / AIDS)	• Preparation of appropriate working health plan • Training / Education of working health for construction workers • Incorporation of above measures into bidding and contract documents	- Ditto -	UPPCB, UPJN, Consultant	Project Cost
5	Working Environment and Safety	• Preparation of construction plan • Training / Education of construction workers • Provide construction workers with sufficient personal protection equipment such as hard hats, earpiece, safety shoes, and others; • Conduct explanation meetings on safety issues for local communities • Install warning signs whereas	- Ditto -	UPPCB, UPJN, Consultant	Project Cost

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
		the potential dangers are expected • Erect temporary fence around high risk areas to control public access and light them at night if that is on the regular roads used by the locals; • Assign construction staffs on or near places where construction vehicles are crowded to ensure safety. • Incorporation of above measures into bidding and contract documents including indemnification clauses for unexpected damage for construction workers and third parties • Environmental monitoring			
6	Air Pollution (Dust)	• Preparation of construction plan for control dust such as water spraying, covering sheets • Examination of Contractor's construction plan especially on dust control • Monitoring of Contractor's dust control • Incorporation of above measures into bidding and contract documents	- Ditto -	UPPCB, UPJN, Consultant	Project Cost
7	Waste	• Preparation of construction plan for excavated soil and demolition waste • Preparation of hazardous waste management such as chemicals, waste oil and asbestos as per the legal requirement • Monitoring of Contractor's management of excavated soil, construction debris • Incorporation of above measures into bidding and contract documents	- Ditto -	UPPCB, UPJN, Consultant	Project Cost
8	Noise / Vibration	• Preparation of appropriate traffic management plan • Utilization of low-noise type construction machineries if applicable. • Temporary enclosure of the site during the construction works if necessary • Instructing the contractors to examine low noise/vibration	- Ditto -	UPPCB, UPJN, Consultant	Project Cost

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
		construction methods. • Encouragement of idling reduction to the workers. • To avoid works at night and early morning at the sites close to residential areas, schools and hospitals • Monitoring of noise level at facility boundaries • Incorporation of above measures into bidding and contract documents			
9	Accident	• Preparation of appropriate construction vehicle operation plan to avoid concentration of machinery and vehicles in limited roads. • Allotment of traffic guide for proper control of traffic in order to minimize disruption to traffic flows • The construction site should be enclosed with temporary fence to provide a visual barrier between the construction site and adjacent traffic. • Contractor's advance notification to communities in case of blocking traffic for transport of heavy equipment the contractor • Incorporation of above measures into bidding and contract documents • Environmental monitoring	- Ditto -	UPPCB, UPJN, Consultant	Project Cost

Notes;
EPC: Engineering and Procurement Contractor, SPC: Special Purpose Company
Source: JICA Survey Team

At Operation Phase

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
1	Poverty	• Establishment of appropriate tariff collection system for urban poor • Implementation of public awareness survey • Implementation of consultation meetings especially for urban poor	UPJN, State Government of UP	UPPCB, Consultant	O &M Cost
2	Working Environment and	• Facility design for prevention of leakage of chlorine gas at detail design	• Sewers: Jal Kal	UPPCB, Consultant	O &M Cost

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
	Safety	• Preparation of appropriate O&M manual for handling of chlorine gas • Preparation of emergency safety plan • Environmental monitoring • Incorporation of above measures into bidding and contract documents	• STP, MPS, IPS: SPC		
3	Water Pollution	• Facility design for sewage treatment • Preparation of appropriate O&M manual for STPs • Regular monitoring of water quality at STPs and surrounding water bodies • Incorporation of above measures into bidding and contract documents	SPC	UPPCB, Consultant	O &M Cost
4	Waste	• Agreement among relevant authorities such as municipalities, farmers in case of landfilling in solid waste landfill sites • Incorporation of above measures into bidding and contract documents	SPC	UPPCB, Consultant	O &M Cost
5	Soil Contamination	• Preparation of appropriate maintenance plan of the facilities for prevention of damage. • Early detection of occurrence of leakage of sewage at main sewers • Visual and odor inspection as regular maintenance • Quick response to the residents' information relating to occurrence of odor and detection of leakage of sewage. • Environmental monitoring • Incorporation of above measures into bidding and contract documents	Sewers: Jal Kal	UPPCB, Consultant	O &M Cost
6	Noise / Vibration	• Equipment layout / configuration plan at detail design • Facility design on the materials with high sound absorption and insulation effects • Monitoring of noise level at the facility boundaries of the STPs and IPSs • Installation of sound proof wall if necessary • Incorporation of above measures into bidding and contract documents	SPC	UPPCB, Consultant	O &M Cost
7	Offensive Odour	• Facility design for reduction of odour generation	SPC	UPPCB, Consultant	O &M Cost

No.	Impacts	Recommended Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority	Budget / Cost
		• Monitoring of odor level at the facility boundaries of the STP sites • Establishment of handling complaints of the residents and quick response to take measures • Incorporation of above measures into bidding and contract documents			
8	Accident	• Facility design for prevention of leakage of chlorine gas at detail design • Preparation of appropriate & M manual for handling of hazardous gas such as methane and chlorine • Regular inspection of sewers • Preparation of emergency safety plan • Environmental monitoring • Incorporation of above measures into bidding and contract documents	SPC	UPPCB, Consultant	O &M Cost
9	Climate Change	• Facility design of pump units and blower with high efficiency, inverter type air blower • Optimum operation of pump in accordance with process flow rate • Incorporation of energy saving measures into bidding and contract documents • Recovery of GHGs in treatment process in STPs in future stage through installing a biogas power generation or an incineration to reduce the generation of GHGs for the STPs which has no biogas generation unit	SPC	UPPCB, Consultant	O &M Cost

Source: JICA Survey Team

11.8 Environmental Monitoring Plan

11.8.1 Environmental Monitoring Plan

The environmental monitoring plan at each project phase is shown in **Table 11.8.1**. With regard to the monitoring of the land acquisition, necessary items for its monitoring will be prepared at preparation of the RAP (Resettlement Action Plan) after the project scope is finalized and the approval is obtained for the project component by the project proponent.

Table 11.8.1 Environmental Monitoring Plan

Construction Phase

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency	Approximate Cost
1	Hydrology (Drainage, Soil Erosion)	• Construction sites for excavation works and construction works	• Contractor's practice for drainage control • Status of soil erosion	• Visual inspection • Examination of daily or monthly report	Monthly	• Varanasi: EPC / SPC • Mirzapur, Chunar, Ghazipur: SPC • Ramnagar: EPC / SPC	To be covered in project cost
2	Social Infrastructure / Service	• Construction sites • Vicinity roads of the construction sites	• Contractor's practice for traffic control • Complaints of surrounding residents	• Visual inspection • Examination of daily or monthly report	Monthly	- Ditto -	To be covered in project cost
3	Working Environment and Safety	• Construction sites	• Contractor's practice for working environment and safety	• Visual inspection • Examination of daily or monthly report	Monthly	- Ditto -	To be covered in project cost
4	Air Pollution	• Construction sites for excavation works and construction works	• Contractor's practice for dust control	• Visual inspection • Examination of daily or monthly report	Monthly	- Ditto -	To be covered in project cost
5	Waste	• Construction sites for excavation works • Construction sites for Backfill • Final disposal site of construction debris	• Type of construction debris • Amount of construction debris • Amount of excavated soil • Contractor's management for hazardous wastes	• Visual inspection • Examination of daily or monthly report	Monthly	- Ditto -	To be covered in project cost
6	Noise / Vibration	Facility boundaries at the following facilities; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP	• Noise level • Complaints of surrounding residents	Measurement of noise level by sound level meter for 2 samples (day time, night time) per 1 STP	Monthly	- Ditto -	60,000 Rp. per time
7	Accident	• Construction sites • Vicinity roads of	• Construction practice for	• Visual inspection	Monthly	- Ditto -	To be covered

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency	Approximate Cost
		the construction sites	safety measure	• Examination of daily or monthly report			in project cost

Source: JICA Survey Team

Operation Phase

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency	Approximate Cost
1	Working Environment and Safety	• STPs • Pumping stations • Sewers	• Practice for working environment and safety	• Visual inspection • Examination of daily or monthly report	• Monthly	SPC	To be covered in operation and maintenance cost
2	Water Quality	The following STPs (Raw sewage, Effluent); • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP	• pH • BOD_5 • COD • TSS • NH_4-N • T-P • T-N • Faecal Coliform	As per CPCB's new standards dated 27th April 2016	Daily	SPC	50,000 Rp. x 6 STPs per month = 300,000 Rp./month By Chemist and an assistant
3	Soil Contamination	• Sewers	Complaints of surrounding residents for smell	• Visual inspection • Interview with residents • Examination of daily or monthly report	• Monthly	SPC	To be covered in operation and maintenance cost
4	Noise / Vibration	Facility boundaries at the following STPs; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP	Noise level	Measurement of noise level by sound level meter	• Monthly	SPC	60,000 Rp. per time
5	Offensive Odour	Facility boundaries at the following STPs; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP	1) Odour level The following chemical substances as odour source; • Ammonia • Methyl	Measurement method which is regulated in Japanese Offensive Odor Control Law	• Monthly	SPC	60,000 Rp. per time

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency	Approximate Cost
		• Ramnagar STP • Chunar STP	mercaptan • Hydrogen sulfide • Methyl sulfide • Styrene 2) Complaints of surrounding residents for smell	(Law No. 91 of 1971, Latest Amendment by Law No. 71 of 1995) • Interview with residents			
7	Accident	• STPs • Pumping stations • Sewers	• EPC's practice for safety measure	• Visual inspection • Examination of daily or monthly report	Monthly	- Ditto -	To be covered in operation and maintenance cost

Source: JICA Survey Team

11.8.2 Implementation Structure for Environmental Monitoring

Since the components of the proposed projects have not been approved by NMCG, the implementation structure and its concrete framework for the environmental monitoring cannot be established at this stage.

11.9 Land Acquisition and Resettlement

11.9.1 Necessity of Land Acquisition and Resettlement

The necessity of land acquisition for the project sites is shown in **Table 11.9.1** as interim results. For the project sites of pumping stations and Ramnagar STP, land acquisition will be necessary. There will be no resettlement for these sites because of no inhabitation at these sites. However, since the components of the proposed projects and the selection of sewage collection method for either ID & T or the Comprehensive method (sewer networks) have not been approved by NMCG, the process of the land acquisition and their relevant surveys cannot be initiated. In addition, the facility plan of the pumping stations have not been approved by NMCG since the sewage collection system for Mirzapur, Ghazipur, Ramnagar and Chunar cities have not been decided, and thus, NMCG cannot initiate the process for the land acquisition of the pumping stations.

Table 11.9.1 Necessity of Land Acquisition and Resettlement (Interim)

No.	City	District	Project Site	Facility Area of Length in Approximate Scale	Necessity of Land Acquisition	Remarks
1.	Varanasi					
1.1	- Ditto -	District I	Sewer networks	• Open: 217,772 m, • Micro Tunnelling: 1,876 m	Not Necessary	
1.2	- Ditto -	District II	Sewer networks	• Open: 272,096 m, • Micro Tunnelling: 3,911 m	Not Necessary	
1.3	- Ditto -	District III	Sewer networks	• Length: 807 m,	Not Necessary	
1.4	- Ditto -	- Ditto -	Pumping Station	Area: 100 m^2	Necessary	
1.5	- Ditto -	- Ditto -	Ramna STP	Area: 141,000 m^2	Not Necessary	
2.	Mirzapur					
2.1	- Ditto -	Mirzapur	Sewer networks	• Open: 8,835 m, • Rising Main: 5,340 m • Reuse Line: 7,000 m	Not Necessary	The collection system has not been decided by NMGC
2.2	- Ditto -	- Ditto -	Pumping Station • IPS 1 • IPS 2 • IPS 3 • MPS 1	• IPS 1: 100 m^2 • IPS 2: 100 m^2 • IPS 3: 100 m^2 • MPS 1: 900 m^2	Necessary	Pumping stations incase of sewer networks
2.3	- Ditto -	- Ditto -	Mirzapur STP	Area: 37,000 m^2	Not Necessary	
2.4	- Ditto -	- Ditto -	Vindhyachal STP	Area: 57,000 m^2	Not Necessary	
3.	Ghazipur					
3.1	- Ditto -	Ghazipur	Sewer networks (Intercept Sewer)	• Open: 8,335 m, • Rising Main: 25 m	Not Necessary	The collection system has not been decided by NMGC
4.	Ramnagar					
4.1	- Ditto -	Varanasi	ID & T	Length: 3,080 m	Not Necessary	The collection system has not been decided by NMGC
4.2	- Ditto -	- Ditto -	Pumping Station	Area: 900 m^2	Necessary	Pumping stations incase of ID & T
4.3	- Ditto -	- Ditto -	Ramnagar STP	Area: 23,000 m^2	Necessary Under Negotiation	
5.	Chunar					
5.1	Chunar	Mirzapur	ID & T	• Open: 4,308 m, • Rising Main: 2,160 m • Reuse Line: 3,695 m	Not Necessary	The collection system has not been decided by NMGC
5.2	- Ditto -	Ditto -	Pumping Station • IPS: 1 • MPS: 1	• IPS 1: 10 m^2 • MPS 1: 100 m^2	Necessary	Pumping stations incase of ID & T
5.3	- Ditto -	Ditto -	Chunar STP	Area: 98,000 m^2	Not Necessary	

Source: JICA Survey Team

11.9.2 Legislative Framework for Land Acquisition and Resettlement

(1) Land Acquisition, Rehabilitation and Resettlement Act, 2013

Land acquisition and resettlement shall be conducted based on the Land Acquisition, Rehabilitation and Resettlement (LARR) Act 2013. The rehabilitation measures against the loss of income of agricultural lands, plantation and other lands shall follow the requirement of the act as shown in **Table 11.9.2**.

Table 11.9.2 Entitlement Matrix as per LARR 2013

Target Loss/ Elements	Entitlement
1. Acquisition or Compensation Packages (No Resettlement Required)	
1.1 Loss of Land	• Market value of land; plus • Market value multiplied by a factor, at least 1 or 2 times in rural areas and 1 times in urban areas; plus • Amount calculated at the rate of 12% per annum on such market value for the period from 4(2) SIA study publication to the date of award or the date of taking possession of the land, whichever is earlier; plus • Solarium of 100% over the total compensation amount
1.2 Loss of House, Building and Other Immovable Property or Assets	• Market value based on the computation of a competent engineer or any specialist in the relevant field
1.3 Loss of Trees and Plants Attached to the Land Acquired	• Current value determined by persons in the field of agriculture, forestry, horticulture, sericulture or any related field
1.4 Loss of the Standing Crops Damaged During the Process of Land Acquisition	• Current value assessed by the experienced persons in the field of agricultures
2. In Case of Displacement (Need for Rehabilitation and Resettlement)	
2.1 Provision of Housing Units	• If house is in rural areas, house should be constructed according to Indira Awas Yojana specification; • In case in urban areas, house to be constructed should not be less than 50 sq.m in plinth area; • Families must be continuously residing in the area of not less than 3 years preceding the date of notification of the affected area which has been involuntarily displaced; • Equivalent cost of the house may be offered in lieu of the constructed house; and • No affected family must be given more than 1 house
2.2 Land to Land	• For multi-crop irrigated land, equivalent area of culturable wasteland shall be developed for agricultural purpose or an amount equivalent to the value of land acquired shall be deposited with the appropriate government for investment in agriculture for enhancing food security; • For non-irrigated multi-crop land, acquisition of the agricultural land shall in no case exceed such limits of the total sown area and be notified by appropriate government
2.3 Choice of Annuity and Employment	• Priority for employment after suitable training and skill development at a rate not lower than the minimum wage to at least 1 member per affected family in the project or arrange for a job in such other project as may be required; or • One-time payment of INR 500000.00 per affected family; or • Annuity policies that shall pay not less than INR 2000 per month per family for 20 years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers.
2.4 Subsistence Grant for Displaced Families for a Period of One Year	• Each displaced family shall be given a monthly subsistence allowance equivalent to INR 3000 for a period of 1 year from the date of award; • In case displaced from the Scheduled Areas (Scheduled Castes and Scheduled Tribes), INR 50000 to preserve the economic opportunities, language, culture and community life of the tribal communications.
2.5 Transportation Cost for Displaced Families	• Each displaced family shall get a 1-time financial assistance of INR 50000 for shifting of the family, building materials, belongings and cattle.
2.6 Cattle Shed/Petty Shops Cost	• Each affected family having cattle shed or petty shop shall get 1-time financial assistance from appropriate government but should be minimum of

Target Loss/ Elements	Entitlement
	INR 25000 for construction of cattle shed and petty shop as the case may be.
2.7 One-time Grant to Artisan, Small Traders and Certain Others	• Each affected family belonged to this and has been involuntarily displaced from the affected land due to land acquisition shall get 1-time financial assistance from appropriate government and should be minimum of INR 25000.
2.8 Fishing Rights	• In case applicable, affected families may be allowed fishing rights in the reservoirs, in such manner as may be prescribed by the appropriate government.
2.9 One-Time Resettlement Allowance	• Each affected family shall be given a 1-time "Resettlement Allowance" of INR 50000 only.
2.10 Stamp Duty and Registration Fee	• All fees subject for payments to the stamp duty and registration fee shall be borne by the Requiring Body; • The land for house shall be free from all encumbrances; and • The land or house allotted may be in the joint names of wife and husband of the affected family.

Source: JICA Survey Team

(2) National Rehabilitation and Resettlement Policy (NRRP), 2007

This policy was prepared by the Department of Land Resources, Ministry of Rural Development, and Government of India, and stipulates the minimum benefits to be ensured for persons displaced due to acquisition of land for public purposes. The objectives of the Policy are:

- To minimize displacement and to identify the non-displacing or least-displacing alternatives;
- To plan the Resettlement and Rehabilitation of PAFs (Project Affected Families), or PAHs (Project Affected Households) including tribal and vulnerable households;
- To provide improved standard of living to PAFs or PAHs; and
- To facilitate a harmonious relationship between Requiring Body/Competent Authority (CA) and PAFs.

The Policy is applicable to projects displacing 400 or more families in plain areas, or 200 or more families in tribal or hilly areas, Desert Development Program (DDP) blocks, areas mentioned in Schedule V and Schedule VI of the Constitution of India.

Main points of the policy are shown as below:

- Recognizes apparent need for additional R&R (Rehabilitation and Resettlement) benefits which must be beyond compensation of loss of land or structure;
- SIA (Social Impact Assessment) as mandatory component where a project is likely to cause impact 400 or more families (in plain areas), or 200 or more families in tribal or hilly areas;

- Detailed R&R planning in case anticipated displacement is more than 400 families in plains (200 families in hilly/tribal areas). The plan to have details such as extent of land to be acquired with names and identification of affected families, village wise list of affected persons, their profile, agricultural labourers as affected persons, people with livelihood affected, list of occupiers, public utilities, comprehensive list of benefits and packages to be provided to affected persons;
- Special care to protect rights of vulnerable society such as SC (Scheduled Cast) and ST (Scheduled Tribe) community sensitivity;
- R&R cost (arising out of benefits and packages beyond compensation) will be included as part of project cost;
- Compensation and resettlement activities to be done well in advance of ouster of affected families;
- R&R (Rehabilitation and Resettlement) benefits to be extended to all affected families. Benefits includes possible allotment of house site, one time assistance for house construction to BPL families (quantum aligned with existing house construction schemes by state), Replacement cost basis or land for land approach for PAFs who have become landless or marginal account of project impacts. Stamp duty and other fees to be borne by requiring body. Provisions of assistance for land development, cattle shed, shifting allowance (on actual cost basis), assistance to rural artisans, self-employed for construction of working shed/shop. Conditional provision for employment of those rendered jobless or rehabilitation grant, subsistence allowance for displaced PAFs; and
- Requirement of developing of tribal development plan and recommended consultation with tribal advisory council where project entails displacement of 200 or more ST families. Consultation with Gram Sabha or Panchayats for land acquisition in scheduled areas.

(3) Gaps Between JICA Policy and Indian Legislative System on Resettlement and Land Acquisition

The gap of JICA Guideline and the Indian legal system on land acquisition and resettlement as per the Indian LARR and NRRP is shown in **Table 11.9.3.** .The project will basically follow the Indian policy listed in **Table 11.9.3**.

Table 11.9.3 Gap between JICA Guideline and Indian Legislative Policy

Sl. No.	JICA Guidelines (2010)	Indian Applicable Policy (as per LARR and NRRP)	Gap between JICA's Guidelines and Indian LARR	Policy by the Project
1	Involuntary resettlement should be avoided wherever possible	• NRRP aims to minimize large scale displacement. • NRRP Encourages projects to be set up on waste land, degraded land, Un-irrigated land. (NRRP 2007, #1.4, Chap 1)	None	The project will follow the Indian applicable policy as per the LARR and NRRP.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	If unavoidable, Govt. to consider different alternatives to minimize displacement, total land acquired and total agricultural land acquired for non agricultural use (NRRP2007, #1.4, Chap 1), LARR has provision for compensation for losses incurred.	None	- Ditto -
3	People who will be settled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	Provisions made for R&R* benefits to all; but subject to condition that non titleholders must be residing or drawing livelihood in the affected area *for a period not less than 3 years preceding date of declaration of the affected area.* (NRRP, #3.1.b.iii). *R&R: Rehabilitation and Resettlement	Yes. • Non titleholders need to be residing continuously or drawing livelihood from the affected area for a period not less than 3 years preceding the date of declaration. • R&R benefits such as housing improvement, development benefits, loss of crops, trees, transitional support etc to be provided only if residing/ drawing livelihood for a continuous 3 year period in the area, preceding declaration of 'affected area'	- Ditto -
4	Compensation must be *based on the full replacement cost* as much as possible	Compensation made on market rate as determined or recognized by state	Yes.	- Ditto -
5	Compensation and other kinds of assistance must be provided prior to displacement	Provisions are covered in NRRP	None	- Ditto -
6	For projects that entails large-scale involuntary resettlement, RAP (Resettlement Action Plans) must be prepared and made available to the public.	Requirement for RAP is mentioned subject to number of displaced exceeding 400 families in plains or 200 in hilly/tribal areas or Desert Development Programme (DDP) blocks.	Yes, Numerical condition (400 in plain area, 200 in tribal, hilly or DDP blocks) attached.	- Ditto -
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	Specific mention provided in NRRP.	None	- Ditto -

Sl. No.	JICA Guidelines (2010)	Indian Applicable Policy (as per LARR and NRRP)	Gap between JICA's Guidelines and Indian LARR	Policy by the Project
8	When consultation held, explanation must be given in a form, manner, and language that are understandable to the affected people.	• The draft Rehabilitation and Resettlement Scheme prepared shall be made known locally by wide publicity in the affected area and discussed in the concerned Gram Sabhas or Municipalities and in website. Section: 16. (4) • The approved Rehabilitation and Resettlement Scheme to be made available in the local language to the Panchayat, Municipality or Municipal Corporation and in website. Section: 18.	None	- Ditto -
9	Appropriate participation of PAPs (Project Affected Peoples) must be promoted in planning, implementation, and monitoring of RAP (Resettlement Action Plans)	Provisions covered	None	- Ditto -
10	Appropriate and accessible grievance mechanisms must be established for the PAPs and their communities.	Specified	Yes. R&R Committee to be set up only if in the project area over 400 families (in plains) or 200 in tribal/hilly areas are to be displaced.	- Ditto -
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Specified under NRRP for identification of all PAPs.	None	- Ditto -
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Specified-R&R benefits to non-titleholders provisioned by subject to them residing/ drawing livelihood for period not less than 3 years in the project affected area (from the date formal declaration)	Yes, Non-titleholders if residing or drawing livelihood for a period less than 3 years are not eligible for R&R benefits	- Ditto -

Sl. No.	JICA Guidelines (2010)	Indian Applicable Policy (as per LARR and NRRP)	Gap between JICA's Guidelines and Indian LARR	Policy by the Project
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Specified	None	- Ditto -
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	Specified	Yes. No such benefits provision for non-titleholder residing /drawing livelihood for a period less than 3 years	- Ditto -
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	Mentioned for vulnerable groups as defined under NRRP. Specific mention of additional provisions for SC (Scheduled Cast) and ST (Scheduled Tribes) community mentioned under #7.21 of the NRRP. Requirement of a separate tribal development plan to be prepared if number of tribal displaced families exceeds 200 families.	None	- Ditto -

Source: JICA Survey Team

11.9.3 Scope of Impact of Land Acquisition and Resettlement

Since the components of the proposed projects have not been approved by NMCG, the process of the land acquisition and their relevant surveys cannot be initiated. Therefore, the baseline data on the PAPs (Project Affected Persons) and PAHs (Project Affected Households) to identify the scope of the impact by the land acquisition cannot be obtained in this survey. The issues should be clarified after the proposed projects are approved by NMCG.

11.9.4 Concrete Measures on Compensation and Support

Since the components of the proposed projects have not been approved by NMCG, the process of the land acquisition and their relevant surveys cannot be initiated. Therefore, the concrete measures on compensation and support for the PAPs cannot be identified. The issues should be clarified after the proposed projects are approved by NMCG.

11.9.5 Grievance Mechanism

From the same reason as mentioned before, the specific grievance mechanisms cannot be identified. The issues should be clarified after the proposed projects are approved by NMCG.

11.9.6 Implementation Structure for Land Acquisition and Resettlement

From the same reason as mentioned before, the implementation structure for the land acquisition cannot be identified. The issues should be clarified after the proposed projects are approved by NMCG.

11.9.7 Implementation Schedule for Land Acquisition and Resettlement

From the same reason as mentioned before, the implementation schedule for the land acquisition cannot be identified. This issue on holding SHMs will be a pending issue in this survey.

11.9.8 Cost and Budget for Land Acquisition and Resettlement

From the same reason as mentioned before, the cost and budget for the land acquisition cannot be identified. This issue on holding SHMs will be a pending issue in this survey.

11.9.9 Project Proponent's Monitoring System for Land Acquisition and Resettlement

From the same reason as mentioned before, the monitoring system for the land acquisition cannot be identified. This issue on holding SHMs will be a pending issue in this survey.

11.9.10 Consultation Meetings for Land Acquisition and Resettlement

The SHMs (Stakeholder Meetings) for the project could not be held because of the reasons that 1) the project proponent (NMCG) could not approve the project scopes and its components as shown below 2) problems of allocation of responsible personnel for the project;

Varanasi:

- The DPRs for District 3 of the proposed projects have not been approved by NMCG.
- Although there is planned one (1) pump station in District 3, it is impossible to foresee whether the land acquisition of the project sites will be actually realized or not.

Ramnagar:

- NMCG has not approved the sewage collection methods
- The DPRs of the proposed projects have not been approved by NMCG.

- It is impossible to foresee whether the land acquisition of the project sites will be actually realized or not.

Mughal Sarai:

- The DPR was not submitted and excluded from the project scope.

Mirzapur:

- NMCG has not approved the sewage collection methods
- The DPRs of the proposed projects have not been approved by NMCG.

Chunar:

- NMCG has not approved the sewage collection methods
- The DPRs of the proposed projects have not been approved by NMCG.

Ghazipur:

- NMCG has not approved the sewage collection methods

Saidpur:

- NMCG has not approved the sewage collection methods
- The proposed project was excluded from the project scope.

Above issue on holding SHMs will be a pending issue in this survey.

11.9.11 Variety of Baseline Data

Most of baseline data is addressed to Varanasi since the city is famous and various kind of data is available. However, data of the other project sites are also necessary. Availability of date is not sure in project area besides Varanasi, but it is necessary to collect in further investigation.

11.10 Environmental Checklist / Monitoring Form

11.10.1 Environmental Checklist

The environmental checklist which should be prepared in the JICA form is shown in **Table 11.10.1.**

Table 11.10.1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) N	(a) EIA and a preparation of EIA reports are not required for the proposed project as per the Indian Environmental Notification 2006 and its revision in 2009. (b) - Ditto - (c) - Ditto - (d) For the implementation of the project, the following permissions will be necessary; • Crossing of Railways • Excavation of underground road area • Discharge of treated wastewater • Permission for tree cutting • Power receiving
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N	(a) Public consultation meeting is not required for the project as per EIA notification 2006. (b) - Ditto -, However, as per JICA Guideline, consultation meetings will be necessary for the PAPs (Project Affected People) by the land acquisition.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) The location of project sites is basically based on DPR. The treatment method of the sewage was reviewed for the proposal of the DPR.
2 Pollution Control	(1) Water Quality	(a) Do pollutants, such as SS, BOD, COD, pH contained in treated effluent from a sewage treatment plant comply with the country's effluent standards? (b) Does untreated water contain heavy metals?	(a) Y (b) Y	(a) The emission standard for the proposed STPs will be carried out to be in compliance with the national effluent standards. (b) The proposed STPs will accept the domestic sewage not industrial wastewater. Thus, the untreated sewage will not contain heavy metals.
	(2) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed of in accordance with the country's standards?	(a) Y	(a) There is no standard for the disposal of treated sludge. The treated sludge at the STPs will be used at farm lands.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
	(3) Soil Contamination	(a) If wastes, such as sludge are suspected to contain heavy metals, are adequate measures taken to prevent contamination of soil and groundwater by leachates from the wastes?	(a) Y	(a) The proposed STPs will not accept industrial waste water which may contain heavy metals.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as sludge treatment facilities and pumping stations comply with the country's standards?	(a) Y	(a) Appropriate design for the facilities and equipment will be conducted to follow the national standards. In addition, environmental monitoring will be carried out for the compliance at the operation stage.
	(5) Odor	(a) Are adequate control measures taken for odor sources, such as sludge treatment facilities?	(a) Y	(a) Odor control will be examined at the design stage of the proposed project. In addition, environmental monitoring will be carried out for the compliance at the operation stage.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area in and around the project site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) N (d) N	(a) The project sites will not such forests. However, some appropriate process will be taken in case of tree cutting inside the project sites as per the State regulation. (b) - Ditto - (c) - Ditto - (d) The proposed sewerage project will improve the water quality environment. The treated effluent of improved water quality will be discharged into the lakes nearby area. Then, the improvement of the lake water is expected in the future.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N/A (i) N/A (j) N/A	(a) There will be no resettlement. Several sites of pumping stations and Ramnagar STP site require a land acquisition. However, the concrete compensation measures have not been approved by NMCG. (b) - Ditto - (c) - Ditto - (d) - Ditto - (e) - Ditto - (f) - Ditto - (g) - Ditto - (h) Resettlement will not be expected. (i) Resettlement is not expected. However, in case of land acquisition, UPJN will make a monitoring for the process of land acquisition. (j) Resettlement is not expected. However, in case of land acquisition, UPJN will establish a rehabilitation mechanism for potential affected land owners.
	(2) Living and Livelihood	(a) Is there a possibility that changes in land uses and water uses due to the project will adversely affect the living conditions of inhabitants? (b) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) N (b) N	(a) The proposed projects are planned in open or vacant area not to affect the surrounding environment. (b) In case of sites located close to residential area, environmental monitoring will be carried out for the potential adverse impacts to be caused by noise or odour.
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no local archeological, historical, cultural, and religious heritage in and around the project sites.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There is no area with aesthetic value in and around the project sites. The height of the proposed facilities is below 10 m.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to lands and resources respected?	(a) N (b) N	(a) The project does not relate to such ethnic minorities nor indigenous people. (b) The project does not relate to such ethnic minorities nor indigenous people.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (d) Y	(a) The construction works will follow Indian laws and regulations regarding working environment. (b) Mitigation measures will be made to control the safety and health environment at the construction stage. (c) A consideration will be taken for the safety and health management at the tender and construction stage. (d) A consideration will be taken for the safety and health management at the tender and construction stage.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?(d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) N/A (c) Y (d) Y	(a) At construction phase, there will be some potential adverse impact on hydrology, social infrastructure / service, infectious diseases, working environment / safety, air pollution, waste, noise and accident. Mitigation measures and environmental monitoring will be established for the examination of the contractor's activities to mitigate these impacts. (b) Adverse impact on ecosystem will not be estimated by the project. (c) Explanation of the construction works will be notified for the residents near the construction lots. (d) A mitigation measures for reducing such impacts such as allocating of traffic guides to reduce the impact of traffic congestion in cooperation with the traffic police.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) N/A (c) Y (d) Y	(a) Environmental management and monitoring plan will be established. (b) The items, methods and frequencies for environmental monitoring will be examined at the study. (c) Monitoring framework will be studied at the study and examined by BWSSB. (d) The format and frequencies of the monitoring report will follow Indian regulations or international guidelines.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
6 Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) The consumption of electricity and disposal of treated sludge may generate GHGs at operation phased. However, mitigation measures will be taken for that.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.
Source: JICA Survey Team

11.10.2 Monitoring Form

If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports including measured data submitted by the project proponent. When necessary, the project proponent should refer to the following monitoring form for submitting reports.

When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

The monitoring form for the projects is shown as below.

(1) Mitigation Measures

1) At Construction Phase

Hydrology（Drainage / Soil Erosion）

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Drainage / Soil Erosion		• Contractor's practice for drainage control • Status of soil erosion				• Construction sites • Visual inspection • Examination of daily or monthly report • Monthly

Air Quality（Dust）

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Dust		• Contractor's practice for dust control				• Construction sites • Visual inspection • Examination of daily or monthly report

Waste

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Waste		• Type of construction debris • Amount of construction debris • Amount of excavated soil • Contractor's management for hazardous wastes				• Construction sites • Visual inspection • Examination of daily or monthly report

Noise / Vibration

Monitoring Item	Measured Value (Mean)	Measured Value (Max.)	Standards	Remarks (Measurement Point, Frequency, Method, etc.)
• Noise Level			Indian standard*	1) Measurement Point Facility boundaries at the following facilities; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP 2) Frequency • Monthly

* Indian standard as per Schedule III under the Noise Pollution (Regulation and Control) Rules, 2000 and amendment 2002

Area Code	Category of Area	Limits in dB (A)	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

Note 1: Daytime is reckoned in between six (6) am to 10 p.m.
Note 2: Night time is reckoned in between 10 p.m. to six (6) a.m.
Note 3: Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
Note 4: Mixed categories of areas should be declared as one of the four above-mentioned categories by the Competent Authority and the corresponding standards shall apply.

2) At Operation Phase

Water Quality（Effluent）

Effluent discharge after treatment

Monitoring Item	Measured Value (Mean)	Measured Value (Max.)	Standards*	Remarks (Measurement Point, Frequency, Method, etc.)
pH			6.0-9.5	1) Effluent at the following STPs; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP 2) Frequency: Monthly
BOD			<10	
COD			< 50	
TSS			< 10	
NH4-N			< 5	
T-N			< 10	
Phosphorus			< 2	
Fecal Coliform (MPN/100 ml)			< 230	

* As per CPCB New Standards dated 27th April 2016

Soil Contamination

Monitoring Item	Measured Value (Mean)	Measured Value (Max.)	Standards	Remarks (Measurement Point, Frequency, Method, etc.)
• Soil Contamination				1) Method • Visual inspection • Interview with residents • Examination of daily or monthly report 2) Measurement Point Sewers 3) Monthly

Noise / Vibration

Monitoring Item	Measured Value (Mean)	Measured Value (Max.)	Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level			Indian standard*	1) Measurement Point Facility boundaries at the following facilities; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP

				• Chunar STP 2) Frequency • Monthly

* Indian standard as per Schedule III under the Noise Pollution (Regulation and Control) Rules, 2000 and amendment 2002

Area Code	Category of Area	Limits in dB (A)	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

Note 1: Daytime is reckoned in between six (6) am to 10 p.m.
Note 2: Night time is reckoned in between 10 p.m. to six (6) a.m.
Note 3: Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
Note 4: Mixed categories of areas should be declared as one of the four above-mentioned categories by the Competent Authority and the corresponding standards shall apply.

Offensive Odor

Monitoring Item	Measured Value (Mean)	Measured Value (Max.)	Standards*	Remarks (Measurement Point, Frequency, Method, etc.)
Ammonia			1.0 ppm	1) Measurement Point Facility boundaries at the following facilities; • Dinapur STP • Mirzapur STP • Vindhyachal STP • Ghazipur STP • Ramnagar STP • Chunar STP 2) Frequency Monthly
Methyl mercaptan			0.002 ppm	
Hydrogen Sulfide (H_2S)			0.02 ppm	
Methyl sulfide			0.01 ppm	
Styrene			0.4 ppm	

Notes;

Offensive Odour Control Law, Law No. 91 / 1971 or latest amendment by Law No. 71 / 1995

(2) Social Environment

1) At Construction Phase

Resettlement (At Construction Phase)

Monitoring Item	Monitoring Results during Report Period
The monitoring item will be established later at the preparation of RAP.	

Social Infrastructure

Monitoring Item	Monitoring Results during Report Period
• Contractor's practice for traffic control • Complaints of surrounding residents	

Working Environment and safety

Monitoring Item	Monitoring Results during Report Period
• Contractor's practice for working environment and safety	

Accident

Monitoring Item	Monitoring Results during Report Period
• Contractor's practice for safety measure	

2) At Operation Phase

Working Environment and safety

Monitoring Item	Monitoring Results during Report Period
• EPC's practice for working environment and safety	

Accident

Monitoring Item	Monitoring Results during Report Period
• EPC's practice for safety measure	

11.11 Recommendation

The ESC study will be terminated while the project scopes have not been approved and identified. However, a further ESC study will be necessary for the issues as listed below;

- Clarification of implementation structure for the mitigation measures and environmental monitoring
- Resettlement and land acquisition for the STP sites and pumping stations
- Holding SHMs

CHAPTER 12 Financial and Economic Consideration

<Objective of the Study>

Financial and Economic Analysis of the projects were conducted in this Chapter.

<Result of the Study>

Survey Team defined the key benefit of the project to analyze EIRR as following five elements, benefit of improved water quality of Ganges river, WTP for Sewerage Treatment Service, Saved Medical Expenditure due to water related disease without the project, Saved Salary which would have been lost due to water related disease without the project and Agricultural Benefit of Treated Water for Irrigation (refer to 12.4.1 (1)). Survey Team estimated the EIRR of the entire project would be 11.19% slightly exceeding 10% and Survey Team concluded that this project as a whole is economically feasible. However, in some of the project components such as Chunar ID&T and Ramnagar ID&T, EIRR for each sub-project does not exceed 10% hurdle, due to relatively smaller number of population who will receive economic benefit with the project compared to other areas.

<HAM-PPP>

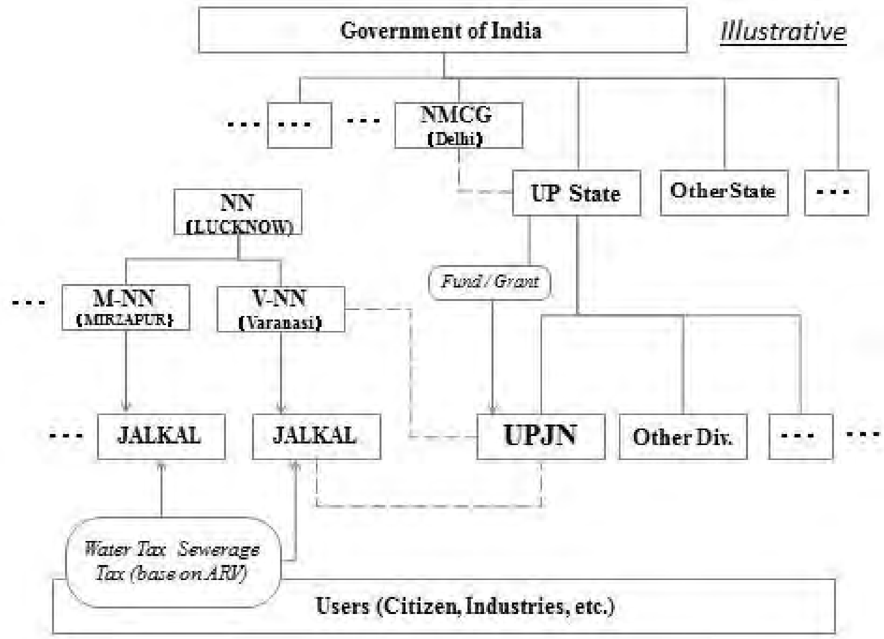
On 12.6, Survey Team analyzed the leading PPP project cases in water and other sectors in India, focusing on Hybrid Annuity Model (HAM). Based on the information as of March 2017, Survey Team established the key requirements to develop HAM-PPP finance modeling Survey Team performed case analysis on Mirzapur and Chunar project in line with assumption and other key conditions defined on RFP released on January 2017 by GOI. Under HAM-PPP model, Survey Team concluded that each project is not financially sustainable without annuity paid by government, and collected user tariff will not cover major part of O&M cost. In addition, Survey Team identified the following four key points to be discussed further, regarding the HAM-PPP model. First, Majority stake on SPV funded by Concessionaire; According to GOI, at least 51% of capital of SPV should be funded by awarded concessionaire, but the other 49% owner and required rate of capital cost is not defined clearly which may impact to concessionaire and lender's financials. Second, Timing of loan withdrawal; according to GoI, 40% of project cost are paid on the date of completion of construction and the other 60% are paid by annuity within 15 years, to SPV. In this case, when the cash loaned from lender are withdrawn for payment from debtor (GOI)'s bank account. It is necessary to determine how the fund flow should be after COD. This is another points to be discussed further. Third, 15 years of O&M activity done by SPV; Current information provided by GOI does not clearly stipulate the approach to calculate O&M Annuity. Lastly, Concessionaire's exit strategy; According to GOI, after 3 years of operation, concessionaire will be allowed to sell the capital share of SPV to O&M operator who currently operates the facility. Survey Team carefully considered the impact of HAM-PPP model, especially if this will attract potential bidders *who should have sufficient financial stability to pay 40% of the construction cost at the beginning and to recover 60% of construction cost during the project period (15 years).*

12.1 Introduction

12.1.1 Main stakeholders

The stakeholders in India for GANGA REJUVENATION PROJECT are mainly five:

- Executing Agency of the project: National Mission for Clean Ganga (NMCG)
- The state: Uttar Pradesh
- Coordinating/implementing agency: Uttar Pradesh Jal Nigam (UPJN)
- Municipal Corporation: Nagar Nigam
- Service provider of O&M in water/sewerage: Jal Kal Nagar Nigam (for each District)



Source: Drawing by JICA Study Team

Figure 12.1.1 Overall Structures among main Stakeholders

12.1.2 Roles and Responsibilities

Urban infrastructure service such as Water and Sewage are not maintained by one organization but are handled by two, UP Jal Nigam and Jal Kal. The UP Jal Nigam looks after the O&M of sewage pump stations and sewage treatment plants on behalf of Nagar Nigam. The UPJN, Varanasi division prepares the estimate for annual O&M and the same is then sent to Varanasi Nagar Nigam for review and counter signature. Once signed by the Nagar Nigam, the estimate is forwarded by UPJN, Varanasi office to the

UPJN head office in Lucknow. UPJN head office compiles such as O&M budgets received from various offices and then gets the funds from the State Government, which is then utilized for the O&M. The O&M budget is inclusive of electricity charges, and these are directly paid by the UPJN head office to the electricity board. The remaining amount is transferred to the respective office for O&M of STPs and pump stations. The O&M budget for Varanasi City sewage facilities for 2015-16 is Rs.252.5 million. The O&M budget is prepared as per the NGRBA (National Ganga River Basin Authority), Government of India, guidelines, which specify the staff and other O&M requirements for different capacity STPs and based on capital cost. The costs such calculated are used for tendering purpose. The entire loan from JICA for the GAP is taken by the Government of India, and the same is passed on to UPJN as grant. So UPJN does not repay the loan.

The Jal Kal operates under the Nagar Nigam and looks after O&M of all the water supply infrastructure (treatment plant to house connection) and underground sewer network (home connection to pump station or STP inlet). The current clear water production is 330 MLD, out of which 125 MLD is from surface source and balance 205 MLD is from tube wells (groundwater). Under JnNURM (Jawaharlal Nehru National Urban Renewal Mission), the entire water supply is proposed to be sourced from surface water. Total O&M cost is not recovered from the revenue collected. (Interviews with UPJN and Jal Kal)

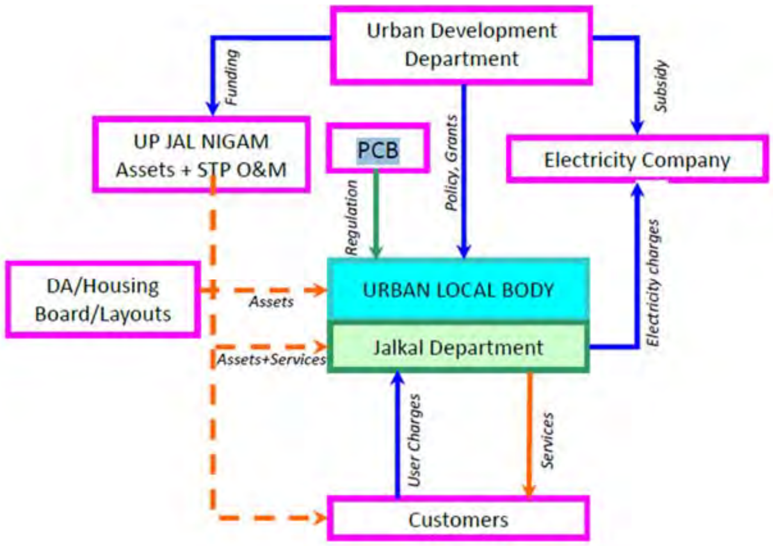
	Water Supply				Sewer			
	Plant (WTP)		Networks		Plant (STP)		Networks	
	Design& Construction	O&M	Design& Construction	O&M	Design& Construction	O&M	Design& Construction	O&M
UP JN	YES		YES		YES	YES	YES	
JAL KAL		YES		YES				YES

O&M: Operation and Maintenance

YES	NO

Source: Interview with UNJP and Jal Kal

Figure 12.1.2 Roles and Responsibilities in Varanasi (1)



Source: City Development Plan for Varanasi, 2041 (Issued in March 2015)

Figure 12.1.3 Roles and Responsibilities in Varanasi (2)

12.1.3 House Connection

There are two types of House connections, the connection with water pipe and/or the one with sewage pipe, and so theoretically, there are four patterns:

Table 12.1.1 Combination of Water and Sewage Connections

Type	Water Connection	Sewage Connection
1	YES	YES
2	YES	NO
3	NO	YES
4	NO	NO

Source: Interview with UNJP and Jal Kal

The picture taken in Varanasi below shows Type-1, the left thin pile is Water pipe and the right big pipe is for Sewage. Both systems are connected in this household. Water/Sewage tax and User-Charges varies depend upon each household environment.

Source: Pictures in Varanasi taken by JICA Study Team

Photo 12.1.1 How the connection of Water/Sewerage looks like

The connection of Water Supply

The connection of Water in Varanasi is 66% at 5th November 2015.

Table 12.1.2 House connection for Water in Varanasi

List of Tap & Nontap Houses for Water					
Ward	Total Houses (z)	Tap Houses (x)	Nontap Houses (y)	x/z	y/z
B	21,233	15,643	5,590	74%	26%
N	17,452	11,579	5,873	66%	34%
D	17,044	12,492	4,552	73%	27%
C	15,391	8,050	7,341	52%	48%
A	14,740	10,175	4,565	69%	31%
K	8,304	6,146	2,158	74%	26%
CK	6,670	4,275	2,395	64%	36%
S	18,992	12,096	6,896	64%	36%
SH	5,929	2,340	3,589	39%	61%
SN	11,358	8,572	2,786	75%	25%
J	13,123	8,508	4,615	65%	35%
	150,236	99,876	50,360	66%	34%

Source: The documents obtained from Jal Kal

The connection of Sewer

The connection of Sewer in Varanasi is 73% at 5th November 2015.

Table 12.1.3 House connection for Sewer in Varanasi

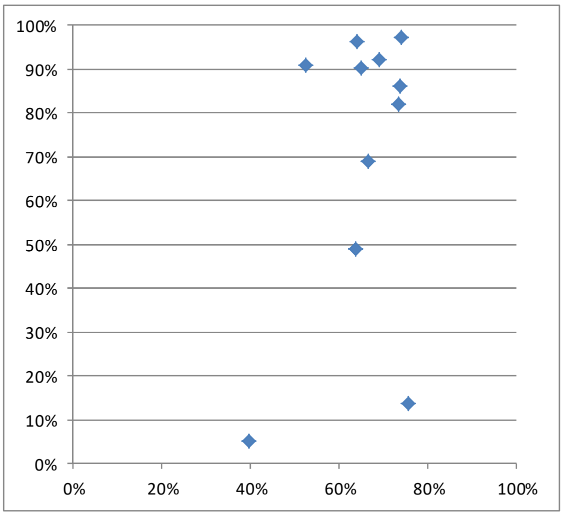
Ward	List of Tap & Nontap Houses for Sewer				x/z	y/z
	Total Houses (z)	Tap Houses (x)	Nontap Houses (y)			
B	21,233	18,255	2,978		86%	14%
N	17,452	12,046	5,406		69%	31%
D	17,044	13,966	3,078		82%	18%
C	15,391	13,973	1,418		91%	9%
A	14,740	13,601	1,139		92%	8%
K	8,304	8,084	220		97%	3%
CK	6,670	6,413	257		96%	4%
S	18,992	9,323	9,669		49%	51%
SH	5,929	312	5,617		5%	95%
SN	11,358	1,564	9,794		14%	86%
J	13,123	11,855	1,268		90%	10%
	150,236	109,392	40,844		73%	27%

Source: The documents obtained from Jal Kal

The scatter diagram of Awards in Varanasi regarding the connections

From the above two tables of Water connection and Sewage connection, eleven Awards in Varanasi have scattered mapping in the following picture. About 70 % of eleven Awards, seven Awards, locate in the area that have higher connection in both Water and Sewage. Other four Awards seemingly will be necessary to be connected with water and sewerage connection.

(Vertical axis is Sewage-connection % and horizontal axis is Water-connection %)



	B	N	D	C	A	K	CK	S	SH	SN	J
W	74%	66%	73%	52%	69%	74%	64%	64%	39%	75%	65%
S	86%	69%	82%	91%	92%	97%	96%	49%	5%	14%	90%

Source: Analysis by JICA Study Team

Figure 12.1.4 Scatter diagram of 11 Awards in Varanasi regarding the connections

12.1.4 Tariff system and Connection

Jal Kal collects Tariff. The billing for water supply and sewerage is through the property tax (annual rental value – ARV – of the buildings) and is not volumetric. The revenue is through: (a) 12.5% of ARV as water tax, and (b) 4% of ARV as sewerage tax. The above noted water and sewerage taxes are collected through property tax from all households irrespective of whether the household has a water and/or sewerage connection, as long as the household is within the coverage area.

A household is said to be in the water supply coverage area if it is within 100m of a water main who is supposed to pay the water tax.

1) Tariff and its calculation

Tariff is charged to each household once a year (around in March). Table 12.1.4 shows the most updated 2015's Tariff system in Varanasi. "Water charge/tax" and "Sewage charge/tax" is about 4 to 1 (80%, 20%). Grand Total gradually increases in five classifications.

There are two names, Tax (water/sewage) and User-Charges in this Tariff system but both/either of them are levied at once from Table 12.1.4 (theoretically there are four types household which are with the same explanation of Table 12.1.1 as noted before)

If the household is connection "A" type and its ARV is Rs. 3568 (belong Serial No.5 of the Figure), the water tax is calculated Rs. 446 (3568 times 12.5%) and the Water charge is Rs.1089 (1535 deduct 446), or those total Rs.1535 is in the "Water tax/charge" of Serial No.5. Similarly, the sewage tax is calculated Rs. 143 (3568 times 4.0%) and then the Sewage charge is Rs.241 (384 deduct 143) which is the same Rs.384 in the "Water tax/charge" of Serial No.5. And then Rs.1535 and Rs.384 plus Rs.38 (Service charge) lead to total Rs.1957, or the Grand Total of No.5. Each household will pay one of each Grand Total basis, from No.1 toNo.5 patterns. In this Tariff system, the portion of the tax-based and the user-charge varies but both total amounts are always the same of one of each five Grand-totals if the household has both connections (water/sewage). However, if the ARV should be rather big and so its calculated tax (water/sewage) based on the ARV is bigger than the Grand-Total in the table, the calculated water/sewage tax is levied instead of from Tariff tables. For example, if the ARV is Rs.20000, then the water tax is Rs.2500 (2000 times 12.5%) which is higher that Rs.1918 of the table No.5, Rs.2500 will be charged instead of Rs.1918. (and the same logic for Sewage tax).

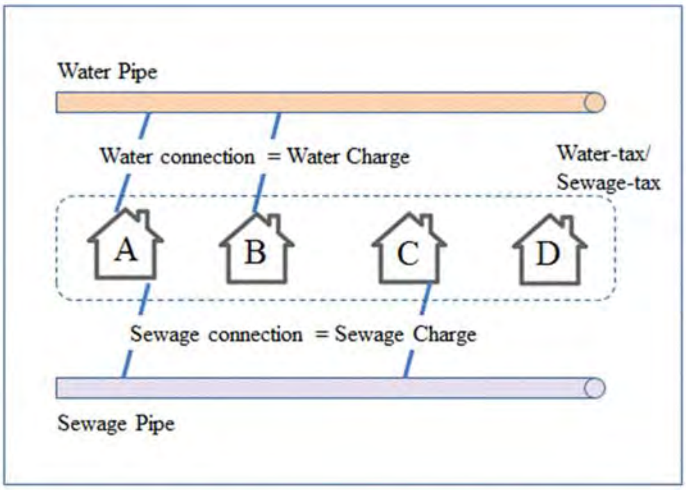


Figure 12.1.5 Connection for Water supply and Sewer

Table 12.1.4 Tariff system of 2015-16

JALKAL DEPARTMENT, NAGAR NIGAM, VARANASI							
TARIFF SYSTEM (Rs.)							
Previous Years (2015-16)							
Serial No.	Annual Valuation	Water Charge / Tax	Service Charge	Sewerage Charge / Tax	Grand Total	Discount	After Discount
1	01-360	575	38	144	**758**	72	685
2	361-2000	768	38	192	**998**	96	902
3	2001-3500	1151	38	288	**1477**	144	1333
4	3501-5000	1535	38	384	**1957**	192	1765
5	5001-	1918	38	480	**2436**	240	2196

Source: The documents from Jal Kal Varanasi

2) Water Tariffs

As noted in the above, the water tax is being collected based on the Annual Rental Value (ARV) of the buildings at the rate of 12.5% of ARV. In addition to the water tax, water charges, based on the ARV slab rate, are applicable for those customers with service connections. For tenants, connection about 15 mm will not be given. Following table shows the breakup of charges applicable for new water connections. ("Developing Strategy for Reduction of NRW" from Jal Kal)

Table 12.1.5 Connection Charges in Varanasi Jal Kal

No.	New Connection Charges	Rs.
1	Registration fee	100
2	Water Connection fee	450
3	Supervision fee	150
4	Ferrule charge	250
5	Minimum Development Fee (water)	1,600
	Total	2,550

Source: Varanasi Final Report from Jal Kal

3) The relationship of Tariffs and population of households

The combination of Tariff table and the number of household in 2013 is summarized in Table 13.1.8. The household in 2013 in Varanasi is 137,472 (while 150,236 at 5th November 2015). Class No.5 (ARV: over R.5001) is the most and class No.3 (ARV: Rs.361-2000) is the second in its population. The total Tariff amounts calculated by each Grand Total times each household numbers show Rs.232 million which is very close to annual total tariff income from audited financial report of Jal Kal 2013 (this will be noted later). It is can be said that half (50.8%) of total tariff revenue paid by the household whose ARV is over that Rs.5000. In others words, about 65% of households pay about 50% of total tariff revenue. (Household in No.5 pays at least Rs.2436, which is about twice of the average of other four classes, Rs.1281)

Table 12.1.6 Calculation Connection Charges in Varanasi Jal Kal

Serial No.	Annual Valuation	Minimum Water Tax	Service Charge	Sewerage Charge / Tax	Grand (a) Total	Househould (b) (2013)		Tariff (a) x (b)	Ratio	
1	01-360	575	38	144	758	**13,663**	9.9%	Rs. 10,356,554	4.5%	
2	361-2000	768	38	192	998	**33,196**	24.1%	Rs. 33,129,608	14.3%	
3	2001-3500	1151	38	288	1477	**24,951**	18.1%	Rs. 36,852,627	15.9%	
4	3501-5000	1535	38	384	1957	**17,286**	12.6%	Rs. 33,828,702	14.6%	
5	5001-	1918	38	480	2436	**48,376**	35.2%	Rs. 117,843,936	50.8%	
						137,472	100.0%	Rs. 232,011,427	100.0%	(x)
								Rs. 227,986,770		(y)
								98.3%	(y) / (x)	

Source: Varanasi Final Report from Jal Kal

4) Water/Sewage Charge collection

Although the total amount of Charges from Sewage is less than Water, the collection ratio of Sewage is higher than that of Water. But both ratios seem to be almost the same % in recent year.

Table 12.1.7 Actual tariff collection at Jal Kal Varanasi

Lacs.	2012-2013	2013-2014	2014-2015
Non revenue water and Un accounted flow of Water			
Water Charges target (Rs)	2,952.25	2,688.00	2,688.00
Water Charges Collected (Rs)	1,524.94	1,539.36	1,928.30
Sewerage Charges target (Rs)	563.20	813.00	813.00
Sewerage Charges Collected (Rs)	476.18	513.06	620.04
Collection ratio			
Water	*52%*	*57%*	*72%*
Sewerage	*85%*	*63%*	*76%*

Source: Data obtained from Jal Kal

12.2 Existing Financial Situation

Under this Chapter we will discuss in brief the financial situation of various organizations that affect this Project and National Government (Government of India) and Government of Uttar Pradesh.

1. NMCG (National Mission for Clean Ganga)
2. State Government, in this case Uttar Pradesh
3. UP Jal Nigam
4. ULB (Urban Local Bodies): Varanasi Nagar Nigam and Jal Kal Varanasi
5. ULB: (Ramnagar, Chunar, Mirzapur and Ghazipur)

12.2.1 NMCG (National Mission for Clean Ganga)

JICA study team analyzed Income Statement and Balance Sheet of NMCG.

1) Income statement

The total amount has been rapidly increasing from 2011 to 2013 but 2014 was fell down from 2013. The total amount of Income and Expenditure of each year is the same, so no surplus. The Grant Utilized is a major source of NMCG income and Grant Unlisted is booked in the Balance sheet (see Table 12.2.1). The portion of Grants Untiled in NMCG Income compared with Grant Unlisted in the Balance Sheet is 3.2% (2011), 28.7% (2012), 40.2% (2013) and 14.6% (2014), or has been relatively increasing.

Table 12.2.1 Income/Expense Analysis of NMCG

	Description	2011-12	2012-13	2013-14	2014-15	Total	CAGR
A.	**INCOME**						
	Grants Utilised	37,449,325	809,359,418	1,607,374,611	741,057,488	3,195,240,842	170.5%
	Bank Interest & Others	23,075,069	43,148,370	76,402,409	134,471,781	277,097,629	80.0%
	TOTAL A)	**60,524,394**	**852,507,788**	**1,683,777,020**	**875,529,269**	**3,472,338,471**	143.7%
B.	**EXPENDITURES**						
	Under Institutional Development	33,823,201	72,309,998	110,550,105	164,488,255	381,171,559	69.4%
	Under Priority Infrastructure Development	-	766,200,000	1,560,546,000	682,694,300	3,009,440,300	-5.6%
	Under State SPMG's	3,371,709	13,997,790	12,680,915	28,346,714	58,397,128	103.3%
	TOTAL B)	**37,194,910**	**852,507,788**	**1,683,777,020**	**875,529,269**	**3,449,008,987**	
C.	**Excess of Income over Expenditure**	**23,329,484**	-	-	-		
D.	**Transfer to Capital Fund Account**	**23,329,484**	-	-	-		

Source: (Rs.) NMCG, Finance at Glance 2011, 2012, 2013 and 2014

2) Statement of financial position

The NMCG Balance sheet has been increasing for 35% per year (Note: the same amount of Grant-in-aid is booked in 2014, so it is netted out) Most of its Asset is current assets / loan / advances, and it has its own fixed asset, such as Computer or office equipment, which is small portion. "Advance" is a Grant which was moved from NMCG to SPMG but Unutilized. Since this Unutilized Grant has been increasing, it can be assumed that sanctioned projects to be started may be delayed or have to be waiting at each State or on-the-ground level.

Table 12.2.2 Balance Sheet Summary of NMCG

(Unit Rs.)

	ASSETS	Fiscal Year (actual) 2011-12	2012-13	2013-14	2014-15	CAGR
1	Fixed Assets	254,415	7,105,681	11,867,043	20,439,439	
2	Current Assets, Loans & Advances etc.	1,903,075,018	2,959,505,659	4,178,073,199	5,989,498,897	46.5%
	(Grant-in-Aid (Capital Assets/General))				*(1,331,765,000)*	
		1,903,329,433	**2,966,611,340**	**4,189,940,242**	6,009,938,336	46.7%
					4,678,173,336	35.0%

	CAPITAL FUNDS & LIABILITIES	Fiscal Year (actual) 2011-12	2012-13	2013-14	2014-15	CAGR
1	Unutilised Grants	1,876,628,240	2,933,324,281	4,173,531,739	5,981,239,251	47.2%
	Capital Funds	23,329,484	23,075,069	-	-	
2	Current Liabilities	3,371,709	3,106,309	2,840,553	3,038,767	-3.4%
	Fixed Assets Reserves	-	7,105,681	13,567,950	25,660,318	
	(Grant in Receivable)				*(1,331,765,000)*	
		1,903,329,433	**2,966,611,340**	**4,189,940,242**	6,009,938,336	
					4,678,173,336	

Source: NMCG, Finance at Glance 2011, 2012, 2013 and 2014

NMCG in 2014 has Current Asset abound Rs. 4,678 million. 44% of the total current asset at the Bank and 53% is Advance. It can be noted that NMCG is financially stable because almost half of the asset is cash. In Advance or 53% of total current asset, about 30% belongs to UP State and 70% belongs to other States. Regarding EAP (external aided project), EAP is 44% and Non-EAP is 56%. EAP to UP State in SMPG is 21% of all Advances.

Table 12.2.3 Current Asset of NMCG

(Unit Rs.)

		Bank	Advance	Other	Total	%	Advance
BOI	EAP	643,136,867			2,058,299,509	44.0%	
	Non-EAP	1,415,162,642					
SPMG UP	EAP		504,653,435		712,353,435	15.2%	21%
	Non-EAP		207,700,000				9%
SPMG Non-UP	EAP		840,754,151		1,723,141,951	36.8%	35%
	Non-EAP		882,387,800				36%
Other		107,352,098	54,523,371	22,502,972	184,378,441	3.9%	
Total		2,165,651,607	2,490,018,757	22,502,972	4,678,173,336	100.0%	100.0%
		46%	53%	0%			

SPMG UP	712,353,435	29%
SPMG Non-UP	1,723,141,951	71%
	2,435,495,386	

EAP	1,988,544,453	44%
Non-EAP	2,505,250,442	56%
	4,493,794,895	

Source: NMCG, Finance at Glance 2011, 2012, 2013 and 2014

More details about SPMG/EPA/Non-EAP from 2013and 2015 are noted in the Table 12.2.4. Regarding UP State, EAP is about 40% of Advance in 2015 and Non-EAP to the UP was very few.

Table 12.2.4 SPMG/EPA/Non-EAP of NMCG

(Unit Rs.)

	2013/3/31	2014/3/31	2015/3/31	2015/3/31
(5) Advances to SPMGs EAP				
(i) SPMG Uttrakhand	6,648,101	54,721,710	47,311,510	4%
(ii) SPMG Uttar Pradesh	12,375,500	311,837,135	504,653,435	38%
(iii) SPMG Bihar	6,000,000	473,600,000	561,530,000	42%
(iv) SPMG Jharkhand	4,577,900	65,762,214	70,753,714	5%
(v) SPMG West Bengal	3,459,000	167,158,527	161,158,927	12%
	33,060,501	1,073,079,586	1,345,407,586	
(6) Advances to SPMGs Non EAP				
(i)SPMG Bihar			197,108,100	18%
(ii)SPMG Uttrakhand			5,095,700	0%
(iii)SPMG Uttar Pradesh		85,000,000	207,700,000	19%
(iv)SPMG West Bengal		321,875,000	680,184,000	62%
	0	406,875,000	1,090,087,800	

Source: NMCG, Finance at Glance 2011, 2012, 2013 and 2014

12.2.2 Uttar Pradesh State Government

JICA study team analyzed Income Statement and Balance Sheet of Uttar Pradesh Government.

1) Budget of UP Government

Uttar Pradesh State's Budget of 2015-2016 is 302,677 Cr. rupees (Table 12.2.5). This budget size is 10.2% more than the budget of 2014-15 (274,704 Cr.). Tax revenue is increased from 157,501Cr. (2014) to 178,644 Cr. (2015), or 13.4% increase. The ratio of Tax revenue in Revenue of 2015 gets a bit higher than that of Non Tax Revenue compared in 2014. The Relocation from Loan in Capital Receipt is quite decreased from 490 Cr. (2014) to 263 Cr., or 46.4% decrease. The increase of Capital Receipt is lower (6.1%: from 44,153 to 46,843) and that of Receipt from Revenue (10.4%: from 226.418 to 249,880), which leads to the increase of Total Receipt is 9.7% (from 270,572 to 296,723). The ratio of Capital Receipt is decreased to 13.4% in 2015 from 16.3% in 2014. The ratio of Receipt of Revenue and Capital Receipt is around 85% to 15% for both years. Although the increase of Capital related expense surpass the increase of Revenue related (12.5% vv. 9.3%), the ratio of Revenue related expense and Capital related is not changed, around 70% to 30% for both years. The saving from Revenue increases by 17.7% from 34,124 Cr. (2015) from 28,993 Cr. (2015). However, the ratios of various kinds of Loss for both years are almost the same. Regarding the budget of 2015, total budget will increase and the Surplus is high of 13.66%, but the portion of Deficit in 2015 budget is rather higher than before.

2) Actual of UP Government

a) Income Statement

Both revenue and expenditures of UP State since 2008 have been increasing. (Figure 12.2.5)

From this 2008 to 2013 as actual data, the budget growth rate or Total expenditure is 11.7%. In that, Revenue expenditure is 13% growth and Capital expenditure is 6.8%. The Total Receipts is 11.5%, composing Tax Revenue for 13.8% growth and Non Tax Revenue for 13.4%. The portion of Tax Revenue of the each year budget is about 66% and Non tax is 20.5% and Capital receipts 13.5%. Revenue expenditure portion in the total expenditure is 82.1% and Capital expenditure is 17.9%. There is almost no surplus and deficit.

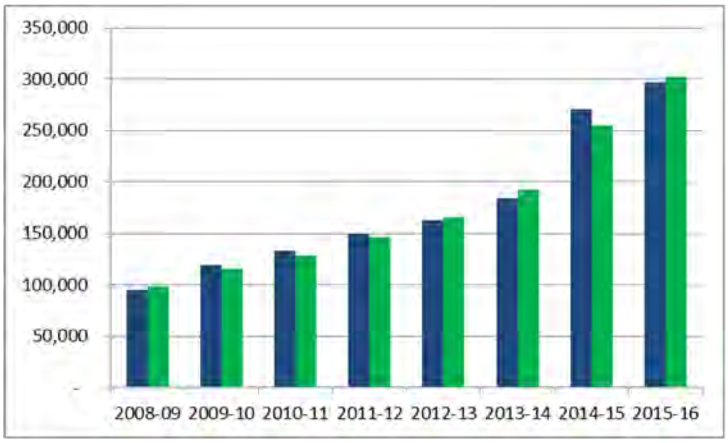
The total Tax Revenue ratio of its GDP in UP State is 22.3%, the one of Tax revenue is 14.2% and Non Tax revenue ratio is 4.8% (Table 12.2.6).

Table 12.2.5 Income Statement of Uttar Pradesh State

(Rs. In crores)

Items Revenue	2008-09 Actual	2009-10 Actual	2010-11 Actual	2011-12 Actual	2012-13 Actual	2013-14 Actual	2014-15 Budgeted	2015-16 Budgeted	Average	CAGR FY08-13	2008-13 (%)
(1) Tax Revenue	**59,565**	**65,674**	**84,574**	**102,964**	**115,596**	**129,359**	**157,502**	**178,644**	**85,675**	**13.8%**	66.1%
State's Own Tax Revenue	28,659	33,878	41,110	52,613	58,098	66,582	81,000	91,915	42,872	15.1%	
Fixed Share in Central Taxes	30,906	31,797	43,464	50,351	57,498	62,777	76,502	86,729	42,803	12.5%	
(2) Non Tax Revenue	**18,266**	**30,747**	**26,610**	**27,905**	**30,308**	**38,855**	**68,917**	**71,236**	**26,767**	**13.4%**	20.5%
State's Own Non Tax Revenue	6,767	13,601	11,176	10,145	12,970	16,450	20,232		10,932	16.0%	
Grants from the Government	11,499	17,146	15,434	17,760	17,338	22,405	48,685		15,835	11.8%	
(3) Capital Receipts	**17,538**	**22,782**	**21,879**	**19,785**	**16,239**	**15,489**	**44,154**	**46,843**	**19,645**	**-2.0%**	13.5%
Non Debt Capital Receipts	778	293	485	133	419	589	491	263	422	-4.5%	
Other Receipt which included to Advance from Reserve Bank of India	16,760	22,489	21,394	19,652	15,820	14,900	43,663	46,580	19,223	-1.9%	
Total Receipts (Revenue + Capital)	**95,369**	**119,203**	**133,063**	**150,654**	**162,143**	**183,704**	**270,573**	**296,723**	**132,086**	**11.5%**	
Expenditure											
(4) Revenue Expenditure	**75,969**	**89,374**	**107,676**	**123,885**	**140,724**	**158,147**	**197,425**	**215,756**	**107,526**	**13.0%**	82.1%
Plan Expenditure	17,291	15,701	21,040	22,616	25,878	31,657	43,720		20,505	10.6%	
Non Plan Revenue Expenditure	58,678	73,672	86,636	101,269	114,846	126,490	153,704		87,020	13.7%	
(5) Capital Expenditure	**23,153**	**26,033**	**21,241**	**22,550**	**24,837**	**34,336**	**57,406**	**86,931**	**23,563**	**6.8%**	17.9%
Capital Outlay	22,346	25,091	20,273	21,574	23,834	32,863	55,986		22,624	6.6%	
Loans and Advance	807	942	968	976	1,003	1,473	1,420		939	10.5%	
Total Expenditure	**99,122**	**115,407**	**128,917**	**146,435**	**165,561**	**192,483**	**254,831**	**302,687**	**131,088**	**11.7%**	
(6) Fiscal Deficit (Revenue-Expenditure)	(3,753)	3,796	4,146	4,219	(3,418)	(8,779)	15,742	(5,964)	998	15.2%	
(7) Total Revenue Receipts (1)+(2)	77,831	96,421	111,184	130,869	145,904	168,214	226,419	249,880	112,442	13.7%	
(8) Revenue Surplus (7)-(4)	1,862	7,047	3,508	6,984	5,180	10,067	28,994	34,124	4,916	32.5%	
(9) Revenue Surplus / Total Revenue(8)/(7)	2.39%	7.31%	3.15%	5.34%	3.55%	5.98%	12.81%	13.66%			

Source: Financial Statement of UP Sate by JICA Study Team



Figures 12.2.1 Revenue (blue) and Expenditure (green) of Uttar Pradesh State

Source: Data obtained by JICA study team

Table 12.2.6 Comparison of GDP and Budget of Uttar Pradesh

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2013-14	Average
GSDP (GDP in UP State)	491,302	523,394	600,286	685,292	782,285	862,746	976,297	
Tax Revenue Comapred to GSDP	12.1%	12.5%	14.1%	15.0%	14.8%	15.0%	16.1%	14.2%
Non-Tax Revenue Comapred to GSDP	3.7%	5.9%	4.4%	4.1%	3.9%	4.5%	7.1%	4.8%
Total Revenue Comapred to GSDP	19.4%	22.8%	22.2%	22.0%	20.7%	21.3%	27.7%	22.3%

Source: http://www.statisticstimes.com/economy/gdp-of-indian-states.php

b) Statement of financial position (balance sheet)

Asset of UP State has been increasing from 2008 to 2013 by 11.8% and its Liability is 6.6%. So the cumulative deficit is decreasing about 11.5% per year, which can imply in the near future no deficit. Annual growth rate (CAGR) of Capital expenditure of Water and Sewerage is about 30% which surpasses the total capital expenditure growth (13.2%).

Liability is mainly composed of three sources, Public Debt, Contingency Fund and Public Account (these three accounts are illustrated in the Figure 12.2.7). The portion of Public Debt is 62% and Public account is 35% (In Public Account, Provision or Pension occupies 42% of its account).

Table 12.2.7 Financial position of Uttar Pradesh

(Rs. In crores)

Asset	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	CAGR	
Cash	9,112	3,451	10,350	13,492	15,218	4,066	-12.6%	
Capital Expenditure	111,501	136,593	156,865	178,439	202,274	235,136	13.2%	
i)Investment in share of company, corporations in Non-financial Public Sector Undertakings (PSUs)	28,129	34,275	38,273	42,607	46,228	52,467	10.9%	
ii)Other Capital Expenditure	83,373	102,318	118,593	135,832	156,046	182,670	14.0%	
*Water and Sewerage**	*884*	*914*	*1,190*	*1,367*	*2,835*	*4,328*	*30.3%*	
Other Assets	9,021	9,670	10,194	11,307	11,844	14,096	7.7%	
Total Asset	129,635	149,713	177,410	203,238	229,335	253,298	11.8%	
Liability								
Public Debt	117,703	132,524	146,535	157,899	164,810	171,544	6.5%	62%
i)Internal Debt	97,339	113,077	128,025	140,389	148,399	156,208	8.2%	
ii)Loans and Advances from Central Government	20,364	19,447	18,510	17,511	16,412	15,336	-4.6%	
Contingency Fund	517	600	600	600	600	600	2.5%	0%
Public Account	69,707	69,197	78,250	85,330	94,810	110,165	7.9%	35%
i)Small Savings, Provident Funds, etc.	25,359	29,229	34,100	37,730	41,072	43,435	9.4%	
ii)Reserve Funds	16,116	16,210	26,096	31,584	35,970	43,924	18.2%	
iii)Deposits	28,232	23,758	18,054	16,016	17,769	22,806	-3.5%	
Suspense and Miscellaneous Balances	272	276	3,947	4,555	8,095	0	-100.0%	
Remittance Balances	4,555	3,190	642	434	1,419	1,322	-18.6%	
Total Liability	192,755	205,786	229,974	248,818	269,735	283,631	6.6%	
Cumulative excess of receipts over expenditure	-63,120	-56,073	-52,564	-45,580	-40,400	-30,333	-11.5%	

**: Included to Capital Investment*

Source: Financial Statement of UP Sate by JICA Study Team

3) Budget of UP Government

Uttar Pradesh State's Budget of 2015-2016 is 302,677 Cr. rupees. This budget size is 10.2% more than the budget of 2014-15 (274,704 Cr.). Tax revenue is increased from 157,501Cr. (2014) to 178,644 Cr. (2015), or 13.4% increase. The ratio of Tax revenue in Revenue of 2015 gets a bit higher than that of Non Tax Revenue compared in 2014. The Relocation from Loan in Capital Receipt is quite decreased from 490 Cr. (2014) to 263 Cr., or 46.4% decrease. The increase of Capital Receipt is lower (6.1%: from 44,153 to 46,843) and that of Receipt from Revenue (10.4%: from 226.418 to 249,880), which leads to the increase of Total Receipt is 9.7% (from 270,572 to 296,723). The ratio of Capital Receipt is decreased to 13.4% in 2015 from 16.3% in 2014. The ratio of Receipt of Revenue and Capital Receipt is around 85% to 15% for both years. Although the increase of Capital related expense surpass the increase of Revenue related (12.5% vv. 9.3%), the ratio of Revenue related expense and Capital related is not changed, around 70% to 30% for both years. The saving from Revenue increases by 17.7% from 34,124 Cr. (2015) from 28,993 Cr. (2015). However, the ratios of various kinds of Loss for both years are almost the same

Table 12.2.8 The State Budget of Uttar Pradesh

UP Government				
SUMMARY OF BUDGET (Cr.)				
	2013-2014 Actual Data	2014-2015 Budget Estimate	2014-2015 Revised Estimate	2015-2016 Budget Estimate
1 Receipt from Revenue (2 + 3)	168,213.75	226,418.77	223,997.46	249,880.23
2 Tax revenue(*)	129,358.77	157,501.55	151,391.31	178,644.11
3 Non Tax revenue(@)	38,854.98	68,917.22	72,606.15	71,236.12
4 Capital Receipt (5 + 6 + 7)	15,490.02	44,153.90	34,704.22	46,843.02
5 Relisation from Loan	589.57	490.96	540.68	263.40
6 Other receipt	0.00	0.00	0.00	0.00
7 Other receivables which included advance from Reserve Bank of India	14,900.45	43,662.94	34,163.54	46,579.62
8 Total Receipt (1 + 4)	183,703.77	270,572.67	258,701.68	296,723.25
9 Sundry Expenses (10 + 12)	137,561.36	179,665.45	164,909.17	195,966.90
10 Revenue Expenses	126,489.47	153,704.40	146,342.63	165,411.02
11 Interest Expenses	17,412.44	18,885.34	18,636.80	21,116.97
12 Capital Expenses	11,071.89	25,961.05	18,566.54	30,555.88
13 Payment / redemption of Loan which included advance from Reserve Bank of India	8,166.74	19,383.88	10,383.88	20,983.89
14 Expenses related Events	63,088.24	95,039.14	98,393.66	106,720.42
15 Related with revenue	31,657.40	43,720.48	45,247.60	50,345.16
16 Related with Capital Expenses	31,430.84	51,318.66	53,146.06	56,375.26
17 Total Expenditure (9 + 14)	200,649.60	**274,704.59**	263,302.83	**302,687.32**
18 Revenue Expenditure (10 + 15)	158,146.87	197,424.88	191,590.23	215,756.18
19 Capital Expenditure (12 + 16)	42,502.73	77,279.71	71,712.60	86,931.14
20 Saving from Revenue (1 - 18)	10,066.88	28,993.89	32,407.23	34,124.05
21 Fiscal Loss	23,679.54	28,410.98	28,380.81	31,559.80
22 Preliminary Loss (21 - 11)	6,267.10	9,525.64	9,744.01	10,442.83

(*) It's included state revenue tax as well as Central revenue Tax
(@) It's included state revenue tax as well as Central Grant

Source: Budget of Uttar Pradesh Government

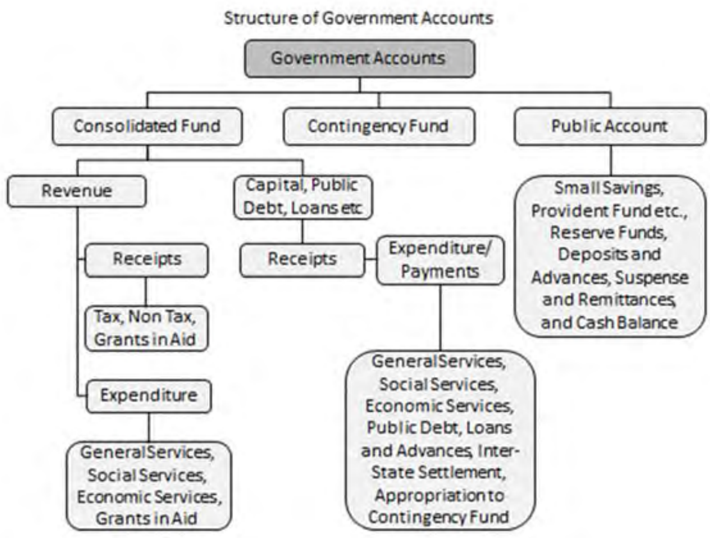
4) Budget/Actual of Grant 37

Grant 37 comes from The Ministry of Urban Development (MoUD) to each State including UP Government and is distributed to each district of the State. This contains the budget related to Water/Sewage, so this is the source of UP JN budget. The Revenue account growth per year (CAGR) is rather higher than Capital account. Revenue account growth surpasses Capital accounts; especially Non plan Revenue account has been increasing rapidly for both budget and actual.

Table 12.2.9 The total "Grant 37" of Uttar Pradesh

(Rs. In crores)		2009-10		2010-11		2011-12		2012-13		2013-14		2014-15		2015-16		CAGR	
		Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	B)FY15	A)FY13
Revenue	Plan	-	361	1,003	307	635	275	148	85	2,438	3,512	3,512	0	2,928	-	24%	113%
Account	Non Plan	-	128	42	310	477	216	978	827	792	1,467	1,467	0	1,703	-	110%	125%
	R-total		**489**	**1,045**	**617**	**1,112**	**491**	**1,127**	**912**	**3,230**	**4,979**	**4,979**	**0**	**4,631**		35%	117%
Capital	Plan	-	877	2,040	1,373	1,682	2,030	3,388	2,650	1,645	1,467	1,467	0	1,520	-	-6%	19%
Account	Non Plan	-	15	0	0	0	0	0	0	0	141	141	0	0	-		112%
	C-total	-	**891**	**2,040**	**1,373**	**1,682**	**2,030**	**3,388**	**2,650**	**1,645**	**1,608**	**1,608**	**0**	**1,520**	-	-6%	22%
Total		-	**1,381**	**3,085**	**1,990**	**2,794**	**2,521**	**4,515**	**3,562**	**4,875**	**6,586**	**6,586**		**6,151**	-	**15%**	**68%**
Actual																	
Revenue/Capital	Budget			51%		66%		33%		196%		310%		305%			
	Actual		55%		45%		24%		34%		310%						
Actual/Budget	R-total			59%		44%		81%		154%							
	C-total			67%		121%		78%		98%							

Source: Financial Statement of Grant 37 of UP Government



Figures 12.2.2 Structure of Government account of UP State

Source: Finance Account, UP State

Water/Cleaning budget of Grant 37, Capital Account growth is small but Revenue Account growth is very high (59.3%) per year.

Table 12.2.10 Water/Cleaning in "Grant 37" of Uttar Pradesh

(Rs. In crores)

			2009-10		2010-11		2011-12		2012-13		2013-14		2014-15		2015-16		CAGR	
			B	A	B	A	B	A	B	A	B	A	B	A	B	A	B)FY15	A)FY13
Revenue	Water Supply and	Plan		112	104	57	40	37	10	20	495	478	828		1,066		59.3%	103.1%
Account	Cleaning	Non Plan						3	3	3	4	4	4		4			
	Total			**112**	**104**	**57**	**40**	**40**	**13**	**23**	**499**	**482**	**832**		**1,070**		59.4%	1.037135027
Capital Account	Capital Expenditure on water supply and Cleaning	Plan		**126**	**586**	**440**	**672**	**246**	**586**	**371**	**315**	**323**	**366**		**650**		2.1%	-9.7%

12.2.3 Budgetary system in GOI and UP State Government

The financial sustainability of UP State Government can be known from the 14the commission report issued in 2016.

1) Transfers Recommended by the 14th Finance Commission

14th Commission report in 2016 says that Transfers Recommended by the 14th Finance Commission, the grant from central government to each state, shows about RS.596 billion from 2015-2020.

Table 12.2.11 Transfers Recommended by the 14th Finance Commission

	2014-15 (BE)	2015-16	2016-17	2017-18	2018-19	2019-20	Total (2015-20)
1 Tax Devolution to States	3,822,160	5,792,820	6,684,250	7,723,040	8,934,300	10,347,450	39,481,870
2 Total Grants to States from Finance Commission (A+B+C)	646,750*	888,650	1,006,460	1,031,010	1,110,630	1,336,780	5,373,540
A Post Devolution Revenue Deficit Grant to States	75,500	489,060	413,080	358,200	345,810	342,060	1,948,210
B Disaster Relief Grant to States	57,910	99,710	104,700	109,930	115,430	121,200	550,970
C Grants to Local Bodies to States	224,940	299,880	488,680	562,880	649,390	873,520	2,874,360
3 Aggregate Transfers to States from Finance Commission (1+2)	4,468,910	6,681,460	7,690,710	8,754,060	10,044,940	11,684,240	44,855,410
4 Divisible Pool**	12,116,630	13,792,430	15,914,880	18,388,200	21,272,150	24,636,790	94,004,440
5 Fiscal Space Available with the Union Government (4-3) of	7,647,720	7,110,960	8,224,160	9,634,140	11,227,210	12,952,560	49,149,040
6 Provision for other transfers (expected) to states (7-2)	1,973,500	2,350,040	2,902,630	3,496,650	4,056,620	14,779,430	0
7 Total Grants from the Union to States	3,675,290	2,862,140	3,356,500	3,933,640	4,607,290	5,393,400	20,152,970
8 Aggregate Transfers to States (1+7)	7,497,450	8,654,960	10,040,750	11,656,690	13,541,590	15,740,850	**59,634,840**
As a Percentage of Divisible Pool							
1 Tax Devolution to States	31.54%	42.00%	42.00%	42.00%	42.00%	42.00%	42.00%
2 Grants from FC to States	5.34%	6.44%	6.32%	5.61%	5.22%	5.43%	5.72%
3 Tax Devolution and FC Grants to States	36.88%	48.44%	48.32%	47.61%	47.22%	47.43%	47.72%
4 Fiscal Space with the Union of which	63.12%	51.56%	51.68%	52.39%	52.78%	52.57%	52.28%
5 Provision for other transfers (expected) to states	14.31%	14.77%	15.79%	16.44%	16.47%	15.72%	
6 Aggregate Transfers to States	61.88%	62.75%	63.09%	63.39%	63.66%	63.89%	63.44%

Source: 14th Commission report in 2016

2) Share of States

14th Commission report in 2016 also says that Share of States of Uttar Pradesh State is 17.96%. As the grant of 14th Commission from Government is about Rs.596 billion as noted in the previous table, this Grant to UP State from 2015 to 2020 is Rs.1,070,982 million. (Rs.596 billion times 17.96%)

Table 12.2.12 Share of States

States	Share of States	States	Share of States
Andhra Pradesh	4.31%	Manipur	0.62%
Arunachal Pradesh	1.37%	Meghalaya	0.64%
Assam	3.31%	Mizoram	0.46%
Bihar	9.67%	Nagaland	0.50%
Chhattisgarh	3.08%	Odisha	4.64%
Goa	0.38%	Punjab	1.58%
Gujarat	3.08%	Rajasthan	5.50%
Haryana	1.08%	Sikkim	0.37%
Himachal Pradesh	0.71%	Tamil Nadu	4.02%
Jammu & Kashmir	1.85%	Telangana	2.44%
Jharkhand	3.14%	Tripura	0.64%
Karnataka	4.71%	**Uttar Pradesh**	**17.96%**
Kerala	2.50%	Uttarakhand	1.05%
Madhya Pradesh	7.55%	West Bengal	7.32%
Maharashtra	5.52%	All States	100.00%

Source: 14th Commission report in 2016

3) Uttar Pradesh State Assessed Own Revenue Receipts and Revenue Expenditure

14th Commission report in 2016 shows that Uttar Pradesh State Assessed Own Revenue Receipts and Revenue Expenditure as the table below. Although Own Revenue Receipt has been increasing by about 14.3% from 2015 to 2010, Revenue Expenditure has surpassed which lead to Revenue Deficit Rs.5,373,350 million between 2015 and 2010. However, as noted before, the Grant of 14the Commission to UP State from 2015 to 2020 is Rs.1,070,982 million. (Rs.596 billion times 17.96%) which can well recover its Deficit.

Table 12.2.13 Uttar Pradesh State Assessed Own Revenue Receipts and Revenue Expenditure

Rs. million

		2015-16	2016-17	2017-18	2018-19	2019-20	2015-20	
A	GSDP	11,029,150	12,430,430	14,009,750	15,789,730	17,795,850	71,054,900	12.7%
B	**Own Revenue Receipts**	**1,148,420**	**1,308,500**	**1,493,480**	**1,707,480**	**1,958,430**	**7,616,330**	**14.3%**
	1 Own Tax Revenue	918,060	1,040,530	1,179,340	1,336,680	1,515,000	5,989,610	13.3%
	2 Own Non-Tax Revenue	230,360	267,970	314,140	370,810	443,440	1,626,720	17.8%
C	Revenue Expenditure	1,967,640	2,233,920	2,525,330	2,863,790	3,399,010	12,989,680	14.6%
	1 Equalization	91,140	123,770	151,510	192,390	391,720	950,510	44.0%
	2 Interest Payment	223,720	246,740	272,680	301,920	334,870	1,379,910	10.6%
	3 Pension	283,790	312,170	343,390	377,730	415,500	1,732,580	10.0%
D	Pre-Devolution Revenue Deficit (+) / Surplus (-)	819,210	925,410	1,031,850	1,156,310	1,440,570	5,373,350	15.2%

Source: 14th Commission report in 2016

12.2.4 Urban Local Bodies (ULB)

JICA study team analyzed financial information of Urban Local Bodies

1) Varanasi Nagar Nigam (VNN)

JICA study team analyzed five years Income Statement (actual) from 2010 to 2014 and three years financial position (balance sheet) from 2010 to 2012. (All data is obtained from VMC. Income statement is from two sources, one is between from 2010 to 2013 and the other from 2013 to 2014. Since the Chart of Account (C/A) is different between two sources, the latest CA is complied with the previous years' C/A by allocation used the ratio of the previous years)

a) Income/Expense Analysis of VNN

The total Receipt (Revenue and Capital) increases 11.2% per year, total Expenditure (Revenue and Capital) does by 16.1%, and surplus -15.8%, however, the surplus is being accumulated by 23% per year (see "Closing Balance" of Income statement). The total Receipt growth is not steady, or the budget in 2013 was pretty larger than other years. Total Revenue receipt is less growth (16.7%) than Revenue expenditure growth (18.7%). And in total Revenue, the portion of Tax revenue is 21% from 2010-2014 or that of Non tax revenue is 79%, and this Not tax revenue growth (9%) surpasses that of Tax revenue (18.6%) per year. In Non tax revenue, about 93% comes from Grants and has been rapidly increasing by 22.5% per year. Although the financial statement shows seemingly sound as it has surplus but it is supported by Grants. In Revenue expenditure, there is Water Supply account whose portion is 34%, which is the largest one among Expenditure.

Per observation of the income and expenditure statement of VNN, it is noted that every year VNN records surplus, in terms of revenue receipt against revenue expenditure. Therefore, financial situation is rather healthy and it maintains relatively strong financial sustainability.

Table 12.2.14 Summary of Income & Expenditure of Nagar Nigam Varanasi

(Unit million Rs.)

	Fiscal Year					CAGR	Portion
Current Account Receipts	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	FY10-14	
Revenue Receipts	**1,162**	**990**	**1,291**	**2,072**	**2,152**	16.7%	
1 **Taxes Revenue**	253.5	252.8	308.4	430.6	358.4	9.0%	21%
2 **Non Tax Revenue**	905.9	733.9	974.1	1,636.5	1,793.8	18.6%	79%
Grants	*768.9*	*663.9*	*889.3*	*1,547.9*	*1,731.6*	*22.5%*	
3 **Suspense Account**	2.9	3.6	8.5	5.0	1.9	-9.8%	
Current Account Expenditure							
Revenue Expenditure	**852.3**	**1,160.9**	**1,245.2**	**1,957.2**	**1,690.6**	18.7%	
Water Supply, Drainage & Conservancy	*341.7*	*426.1*	*466.1*	*559.3*	*582.1*	*14.2%*	*34%*
Capital Account Receipts							
1 Capital Receipts	**713.3**	**2,758.2**	**1,065.0**	**3,067.9**	**715.9**	0.1%	
Capital Account Expenditure							
Capital Expenditure	**610.9**	**2,796.7**	**933.6**	**2,700.0**	**969.9**	12.3%	
Sewers & Public Toilets	*610.9*	*2,590.6*	*893.9*	*2,684.8*	*394.8*	*-10.3%*	
Total Receipts - Total Expenditure	*412.3*	*-209.1*	*177.3*	*482.8*	*207.6*	-15.8%	
Opening Balance	99.7	512.0	302.9	480.2	963.0		
Revenue Receipts Total	1,162.3	990.3	1,291.1	2,072.0	2,152.3	11.2%	
Capital Receipts Total	713.3	2,758.2	1,065.0	3,067.9	715.9		
Total	1,975.3	4,260.5	2,659.0	5,620.1	3,831.1		
Revenue Expenditure Total	852.3	1,160.9	1,245.2	1,957.2	1,690.6	16.1%	
Capital Expenditure Total	610.9	2,796.7	933.6	2,700.0	969.9		
Closing Balance	512.0	302.9	480.2	963.0	1,170.6	23.0%	
Total	1,975.3	4,260.5	2,659.0	5,620.1	3,831.1	18.0%	

Source: Financial data from Nagar Nigam Varanasi by JICA study team

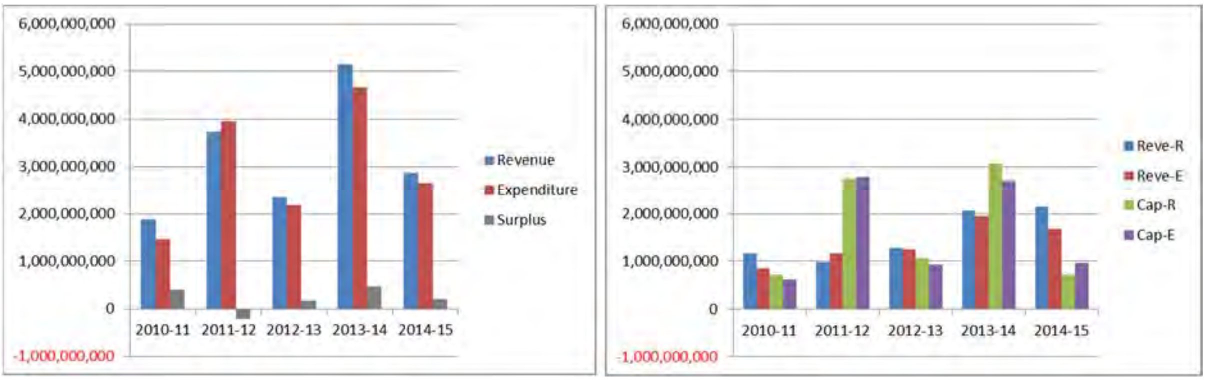


Figure 12.2.3 Revenue and Expenditure of VNN (Rs.)

Source: Financial data from Nagar Nigam Varanasi by JICA study team

b) Financial position (Balance Sheet) from 2010 and 2012 of VNN

The total balance sheet has been increased from Rs. 4,184 million to Rs. 7,744 million for these there years. In Asset side, about 60% is Fixed Asset and about 40% is Current Asset. In Current Asset, Loan, Advances and Deposits have been rapidly increasing, which occupies most of Current Asset. In Liability side, it can be noted that the plug between Asset and Liabilities is charged into the account called “Municipal (General) Fund”. Regarding grants, they are Grants from Central government, grants from State government, Grant from Government agencies, grants from financial institution, grants from international organization and others and VNN has grants from three sources, Grants from Central government (about 75%), Grants from State Government (about 23%) and others (about 2%), from other detailed information.

Table 12.2.15 Summary Balance sheet of VNN from 2010 to 2012

(million Rs.)

	Fiscal Year			CAGR	(%)
	2010-11	**2011-12**	**2012-13**	**FY10-12**	**FY2012**
Fixed Assets					
Fixed Assets	3,540	3,687	3,675	1.9%	47.5%
Capital Work In Progress	0	9	9		0.1%
Total Fixed Assets	3,540	3,696	3,684	2.0%	47.6%
Investments					
Investment-General Fund	0	80	80		1.0%
Investment-Other Fund	124	0	0		0.0%
Total Investments	124	80	80		1.0%
Current Assets, Loans and Advances					
Stock in Hand (Inventories)	7	105	156	366.7%	2.0%
Gross amount outstanding	51	74	72	18.7%	0.9%
Cash and Bank Balances	455	178	380	-8.6%	4.9%
Loan, Advances and Deposits	8	2,605	3,373	1907.5%	43.6%
Total Current Assets, Loans and Advances	521	2,962	3,981	176.4%	51.4%
Total Other Assets	0	0	0		
Total Assets	4,185	6,737	7,744	36.0%	100.0%
Liabilities					
Municipal (General) Fund	3,579	3,540	3,499	-1.1%	45.2%
Earmarked Funds	16	16	16	0.0%	0.2%
Reserves	12	188	188	290.8%	2.4%
Reserve and Surplus	3,607	3,744	3,703		47.8%
Grants, Contribution for Specific Purpose	363	2,871	3,957	230.4%	51.1%
Total Loans	0	0	0		
Current Liabilities and Provisions					
Deposits Received	6	6	11	34.9%	0.1%
Other Liabilities (Sundry Creditors)	209	117	73	-40.8%	0.9%
Total Current Liabilities and Provisions	215	122	84	-37.4%	1.1%
Total Liabilities	4,185	6,737	7,744	36.0%	100.0%

Source: Financial data from Mirzapur by JICA study team

c) Fixed Asset in 2010-11 VNN

As noted in the previous table, a large portion of balance sheet is fixed assets. In this fixed assets, it can be said that most of Fixed Asset is Land, or Depreciable property such as building or vehicles are rather less amount.

Table 12.2.16 Summary of Fixed Asset in 2010-11 of VNN

Rs. Million

Land	3,070.8	**Other Assets**	0.0
Buildings	227.8	Plant & Machinery	10.7
Infrastructure	0.0	Vehicles	62.4
Assets	0.0	Office & other	0.0
Road and Bridges	83.6	Equipment	3.3
Sewerage and	0.0	Lane	5.9
Drainage	43.1	Furniture, Fixtures	0.0
Water ways	1.5	Fittings and	0.0
Public lighting	11.9	Electrical	0.0
		Appliances	8.6
		Other Fixed Assets	10.0
		Total	**3,539.6**

2) Mirzapur

The financial information of Mirzapur Nagar Palika Parishad that JICA study team analyzed is the actual Income statement between 2011 and 2013 but Budgets/Estimations of 2014 and 2015. There is no information of Statement of financial position (Balance Sheet), but there is Surplus/Deficit account. This statement contains Water tax, water supply related information. (But no detailed information similar to Jal Kal Varanasi)

a) Income/Expense Analysis of Mirzapur

The total income of the budget (actual) has been increasing from 2011 to 2015 by 33.1%, each growth rate, Tax revenue is 25.5% growth and Non-tax revenue is 34.3%, so the growth rate of Non-tax revenue surpasses Tax revenue growth. The portion of Tax Revenue from 2011 to 2015 is about 12% and that of Non Tax Revenue is 88% among both revenues. This is because Grants occupy as much as 95.8% in Not Tax Revenue (the ratio between 2011 and 2014 or Actual). Although 2012 and 13 had Surplus but 2014 and 2015 will be deficit. The deficit ratio of 2015 budget (estimation) is about 4% of the budget. From these, it could be said that the financial stability of this ULB is not strong. The ratio of Water revenue (Water Tax and Water Price) of total income is about 4.9% which is rather high among the Tax Revenue, and it has been increasing 25.5% per year since 2011. Regarding Expenditure, the annual growth (CAGR) is 29% which is less than that of Total Income. Road (Cleaning and Construction) occupy high, 46% between 2011 and 2014 or Actual. The portion of Public Health and Comfort (or Water related) is 5.6% and its growth rate is very high as much as 75.6%.

Table 12.2.17 Summary of Income & Expenditure of Nagar Palika Parishad Mirzapur

(Unit In Rs.)

	2011-12	2012-13	2013-14	2014-15 Est	2015-16 Est	CAGR	2011-2013 (%)
Income							
Taxes Revenue							
Water Tax & Value	10,082,432	15,434,617	18,943,000	22,500,000	25,000,000	25.5%	4.8%
Stamp & Registration Fee	6,177,611	9,636,543	8,192,655	1,400,000	15,000,000	24.8%	2.6%
Property Tax	10,917,568	15,113,515	19,166,000	22,500,000	25,000,000	23.0%	4.9%
Other Tax	446,589	21,600	22,840	1,100,000	1,100,000	25.3%	0.1%
Total A)	**27,624,200**	**40,206,275**	**46,324,495**	**47,500,000**	**66,100,000**	24.4%	
Non Tax Revenue							
Water Price	199,075	319,344	428,901	400,000	1,200,000		0.1%
Other Income	6,085,187	5,238,807	2,564,402	42,332,000	77,132,000	88.7%	1.5%
Rent from Land & Building	1,325,720	1,405,631	1,367,065	2,500,000	2,500,000	17.2%	0.4%
State F.C. Grant	165,434,428	205,444,470	287,201,418	350,000,000	450,000,000	28.4%	71.6%
Central F.C. Grant	11,578,351	36,691,849	64,912,660	40,000,000	70,000,000	56.8%	12.3%
Backward Regions Grant	-	-	15,105,200	1,750,000	-	-	1.6%
Total B)	**184,622,761**	**249,100,101**	**371,579,646**	**436,982,000**	**600,832,000**	34.3%	
Total Income (A+B)	**212,246,961**	**289,306,376**	**417,904,141**	**484,482,000**	**666,932,000**	33.1%	
Expenditure							
General Government & Collection Expenses	45,501,946	43,519,641	52,938,756	61,700,000	82,200,000	15.9%	18.3%
Citizen Protection (Path Lighting & Material Maintenance)	12,490,818	6,714,885	5,835,488	14,100,000	20,000,000	12.5%	3.2%
Public Health and Comfort	15,765,224	6,220,557	21,310,863	62,500,000	150,000,000	75.6%	5.6%
Cleaning of Road, Drainage & Toilets	78,775,510	49,326,211	57,876,105	81,500,000	114,000,000	9.7%	24.0%
Public Works Road Construction & Salaries	41,438,647	44,644,681	83,994,752	211,500,000	268,300,000	59.5%	22.0%
Loan Recovery	19,155,909	21,110,378	48,373,343	20,000,000	22,500,000	4.1%	11.4%
Miscellaneous Expenses	38,183,668	30,107,452	51,082,355	35,800,000	38,150,000	0.0%	15.4%
Total Expenditure	**251,311,722**	**201,643,805**	**321,411,662**	**487,100,000**	**695,150,000**	29.0%	
Surplus/(Deficit) of Income - Expenditure	**(39,064,761)**	**87,662,571**	**96,492,479**	**(2,618,000)**	**(28,218,000)**	-7.8%	
Surplus Carried forward from Previous period	- 26,187,045	- 12,877,716	74,784,855	171,277,334	168,659,334		
Surplus Carried forward to Next period	- 12,877,716	74,784,855	171,277,334	168,659,334	140,441,334		

Source: Financial data from Mirzapur by JICA study team

b) Water related Income/Expense Analysis of Mirzapur

The actual financial data shows that Water Revenue and its expenditure almost balance, but the (expenditure) budget of 2014 and 2015 well surpasses its revenue.

Table 12.2.18 Water Income & Expenditure of Mirzapur

(Unit In Rs.)

	2011-12	2012-13	2013-14	2014-15 Est	2015-2016 Est
Taxes Revenue (1)					
Water Tax & Value	10,082,432	15,434,617	18,943,000	22,500,000	25,000,000
Water Price	199,075	319,344	428,901	400,000	1,200,000
	10,281,507	**15,753,961**	**19,371,901**	**22,900,000**	**26,200,000**
Expenditure (2)					
Water supply and capital expenditure			12,350,807	22,500,000	50,000,000
Water supply Installation Expenses Salaries				20,000,000	50,000,000
Water supply Relevant/Escort			8,960,056	20,000,000	50,000,000
Public Health and Comfort	**15,765,224**	**6,220,557**	**21,310,863**	**62,500,000**	**150,000,000**
(1) - (2)	(5,483,717)	9,533,404	(1,938,962)	(39,600,000)	(123,800,000)
Accumulation		9,533,404	7,594,442	(32,005,558)	(155,805,558)

Source: Financial data from Mirzapur by JICA study team

3) Ghazipur

The financial information of Nagar Palika Parishad Ghazipur that JICA study team analyzed is the actual Income statement between 2010 and 2014 and Statement of financial position (Balance Sheet) of 2008 and 2009. The Income statement contains Water Tax revenue. (But no detail information similar of Jal Kal Varanasi)

a) Income/Expense Analysis of Ghazipur

The actual total income has been increasing from 2010 to 2014 by 22%, each growth rate, Tax revenue is minus 16% growth and Non-tax revenue is 25%, so the growth rate of Non-tax revenue highly surpasses Tax revenue growth. The portion of Tax Revenue from 2010 to 2014 is 6% or that of Non Tax Revenue is 94%. In Non Tax revenue, Grants occupy as much as 89% (the actual ratio between 2010 and 2014). Tax Revenue has been decreasing from 13% in 2010 to 3% in 2014 which seems to be a problem. However, it has mostly Surplus except in 2010 and has been increasing in high number because Revenue Expenditure has been less than Revenue receipts since 2011 (Expenditure, the annual growth (CAGR) is 5.6%). Although Property tax has been increasing (18.5% per year), the water Tax has been almost the same amount from 2010 to 2014, whose portion is only 1.9% of Revenue. Regarding Expenditure, the portion of HR cost (Salary & Establishment) is almost 60%.

Table 12.2.19 Income & Expenditure of Nagar Palika Parishad Ghazipur

(Unit Rs.)

	Fiscal Year (Rs.)					CAGR	Total Revenue
	2010-11	**2011-12**	**2012-13**	**2013-14**	**2014-15**	FY10-15	FY10-14 (%)
Revenue Receipts	**97,294,952**	**110,490,107**	**144,104,431**	**214,802,686**	**216,980,069**	22.2%	
Taxes Revenue	12,203,595	6,914,058	11,412,274	8,708,511	6,069,568	-16.0%	
Property Tax	1,519,877	1,588,653	1,915,582	1,870,041	2,992,110	18.5%	1.3%
Stamp & Registration Fee	7,655,940	2,242,876	5,676,896	4,532,143	-	-100.0%	2.6%
Water Tax	3,021,253	3,027,758	3,759,853	2,269,864	3,055,869	0.3%	1.9%
Other Taxes (Entertainment, Vehicle)	6,525	54,770	59,942	36,464	21,590	34.9%	0.0%
Non Tax Revenue	85,091,357	103,576,049	132,692,157	206,094,175	210,910,501	25.5%	
Rent from Property of Nagar Palika	1,572,475	1,922,725	1,499,622	1,912,700	1,517,122	-0.9%	1.1%
Fees & Licenses	703,989	2,480,712	1,875,994	1,108,581	1,098,977	11.8%	0.9%
Mutation/Transfer		-	529,600	32,100	637,300		0.2%
Other Income	1,810,525	5,235,780	4,671,113	3,354,068	1,435,706	-5.6%	2.1%
State F.C. Grant	72,096,672	88,296,491	106,399,918	164,966,219	187,036,036	26.9%	79.0%
Central F.C. Grant	8,606,096	5,284,741	16,747,411	29,645,623	18,163,360	20.5%	10.0%
Security Deposits	301,600	355,600	968,500	108,485	1,022,000	35.7%	0.4%
UIDSSMT Plan	-	-	-	4,966,400	-		0.6%
Revenue Expenditure	**97,780,278**	**96,229,314**	**135,580,444**	**122,995,294**	**121,455,427**	5.6%	
Salary & Establishment	57,994,096	59,204,872	64,665,101	70,959,922	78,742,089	7.9%	57.8%
Operation & Maintenance	8,824,634	20,281,367	11,766,654	14,089,950	12,047,394	8.1%	11.7%
Tools & Plants for Health Department	128,550	3,282,250	4,893,514	2,453,077	1,878,786	95.5%	2.2%
Kanshiram Urban Housing Poor	16,554,096	-	-	-	-	-100.0%	2.9%
New Construction Pipe Line Handpump	865,896	4,896,225	8,831,107	2,844,173	5,747,619	60.5%	4.0%
Road Construction	13,413,006	8,564,600	5,293,568	27,681,772	23,039,539	14.5%	13.6%
UIDSSMT	-	-	40,130,500	4,966,400	-		7.9%
Surplus/Deficit	(485,326)	14,260,793	8,523,987	91,807,392	95,524,642	88.5%	26.7%
Rate of Surplus per Revenue	-0.5%	12.9%	5.9%	42.7%	44.0%		

Source: Financial data from Mirzapur by JICA study team

a) Financial position (Balance Sheet) of 2008 and 2009

Although a bit old, JICA study team could obtain Balance sheet of Mirzapur in 2008 and 2009. Form these, it is noted that, 1) about 70% of Asset is Current asset and most of it is Cash. 2) In Liability side, Grants portion is 32%, Current liability is 19% but Surplus is 50% (it seems that almost each year, ULB receives larger Grant than Expenditure or does not consume the received revenue. 3) It had Surplus in 2008 and 2009 while most each year in Income statement show Surplus as well. As the surplus in 2009 is Rs. 32 million and the surplus/deficit trend follows in the income statement, it can be assumed that accumulated surplus is Rs. 242 million in 2014. This surplus amount seems to be over its Revenue receipts in 2014, Rs. 216 million. 4) The size of balance sheet is rather small compared with the income statement. (Since CAGR of Revenue Receipts is 22.2% in Table 12.2.20, Revenue receipt in 2009 could be about Rs.75.7 million while Asset of this year is Rs. 46.9 million in Table 12.2.20)

Table 12.2.20 Water Income & Expenditure of Ghazipur

(Unit Rs.)

Description	2008-09	2009-10	CAGR	% Total Asset
Assets				
Fixed Assets (Net Block)	2,373,544	24,740,554	942.3%	33%
Gross Block	2,926,563	26,632,515	810.0%	
Less: Accumulated Depreciation	-553,019	-1,891,960	242.1%	
Current Assets, Loans & Advances	32,738,344	22,170,387	-32.3%	67%
Stock in Hand (Inventories)	1,260	69,066	5381.4%	
Gross amount outstanding	4,527,428	4,786,329	5.7%	
Receivables for Property Taxes	1,508,239	1,036,892	-31.3%	
Cash and Bank Balances	26,701,417	16,278,100	-39.0%	*52%*
Total	**35,111,888**	**46,910,941**	33.6%	
Liabilities				
Grants, Contributions for specific purposes	12,801,737	13,102,328	2.3%	32%
Current Liabilities & Provisions	14,008,118	1,305,367	-90.7%	19%
Deposits Received	247,600	95,251	-61.5%	
Other Liabilities (Sundry Creditors)	13,547,653	1,210,116	-91.1%	
Provisions	212,865	0	-100.0%	
Reserves & Surplus	8,302,032	**32,503,247**	291.5%	50%
Municipal (General) Fund	8,302,032	5,692,028	-31.4%	
Reserves	0	26,811,219		
Total	**35,111,888**	**46,910,941**	33.6%	

Source: Financial data from Mirzapur by JICA study team

Table 12.2.21 Estimated Surplus of Ghazipur

(Unit Rs.)

	2009-11	2010-11	2011-12	2012-13	2013-14	2014-15	CAGR FY09-14
Reserve and Suplus brought forward from Previous year		32,503,247	32,017,921	46,278,713	54,802,701	146,610,093	
Surplus on this year		(485,326)	14,260,793	8,523,987	91,807,392	95,524,642	
Reserve and Suplus brought forward to next year	32,503,247	32,017,921	46,278,713	54,802,701	146,610,093	242,134,735	65.2%

4) Ramnagar

The financial information of Nagar Palika Parishad Ramnagar that JICA study team analyzed is the actual Income statement between 2011 and 2014. There is no information of Statement of financial position (Balance Sheet), but there is Surplus/Deficit account. This statement contains Water Tax/Value, water supply related information. (But no detail information similar of Jal Kal Varanasi)

a) Income/Expense Analysis of Ramnagar

The actual total income has been increasing from 2011 to 2014 by 31.4%, each growth rate, Tax revenue is minus 7% growth and Non-tax revenue is 31.4%, so the growth rate of Non-tax revenue much higher than Tax revenue growth. The portion of Tax Revenue from 2011 to 2014 is about 10% and that of Non Tax Revenue is 90%. This is because Grants occupy as much as 86.6% in Non Tax Revenue, which is 75.5% from State government and 11.1% from Central government (the ratio between 2011 and 2014 or Actual). Although it has Surplus for all three year, Ramnagar depends upon Grants and also this trend is obvious as times go-by, so it could be said that the financial stability of this ULB is not strong. Total expenditure has been increasing as 29.4% which is slightly faster than that of total income growth. The portion of Salary and Pension of Total expense is 41.8%, which seems to be high level.

Table 12.2.22 Summary of Income & Expenditure of Nagar Palika Parishad Ramnagar

(Unit Rs.)

Discription	Fiscal Year			CAGR	2012-14
	2012-13	**2013-14**	**2014-15**	FY12-14	(%)
Income					
Taxes Revenue					
Stamp & Registration Fee	6,959,183	3,742,121	5,973,255	-7.4%	7.9%
Water Tax	270,311	278,133	259,381	-2.0%	0.4%
Water Value	659,589	698,129	593,720	-5.1%	0.9%
Total A)	**7,889,083**	**4,718,383**	**6,826,356**	-7.0%	9.2%
Non Tax Revenue					
Other Income	2,359,920	3,290,194	3,150,133	15.5%	4.2%
State F.C. Grant	37,053,583	54,213,214	68,401,559	35.9%	75.5%
Central F.C. Grant	5,986,880	10,637,192	6,861,958	7.1%	11.1%
Total B)	**45,400,383**	**68,140,600**	**78,413,650**	31.4%	90.8%
Total Income (A+B)	**53,289,466**	**72,858,983**	**85,240,006**	26.5%	100.0%
Expenditure					
Revenue - Infrastructure, Road, Water Supply, Cleaning, Lighting	4,980,582	5,474,914	5,117,834	1.4%	7.7%
13th Finance Commission - Sewer, Road, Electricity,Cleaning	5,209,633	7,365,049	7,355,978	18.8%	9.9%
State Finance Commission - Salary, Pension etc	25,418,517	29,223,263	29,832,074	8.3%	41.8%
State Finance Commission - Road, Water, Sewer, Lighting, Cleaning, Drainage etc.	13,001,014	30,038,258	39,144,053	73.5%	40.7%
Total Expenditure	**48,609,746**	**72,101,484**	**81,449,939**	29.4%	100.0%
Surplus/(Deficit)	**4,679,720**	**757,499**	**3,790,067**	-10.0%	4.4%

Source: Financial data from Mirzapur by JICA study team

12.2.5 UP Jal Nigam Varanasi

JICA study team analyzed financial information of UP Jal Nigam Varanasi, the actual data from 2011 to 2014 for both Income Statement and Statement of financial position (Balance sheet). UP Jal Nigam Varanasi composes of four, Unit-1, Unit-2, Mirzapur and Dinapur.

1) Income Statement

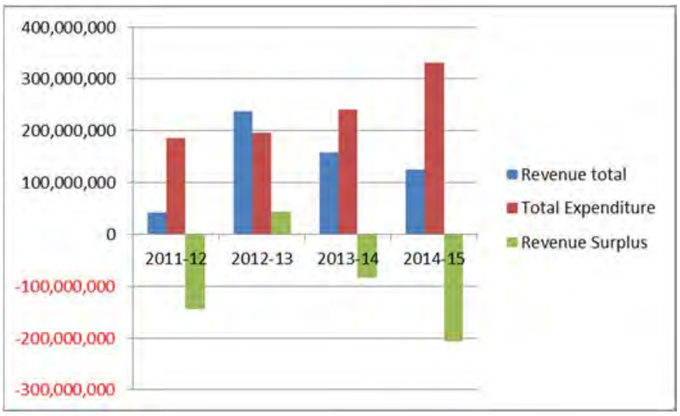
a) Overall findings

Revenue receipts have been increasing 45% per year while the growth of expenditure is 21.4%. Since basically the expenditure is larger than revenue, it often has deficit for each year and this negative growth rate is increasing (12.7%) per year. Looking at revenue/expenditure size, Varanasi Unit-2 is the largest (around 60-70% of total UPJN) and Mirzapur and Dinapur is rather small and both of them a similar business size. Among four areas, only Unit-1 has revenue surplus but all the other three locations have deficit for each year.

Table 12.2.23 Revenue and Expenditure of UP JN

(Rs.)	2011-12	2012-13	2013-14	2014-15	CAGR FY11-FY14	Portion
GPPU, Varanasi, Unit 1						
Revenue total	20,236,302	30,153,185	91,745,646	48,757,366	34.1%	34%
Total Expenditure	14,017,694	18,430,132	24,536,860	29,854,816	28.7%	9%
Revenue Surplus	6,218,608	11,723,053	67,208,786	18,902,551	44.9%	
GPPU, Varanasi, Unit 2						
Revenue total	12,338,387	204,410,392	56,467,895	48,219,724	57.5%	57%
Total Expenditure	135,166,584	137,031,566	166,610,549	222,571,202	18.1%	69%
Revenue Surplus	-122,828,197	67,378,826	-110,142,654	-174,351,478	12.4%	
Mirzapur						
Revenue total	108,767	206,824	5,386,190	16,372,877	432.0%	4%
Total Expenditure	19,006,738	22,245,207	31,398,318	52,080,250	39.9%	13%
Revenue Surplus	-18,897,971	-22,038,383	-26,012,128	-35,707,373	23.6%	
Dinapur						
Revenue total	7,952,368	3,055,803	3,156,951	10,726,852	10.5%	4%
Total Expenditure	17,205,690	17,635,295	17,385,608	26,873,543	16.0%	8%
Revenue Surplus	-9,253,322	-14,579,492	-14,228,657	-16,146,691	20.4%	
All total						
Revenue total	**40,635,824**	**237,826,203**	**156,756,682**	**124,076,820**	**45.1%**	
Total Expenditure	**185,396,706**	**195,342,200**	**239,931,335**	**331,379,811**	**21.4%**	
Revenue Surplus	**-144,760,882**	**42,484,004**	**-83,174,653**	**-207,302,991**	**12.7%**	

Source: Financial data from UP JN



Source: Financial data from JP JN

Figure 12.2.4 Revenue and Expenditure of UP JN (Rs.)

b) Some highlights of Income Statement

In Revenue receipt side, UP JN depends upon Centage Charges for its main revenue source and its growth is 55.2%. There is some small revenue such as Interest Income or other income.

Table 12.2.24 Revenue analysis of UP JN

(Rs.)	2011-12	2012-13	2013-14	2014-15	CAGR	Portion
GPPU, Varanasi, Unit 1						
Centage Charges	18,648,342	28,141,292	86,840,861	42,611,379		92%
Interest Income	1,311,679	1,127,145	4,374,394	5,915,348		7%
Other Income	276,281	884,748	530,391	230,639		1%
GPPU, Varanasi, Unit 2						
Centage Charges	2,213,852	200,008,202	51,104,997	34,968,244		90%
Interest Income	10,032,520	4,173,337	3,257,295	10,566,213		9%
Other Income	92,015	228,853	2,105,603	2,685,267		2%
Mirzapur						
Centage Charges	0	0	4,809,517	16,122,200		95%
Interest Income	75,504	115,558	473,363	160,969		4%
Other Income	33,263	91,266	103,310	89,708		1%
Dinapur						
Centage Charges	6,837,404	187,500	1,045,386	9,776,107		72%
Interest Income	140,652	277,193	63,439	321,062		3%
Other Income	974,312	2,591,110	2,048,126	629,683		25%
Each all total						
Centage Charges	**27,699,598**	**228,336,994**	**143,800,761**	**103,477,930**	55.2%	**90%**
Interest Income	**11,560,355**	**5,693,233**	**8,168,491**	**16,963,592**	13.6%	**8%**
Other Income	**1,375,871**	**3,795,977**	**4,787,430**	**3,635,297**	38.2%	**2%**
	40,635,824	**237,826,203**	**156,756,682**	**124,076,820**	45.1%	100%

Source: Financial data from UP JN

In expenditure side, the major expense is Salary & Reimbursement (37%) and Maintenance cost (61%) among all Expenditures. These growth rates are rather high, 29.1% for Salary and 17.4% for O&M. These costs varies among four areas; At Unit-1 Varanasi and Dinapur, most of the expenditure is Salary which may mean these Units focus on planning and design work. But at Unit-2 and Mirzapur, the same thing is for Maintenance cost, which may mean most of the works there is for O&M works of STP and other sewage facilities.

Table 12.2.25 Expenditure analysis of UP JN

(Rs.)	2011-12	2012-13	2013-14	2014-15	CAGR	Portion
GPPU, Varanasi, Unit 1						
Salary & Reimbursements	12,771,431	16,680,261	22,139,901	27,145,109		91%
Other Miscellaneous Office Expenses	301,554	242,192	495,307	454,122		2%
Depreciation	1,611	1,558	1,506	1,457		0%
Maintenance of Ganga Action Plan Work	80,860	0	0	0		0%
Interest Expenses	862,238	1,506,121	1,900,146	2,254,128		8%
GPPU, Varanasi, Unit 2						
Salary & Reimbursements	28,929,152	39,609,841	40,105,573	72,444,864		27%
Other Miscellaneous Office	782,499	81,147	145,633	252,474		0%
Depreciation	7,896	7,896	7,896	7,896		0%
Maintenance of Ganga Action Plan Work	104,337,009	95,989,912	124,984,801	148,367,308		72%
Interest Expenses	1,110,028	1,342,770	1,366,646	1,498,660		1%
Mirzapur						
Salary & Reimbursements	3,524,090	3,901,747	3,897,113	6,880,550		15%
Other Miscellaneous Office	223,327	52,376	295	500		0%
Depreciation	311	144	0	0		0%
Maintenance of Ganga Action Plan Work	15,081,940	18,185,060	27,296,889	44,933,077		85%
Interest Expenses	177,070	105,880	204,021	266,123		1%
Dinapur						
Salary & Reimbursements	15,727,326	16,248,698	15,654,803	24,638,805		91%
Other Miscellaneous Office	322,440	333,416	420,346	635,417		2%
Depreciation	2,652	1,880	0	0		0%
Maintenance of Ganga Action Plan Work	0	0	0	0		0%
Interest Expenses	1,153,272	1,051,301	1,310,459	1,599,321		6%
Each all total						
Salary & Reimbursements	**60,951,999**	**76,440,547**	**81,797,390**	**131,109,328**	**29.1%**	**37%**
Other Miscellaneous Office	**1,629,820**	**709,131**	**1,061,581**	**1,342,514**	**-6.3%**	**0%**
Depreciation	**12,470**	**11,478**	**9,403**	**9,353**	**-9.1%**	**0%**
Maintenance of Ganga Action Plan Work	**119,499,809**	**114,174,971**	**152,281,690**	**193,300,385**	**17.4%**	**61%**
Interest Expenses	**3,302,608**	**4,006,072**	**4,781,272**	**5,618,232**	**19.4%**	**2%**
	185,396,706	**195,342,200**	**239,931,335**	**331,379,811**	**21.4%**	100%

Source: Financial data from UP JN

2) Statement of Financial position (Balance sheet)

a) Overall findings

Balance sheet of UP Jal Nigam Varanasi has been increasing from 2011 to 2014, Rs. 4,579 million to Rs. 6,699 million, or 13.5% increase per year. Major asset holder in this balance sheet is Varanasi Unit-2, 66% of its total. But as mentioned later, UP JN has very few fixed asset.

Table 12.2.26 The size of Balance Sheet, UP JN

(million Rs.)	2011-12	2012-13	2013-14	2014-15	CAGR FY10-FY14	Portion
Varanasi Unit 1	935.9	1,387.6	1,750.1	1,959.0	27.9%	26%
Varanasi Unit 2	3,132.9	3,176.5	4,510.4	4,285.2	11.0%	66%
Mirzapur	236.5	235.9	237.2	246.4	1.4%	4%
Dinapur	273.8	286.4	193.9	208.9	-8.6%	4%
Total Assets	**4,579.1**	**5,086.3**	**6,691.6**	**6,699.5**	**13.5%**	100%

Source: Financial data from UPJN

b) Some highlights of Balance Sheet

UP JN does not have much fixed asset since its business is design and construction work of water supply and sewer/sewage system; however it has large amount of WIP (work in progress), about 64% (41+23) in total asset. Also the growth rate is rather high, 13.4% and 25.3%. These four years, UPJN suffers a deficit but total own funds are approximately four times larger than accumulated deficit, and thus, financial situation of UPJN is health in total.

Table 12.2.27 Asset of UP JN

Asset (million Rs.)	2011-12	2012-13	2013-14	2014-15	Portion	CAGR
Capital WIP	1,833.8	2,335.1	2,632.5	2,674.3	41%	13.4%
Capital Work in Progress	896.1	1,113.1	1,455.4	1,763.7	23%	25.3%
Cash & Bank Accounts	800.7	449.9	1,595.0	1,153.4	17%	12.9%
GP Completed Projects	441.6	441.6	441.6	441.6	8%	0.0%
Accounts Receivable	212.0	411.3	337.9	427.7	6%	26.4%
Capital WIP & Inventory	269.3	281.7	184.7	199.5	4%	-9.5%
Fixed Deposits with Bank	125.1	53.0	44.0	39.0	1%	-32.2%
Loans & Advances	0.5	0.6	0.5	0.3	0%	-15.1%
Fixed Assets	0.1	0.1	0.1	0.1	0%	
Asset Total	**4,579.1**	**5,086.3**	**6,691.6**	**6,699.5**		

Source: Financial data from UP JN

The liability of UP JN Balance sheet mainly composes of two items, Own funds and Current Liabilities. Own Funds are almost the same amount of WIP in asset.

Table 12.2.28 Liabilities of UP JN

(Rs. Million)	2011-12	2012-13	2013-14	2014-15	CAGR FY11-FY14	Portion
Total Own Funds	2,823.8	3,090.3	3,518.3	3,700.6	9.4%	57%
Total Surplus/(Deficit)	-789.8	-747.3	-757.4	-954.9	6.5%	-14%
Current Liabilities	2,545.2	2,743.4	3,930.7	3,953.8	15.8%	57%
Total	**4,579.1**	**5,086.3**	**6,691.6**	**6,699.5**	13.5%	100%

Source: Financial data from UP JN

12.2.6 Nagar Nigam Jal Kal Varanasi

Jal Kal under Nagar Nigam operates and maintains the water supply system of Varanasi. (O&M of STP is taken care of by UP JN) Jal Kal is now a part of VMC, though it continues to have a large amount of autonomy with regards to administrative and financial functions. Jal Kal is also responsible for billing and collection of user charges.

1) Income Statement

The revenue of Jal Kal is Rs.241.9 million in 2013 and most of it is Water Supply, Rs.238.5 million, while Sewage is only Rs.3.4 million. The revenue has been increasing from 2011(April) to 2014(March) for 9.8% annually. The total revenue has been increasing but the Sewage Tax in 2013 is pretty lower than before two years. Each Sewage Tax of 2011 and 2012 is preciously 12.5% of each Total Income (e.g. 28,533,306/227,986,770 = 12.5% (2012)). The sewage tax in 2013 seems to be contained in the portion of Water Supply (238,501,115). So it may be assumed that Water /Sewage revenue in 2013 will be Rs. 211,684,473 and Rs. 30,240,639 each.

Although the revenue has been increasing, the Expenditure has been over Income, Jal Kal has deficit for every year. The expenditures are two to three times larger than income and its ratio gets worse toward the latest year. The largest share of the expenditure is Establishment Expenses (Salaries and Pension) and Electricity Charge, totaling about as much as 87.5% of total expenditures. The future labor demand is still strong. (Table 12.2.29 in the below) It can be said that current Jal Kal business model depends upon labor and electricity. Although electricity charge is recorded as liability in the financial statements, it is paid by UP State government, which is assured by Fifteenth Finance Commission. The CAGAR for the last three years is 22.2% for Establish Expense, 31.2% for Electricity charge and the 27% for Repair & Maintenance, thought the share of Repair & Maintenance is less than 10% of total expenditure. When if neglect of Electricity payment (since UPJN pays) and depreciation, Jal Kal gets Rs.241 million Revenue and pays Rs.321 million in 2013, so the cost recovery ratio is about 75%.

Table 12.2.29 Income statement of Jal Kal, Varanasi

	Description	Fiscal Year (Rs.)						CAGR	Income (%) on FY13
	Revenue Receipts	**2011-12**		**2012-13**		**2013-14**			
		Water	**Sewerage**	**Water**	**Sewerage**	**Water**	**Sewerage**		
	1 Tax Revenue								
	Water Tax	172,794,744	-	196,812,694	-	236,175,233	-	16.9%	99.0%
	Sewer Tax	0	25,051,256	0	28,533,306	0	3,423,997	-63.0%	0.0%
	2 Excess Water Charges	174,000	0	174,000	0	200,100	0	7.2%	0.1%
	Meter Rent								
	3 Pipeline Charges	219,640	0	159,663	0	181,025	0	-9.2%	0.1%
	4 Other Income	2,380,243	0	2,307,107	0	1,944,757	0	-9.6%	0.8%
(I)	**Sub Total Income**	**175,568,627**	**25,051,256**	**199,453,464**	**28,533,306**	**238,501,115**	**3,423,997**	9.8%	100.0%
	Total Income		**200,619,883**		**227,986,770**		**241,925,112**		
		Fiscal Year							
	Revenue Expenditure	**2011-12**		**2012-13**		**2013-14**		**CAGR**	**Income (%) on FY13**
		Water	**Sewerage**	**Water**	**Sewerage**	**Water**	**Sewerage**		
	1 Establishment Expenses	152,391,924	7,362,546	264,990,534	7,982,037	230,526,193	7,950,124	22.2%	96.7%
	2 Consumption of Stores	9,235,462	0	1,537,741	0	7,513,968	0	-9.8%	3.2%
	3 Electricity Charges	202,006,700	0	217,831,300	0	347,766,144	0	31.2%	145.8%
	4 Repair & Maintenance	10,155,208	36,001,145	11,327,702	23,727,991	21,512,487	52,971,060	27.0%	9.0%
	5 Miscellaneous Expenses	595,699	0	1,206,570	0	504,249	0	-8.0%	0.2%
	6 Interest Charges	390,166	18,625	390,166	18,625	390,166	18,625	0.0%	0.2%
	7 Depreciation	7,342,192	1,326,667	7,488,968	1,345,011	8,092,949	2,741,884	11.8%	3.4%
(II)	**SubTotal Expenditure**	**382,117,351**	**44,708,983**	**504,772,981**	**33,073,664**	**616,306,156**	**63,681,693**	26.2%	258.4%
	Total Expenditure		**426,826,334**		**537,846,645**		**679,987,849**		
	Revenue Deficit	**-206,548,724**	**-19,657,727**	**-305,319,517**	**-4,540,358**	**-377,805,041**	**-60,257,696**	39.2%	-158.4%
	Total Deficit	**-226,206,451**		**-309,859,875**		**-438,062,737**			
	Operating Margin (%)	-117.6%	-78.5%	-153.1%	-15.9%	-158.4%	-1759.9%		

Source: Actual Financial Statements of Jal Kal Varanasi

The Table below provides the number of filled and vacant posts at Jal Kal, Varanasi.

Table 12.2.30 The workforce at Jal Kal Varanasi

Detail of Centralized Service Group-1,2,3

No.	Designation	Sanction Post	Working Employees	Vacant Post
1	General Manager	1	1	-
2	Executive Engineer	5	3	2
3	Assistant Engineer	9	2	7
4	Junior Engineer	15	5	10

Detail of Non Centralized Service Group-1, 2

No.	Designation	Sanction Post	Working Employees	Vacant Post
1	Finance Officer	1	-	1
2	Account Officer	1	-	1

Detail of Non Centralized Service Group-G, GH

No.	Designation	Sanction Post	Working Employees	Vacant Post
1	Group - G	149	86	63
2	Group - GH	936	412	524

Source: Data from Jal Kal

2) Statement of Financial Position

The grand total assets and liability in 2013 is Rs.666 million which has been decreased from 2010 by 4.2% per year. Fix Asset portion is about 60% in 2013 and has been increasing by 3.7% annually. Current asset has been decreasing from 2010 to 2013. Current liabilities have been increasing by

15.7% per year for the last years because Jal Kal does not pay Electricity Charge causing deficit every year. And every single year shows the deficit between Rs. 2.3 million and Rs. 4.4 million, which leads to accumulated deficit as much as Rs. 30 million in 2013. Grant in Aid has been increasing, annually 10% increase, but Capital Fund has been all the same amount. Per observation of financial statement of Jal Kal, it is obvious that Jal Kal is not able to recover O&M cost especially for electricity with its user charge for sewerage collected. Without updating the payment process of electricity and improving the coverage of electricity cost against sewerage tariff, financial sustainability of Jal Kal remains weak.

Table 12.2.31 Statement of financial position of Jal Kal, Varanasi

	Fiscal Year (Rs.)				CAGR	Total Asset (%)
Assets	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**FY10-FY13**	**on FY13**
1 Fixed Assets	359,501,572	358,221,409	358,481,543	400,725,684	3.7%	60.2%
2 Interest on World Bank Loan	1,140,090	1,140,090	1,140,090	1,140,090	0.0%	0.2%
3 Current Assets	398,058,433	381,400,424	295,382,486	264,181,919	-12.8%	39.7%
Water Tax	73,237,500	75,624,130	14,809,030	18,176,223	-37.2%	2.7%
Excess Water Charges & Meter Rent	146,473,632	142,271,944	138,303,556	135,964,426	-2.5%	20.4%
Sewer Tax	131,446,462	114,380,690	78,992,047	24,214,035	-43.1%	3.6%
Other	46,900,839	49,123,660	63,277,853	85,827,236	22.3%	12.9%
Grand Total of Assets	**758,700,095**	**740,761,923**	**655,004,119**	**666,047,693**	-4.2%	100.0%

Description	Fiscal Year				CAGR	Total Liability (%)
Liabilities	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**FY10-FY13**	**on FY13**
1 Capital Fund	790,849,734	790,849,734	790,849,734	790,849,734	0.0%	21.5%
2 Grant in Aid	264,963,023	265,067,023	271,375,023	352,486,943	10.0%	9.6%
3 Loans & Advances	303,885,219	303,885,219	303,885,219	303,885,219	0.0%	8.2%
4 Current Liabilities	1,443,802,145	1,651,966,424	1,869,760,495	2,237,754,887	15.7%	60.7%
Total of Liabilities	**2,803,500,121**	**3,011,768,400**	**3,235,870,471**	**3,684,976,782**	9.5%	100.0%
Accumulated Deficit	- 2,044,800,026	- 2,044,800,026	- 2,271,006,477	- 2,580,866,352	8.1%	-70.0%
Deficit for the year		- 226,206,451	- 309,859,875	- 438,062,737	39.2%	-11.9%
Total of Deficit	**- 2,044,800,026**	**- 2,271,006,477**	**- 2,580,866,352**	**- 3,018,929,090**	13.9%	-81.9%
Grand Total of Liabilities and Deficit	**758,700,095**	**740,761,923**	**655,004,119**	**666,047,693**	-4.2%	18.1%

a) Analysis of Receivables

Analysis of 2012 and 2013 shows that total collection ratio (water and sewer) is about 70% to 80% although each ratio is different; Water tax collection is higher than that of Sewer. Especially, the water tax collection in 2013 is pretty high (End-receivables divided by Addition is 8% or Collection (Additions/Collections) is 101%) Excess water charge & meter is very slow moving. Although the collection status mentioned in the previous section (Figure 12.2.31) shows different from here, through those calculated numbers, we can think the collection ratio of water/sewer at Jal Kal these days is about 68%.

Table 12.2.32 Consumer Receivables of Jal Kal, Varanasi

Particulars (Rs.)	Beginning Amount as on 2012/3/31	Additions Raised during the year ended 2013/3/31	Collections Collected during the year ended 2013/3/31	End Amount as on 2013/3/31	End balance/ Addition	Collection
I. Water Supply Scheme		(y)		(x)	(x)/(y)	
1 Water Tax	75,624,130	196,812,694	255,687,794	14,809,030	8%	77%
			1,940,000			
2 Excess Water Charges & Meter Rent	142,271,944	174,000	4,142,388	138,303,556	79485%	4%
TOTAL	217,896,074	196,986,694	261,770,182	153,112,586	78%	75%
II. Sewerage Scheme						
1 Sewer Tax	114,380,690	28,533,306	63,921,949	78,992,047	277%	45%
Grand TOTAL (I+II)	332,276,764	225,520,000	325,692,131	232,104,633	103%	**69%**
		Raised during the year ended 2014/3/31	Collected during the year ended 2013/4/31	Amount as on 2014/3/31	End balance/ Addition	
I. Water Supply Scheme						
1 Water Tax		236,175,233	232,808,039	18,176,223	8%	101%
2 Excess Water Charges & Meter Rent		200,100	2,539,230	135,964,426	67948%	8%
TOTAL		236,375,333	235,347,269	154,140,649	65%	100%
II. Sewerage Scheme						
1 Sewer Tax		3,423,997	58,202,010	24,214,035	707%	6%
Grand TOTAL (I+II)		239,799,330	293,549,279	178,354,684	74%	**82%**

Source: Actual financial statement of Jal Kal, Varanasi

b) Analysis of fixed Assets

The fixed asset in 2013 is Rs. 400 million and its portion of the total balance sheet is 60%. This contains each fixed assets of Water supply and Sewer scheme in this year, Rs.165 and Rs.48.6 million respectively, so the portion of Water is77% and the one of Sewage is 23% among them. Regarding Sewage fixed asset, it has Pipes & Fittings and Machine. Pipes & Fittings are becoming outdated (accumulated Depreciation is 63.5%) while Machine's is not so. But Machine was newly bought this year, as much as Rs. 29 million, Machine as an asset is outdated as well (the accumulated depreciation would be 78.1%, in at simple math)

Table 12.2.33 Summary of Receipt & Payment, Jal Kal, Varanasi

	a	b	c = a + b	d	e	f = d + e	g = a - d	h = c - f	h/g	e/(a+b)	f/c
Descritpion of Assets (Rs.)	Acquisition Cost on 2013/3/31	Additions during FY201	Acquisition Cost on 2014/3/31	Accumulated Depreciation on 2013/3/3	Depreciation during FY2013	Accumulated Depreciation on 2014/3/3	Net Book Value on 2013/3/31	Net Book Value on 2014/3/31	Growth rate	Annual Depreciation rate	Accumulated Depreciation rate
1 Pipes & Fittings	42,181,216	5,754,190	47,935,406	29,308,800	1,131,276	30,440,076	12,872,416	17,495,330	35.9%	2.4%	**63.5%**
2 Sewer Cleaning Machine	8,123,894	29,332,110	37,456,004	4,737,849	1,610,608	6,348,457	3,386,045	31,107,547	818.7%	4.3%	16.9%
TOTAL(A)	50,305,110	35,086,300	85,391,410	34,046,649	2,741,884	36,788,533	**16,258,461**	**48,602,877.00**	198.9%	3.2%	43.1%
2 Sewer Cleaning Machine	*8,123,894*	*0*	*8,123,894*	*4,737,849*	*1,610,608*	*6,348,457*	*3,386,045*	*1,775,437*	*-47.6%*	*19.8%*	***78.1%***
TOTAL(B)	*50,305,110*	*5,754,190*	*56,059,300*	*34,046,649*	*2,741,884*	*36,788,533*	*16,258,461*	*19,270,767*	*18.5%*	*4.9%*	***65.6%***

3) Receipt & Payment

The total money inflow and its money outflow from 2011 to 2013 is almost the same amount (The money surplus in each year is slight in Table 12.2.34). In the three years, most of the money inflow (86%) comes from Water/Sewer Tax and the other is Grant/Loan (11%). In money outflow, most of it (72%) is paid out concerning employee/labor. “Pension Payment” as cash is being paid but this was not funded as pension liability in the past because the pension system in those days was not designed so. (Provident Fund Deposit is for future pension payment purpose whose pension system was designed recently). The second large portion of money outflow (27%) is related to Maintenance expense. To purchase the new Sewer Machine, Rs. 35 million as Fixed Assets (Sewage) was paid in 2013 when the Grant was rather larger than the other years. Inflow/Outflow ratio of each Water/Sewage varies through these years.

Table 12.2.34 Summary of Receipt & Payment, Jal Kal, Varanasi

	2011-12		2012-13		2013-14		
Rs.	Water	Sewerage	Water	Sewerage	Water	Sewerage	
Opening Balances	4,772,764	-	11,621,103	-	20,233,028	-	
Inflow of Revenue							
1 Water Tax	168,468,114	-	255,687,794	-	232,808,039		
2 Sewer Tax	-	42,117,028	-	63,921,949		58,202,010	86%
3 Jal Sanyojan	558,700	-	455,050	-	461,700		
4 Development Charges	3,816,988	-	3,687,338	-	2,077,530		
5 Miscellaneous Receipts	2,141,810	-	2,032,167	-	1,777,071		
6 Pipeline Charges	219,640	-	159,663	-	181,025		
7 Bank Interest	21,173	-	59,275	-	79,117		11%
8 Loan from Nagar Nigam	4,000,000	-	-	-	8,500,000		
9 Grant in Aid Receipts/ Adjustment	104,000	-	7,619,000	-	81,111,920		3%
10 Adjustment NMP/NN	1,457,422	-	-	3,739,433	6,931,537		
Each total Inflow	**180,787,847**	**42,117,028**	**269,700,287**	**67,661,382**	**333,927,939**	**58,202,010**	
A) Total Inflow	**185,560,611**	**42,117,028**	**281,321,390**	**67,661,382**	**354,160,967**	**58,202,010**	
Grand total Inflow		**227,677,639**		**348,982,772**		**412,362,977**	
Outflow of Revenue							
1 Establishment Expenses	95,225,771	6,069,437	166,888,980	6,766,447	142,708,637	6,861,201	
2 Purchase of Stores	10,373,540	-	3,708,137	-	8,226,611	-	
3 Repairs & Maintenance	9,460,438	35,247,419	10,460,877	23,652,887	11,493,193	47,437,531	
4 Other Expenses	595,699	-	1,206,570	-	504,249	-	
5 Purchases of Fixed Assets	3,268,149	3,416,852	4,296,028	1,133,755	16,594,666	**35,086,300**	
6 Provident Fund Deposit	3,027,133	152,518	13,269,452	488,032	23,516,823	344,971	
7 Pension Payment	27,792,071	-	66,452,757	-	50,503,950	-	
8 Payment Against Deduction	18,031,344	1,170,973	19,655,354	737,712	22,442,705	690,411	
9 Capital WIP	703,696	-	3,664,329	-	1,398,008	-	
10 Payment to Deceased Employee	73,000	-	115,500	-	84,000		72%
11 Handpump Expenses	582,493	-	662,339	-	3,258,603		
12 Pipeline Expenses	866,003	-	279,590	-	12,294,220		27%
13 Payment/Adj to NMP	-	-	4,000,000	-			
14 Refund of Grant	-	-	1,311,000	-			1%
15 Payment Adjustment towards Electricity	-	-	-	-	1,940,000		
B) Each total Outflow	**169,999,337**	**46,057,199**	**295,970,912**	**32,778,833**	**294,965,665**	**90,420,414**	
Closing Balance	**11,621,103**	**-**	**20,233,028**	**-**	**26,976,898**		
Total Outflow	**181,620,440**	**46,057,199**	**316,203,940**	**32,778,833**	**321,942,563**	**90,420,414**	
Grand total Outflow		**227,677,639**		**348,982,773**		**412,362,977**	
Inflow/Outflow	106%	91%	91%	206%	113%	64%	
Inflow - Outflow (A - B)=	10,788,510 -	3,940,171 -	26,270,625	34,882,549	38,962,274 -	32,218,404	
		6,848,339		8,611,924		6,743,870	

Source: Actual financial statement of Jal Kal, Varanasi

Through the analysis of Income Statement, Balance Sheet and Receipt & Payment of Jal Kal, Varanasi, it can be said that Jal Kal can operate because it does not have to pay Electricity Charge or is supported by State Government. It depends upon Water/Sewage tax and charges and this collected money is consumed for paying the expenses for every year, mostly employee/labor expenses.

Figure 12.2.5 illustrates how Jal Kal operates in the financial point of views (in 2013):

A: Cash-flow basis, Jal Kal receives Rs.291 from Tax/Charge from users and Rs.90 from Government/ULB, totaling Rs. 392. And it spends Rs. 385, mostly to employees/Labors expense since electricity charge is not supposed to be paid by Jal Kal.

B-1) Income statement accrual basis: Jal Kal Revenue (Water/Sewage) is Rs. 242 and the total expenditure is Rs. 680. Although UPJN pays Electricity Charges, Jal Kal records it as liabilities. (W-2 Rs.348 from State/ULB is intentionally expressed in this figure) Although assumed that Rs. 348 of Electricity Charges is not here, it is still shortage of Income of Rs.80 as the deficit ((239+3) - (238+94) = - 80) The second large expense is employee/labors.

B-2) the similar view of B-1 but the chart is taken apart by Water/Sewage sectors. In here, the expense of water is over 4 times of Sewage. From all three Charts, Jal Kal business model depends upon Electricity and Labor works as the main expenditures and Water/Sewage as the major incomes. Revenue is much less than Expenditures. It is necessary to improve the productivity by trying to reduce those costs as well as to increase the income by higher collection ration and higher billing rate

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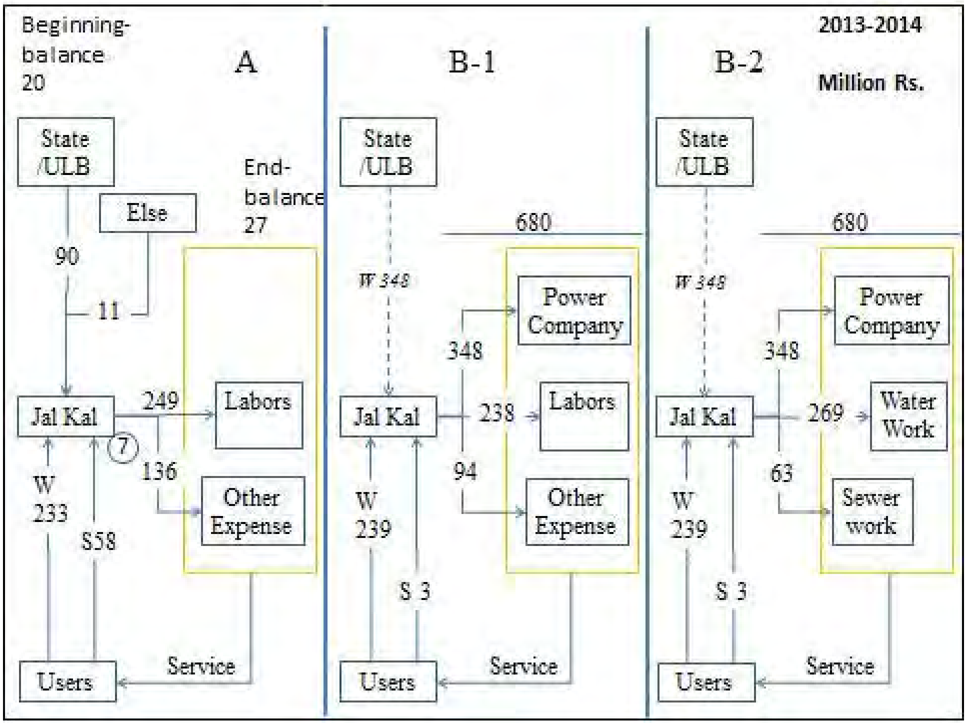


Figure 12.2.5 Income/Expenditure flows of Jal Kal Varanasi

12.2.7 Fund flow among stakeholder

As documented on Chapter 11, institutional structure of governmental organization is comprised of three layers, National level, State Level and Urban Local Body (ULB). NMCG in Government of India (GOI) is the key source of the fund to be provided to each State and ULB. GOI does not distribute the fund to State Government, but to each ULB directly, for the purpose of Capital Expenditure. As public infrastructure development program is sanctioned by GOI, respective fund is disbursed to each ULB based on the approved program or plan. This is the fund flow from GOI to ULB as Grant for Capital Expenditure. On the balance sheet of ULB, received amount is recorded as liability and transferred amount is recorded as asset (capital work in progress), until UPJN approved that capital investment project is completed as planned. After completed the capital development project, liability (H/O remittance) and Liability (Capital WIP) will be offset and written off from their balance sheet.

Once ULB received the fund from GOI, ULB transfers the fund to Head Office of Uttar Pradesh Jal

Nigam (UPJN), who is responsible for plan and manage the development project in each area/district in UP State. Head Office of UPJN allocates the money and distributes to respective district based on the sanctioned plan. And then each UPJN district remits the fund to each UPJN area organization to execute approved development program. Each area of UPJN keeps its own accounting record however; each area level of UPJN is too dependent on H/O remittance. For each area level UPJN organization, there is another source of the fund and its only way of earning income, is the Centage charge collected from Head office of UPJN. Centage can be received by 12.5% of completed capital development project during the year. Thus, revenue of area level UPJN depends on progress of the project and derived Centage income. That is why UPJN's operating income fluctuates year by year.

On the other hand, UP State Government also provides grant for both capital development and operation cost support for ULB. This grant is budgeted by State Government's general fund of Grant No37 for urban development. According to Study team's analysis, ULB spends the grant from UP state government more for making up the operational deficit rather than investing to capital development.

Between ULB and Jal Kal, there is a financial dependency in two ways, salary and wage expense reimbursement and fiscal deficit/surplus transfer. Jal Kal under ULB who operates water and sewerage service is relatively premature in terms of financial independence and institutional organization. Financial statement of ULB and Jal Kal are neither separated completely nor consolidated appropriately in a timely manner. In addition, employees of ULB also serve for Jal Kal and Jal Kal needs to bear their employees payroll expense such as salary, wage and pension. When Jal Kal records the fiscal deficit in a year, that amount should be recovered by general fund of ULB.

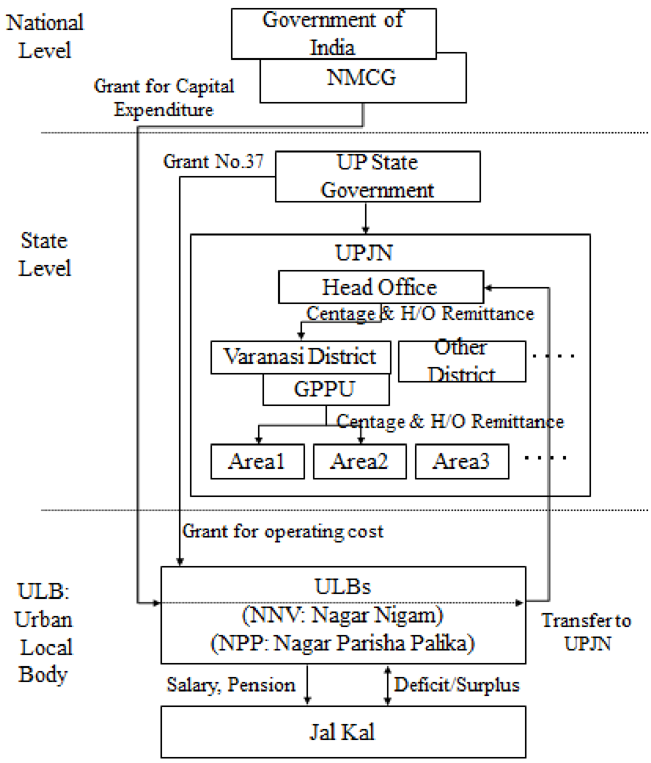


Figure 12.2.6 Fund flow among governmental organizations

12.3 Survey Results for Evaluation

12.3.1 Overview of Survey

Financial and economic survey was conducted in the following five areas: Varanasi, Mirzapur, Ghazipur, Ramnagar and Chunar. Sample size of this survey is in the following number of households: 150 households in Varanasi and individually 17 households in the other areas (representing Low Income Group-LIG, Middle Income Group-MIG, and High Income Group-HIG).

•LIG: Living in their own houses in the areas lacking proper infrastructure, using the CTCs, source of income is unstable (Varanasi: 50 the other areas: 17)

•MIG: Living in non-slums, in their own small houses, having definite source of income. Owner of at least one 2-wheeler (Varanasi: 50 the other areas: 17)

•HIG: Living in their own houses, having at least one 4-wheeler (Varanasi: 50 the other areas: 17)

12.3.2 Findings of Fincancial and Economic viewpoints

Looking at the average monthly total earnings of the family in five regions, it can be said that the earnings in Varanasi is the largest (24,341Rs) number in all five areas, and Varanasi has the biggest gap (34,638Rs) of average monthly earnings between HIG and LIG.

Table 12.3.1 Average Monthly Earnings of the Family (Rs)

	All	LIG	MIG	HIG
1.Varanasi	24,341	8,502	21,380	43,140
2.Mirzapur	22,098	8,471	17,824	40,000
3.Ghazipur	21,080	10,500	21,353	30,765
4.RamNagar	19,765	9,588	18,941	30,765
5.Chunar	16,580	7,500	16,235	25,471

Source: JICA Study Team 2015

Table 12.3.2 Average monthly total expenditure of your household (Rs)

	All	LIG	MIG	HIG
1.Varanasi	24,340	8,500	21,380	43,140
2.Mirzapur	22,098	8,471	17,824	40,000
3.Ghazipur	20,824	10,353	21,353	30,765
4.RamNagar	19,765	9,588	18,941	30,765
5.Chunar	16,490	7,765	16,235	25,471

Source: JICA Study Team 2015

Regarding the average monthly expenditure on individual item in Varanasi, the food expenditures are the largest in all categories. Apart from savings and others, LIG spend on education secondly and health/treatment thirdly. MIG’s second and fourth most spending items are education and cooking fuel. HIG’s secondly and thirdly spending items are education and vehicle fuel.

Table 12.3.3 Average monthly expenditure on individual item (Varanasi) (Rs)

	All	LIG	MIG	HIG
1.(Food)	7,269	3,566	6,620	11,620
2.(Clothing)	1,553	465	814	3,380
3.(House Rent)	-	-	-	-
4.(House Tax)	129	87	97	204
5.(Electricity)	1,185	421	987	2,148
6.(Water/Sewerage service)	102	44	120	142
6.(Water)	-	-	-	-
7.(Sewerage service)	-	-	-	-

8.(Cooking Fuel)	947	561	1,027	1,252
9.(Vehicle Fuel)	1,710	260	930	3,940
10.(Health/treatment)	717	610	596	944
11.(Education)	2,877	621	2,056	5,954
12.(Saving)	3,549	920	3,382	6,344
13(Others)	4,306	945	4,760	7,212
(Total)	24,340	8,500	21,380	43,140

Source: JICA Study Team 2015

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, LIG spend on cooking fuel secondly and electricity thirdly. MIG's second and third spending items are clothing and education. HIG's thirdly and fourthly spending items are clothing and education.

Table 12.3.4 Average monthly expenditure on individual item (Mirzapur) (Rs)

	All	LIG	MIG	HIG
1.(Food)	7,637	3,676	6,412	12,824
2.(Clothing)	2,312	318	2,206	4,412
3.(House Rent)	0	0	0	0
4.(House Tax)	18	13	19	22
5.(Electricity)	863	512	918	1,159
6.(Water/Sewerage service)	19	15	21	21
6.(Water)	0	0	0	0
7.(Sewerage service)	0	0	0	0
8.(Cooking Fuel)	724	535	800	835
9.(Vehicle Fuel)	1,086	29	1,035	2,194
10.(Health/treatment)	125	218	71	88
11.(Education)	1,600	488	1,312	3,000
12.(Saving)	4,755	1,494	3,386	9,386
13(Others)	2,959	1,172	1,645	6,059
(Total)	22,098	8,471	17,824	40,000

Source: JICA Study Team 2015

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, LIG spend on cooking fuel secondly and clothing thirdly. MIG's second and third most spending items are clothing and electricity. HIG's secondly, and thirdly spending items are vehicle fuel and clothing.

Table 12.3.5 Average monthly expenditure on individual item (Ghazipur) (Rs)

	All	LIG	MIG	HIG
1.(Food)	8,127	5,088	8,647	10,647
2.(Clothing)	1,598	647	1,735	2,412
3.(House Rent)	0	0	0	0
4.(House Tax)	15	10	16	19
5.(Electricity)	1,275	529	1,259	2,035
6.(Water)	23	16	27	26
7.(Sewerage service)	875	671	924	1,029
8.(Cooking Fuel)	1,245	147	1,118	2,471
9.(Vehicle Fuel)	59	0	176	0
10.(Health/treatment)	1,218	476	1,088	2,088
11.(Saving)	4,964	2,181	4,999	7,714
12(Others)	1,480	588	1,529	2,324
(Total)	20,863	10,353	21,471	30,765

Source: JICA Study Team 2015

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings, all 3 income groups spend on clothing in the second most money and LIG spend on cooking fuel thirdly. MIGs' third most spending items is vehicle fuel. HIG's thirdly spending item is vehicle fuel.

Table 12.3.6 Average monthly expenditure on individual item (Ramnagar) (Rs)

	All	LIG	MIG	HIG
1.(Food)	7,980	4,882	7,529	11,529
2.(Clothing)	2,069	912	2,118	3,176
3.(House Rent)	0	0	0	0
4.(House Tax)	0	0	0	0
5.(Electricity)	1,206	482	1,124	2,012
6.(Water/Sewerage service)	11	9	11	11
6.(Water)	998	694	824	1,476
7.(Sewerage service)	1,553	88	1,600	2,971
8.(Cooking Fuel)	20	29	0	29
9.(Vehicle Fuel)	1,151	306	1,071	2,076
10.(Health/treatment)	3,446	1,544	3,224	5,571
11.(Education)	1,371	759	1,441	1,912
12.(Saving)	19,804	9,706	18,941	30,765
13(Others)	7,980	4,882	7,529	11,529
(Total)	2,069	912	2,118	3,176

Source: JICA Study Team 2015

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, all 3 income groups spend on health/treatment in the second most money and LIG spend on water thirdly. MIGs' third most spending item is clothing. HIG's thirdly spending item is clothing.

Table 12.3.7 Average monthly expenditure on individual item (Chunar) (Rs)

	All	LIG	MIG	HIG
1.(Food)	6,696	4,324	6,412	9,353
2.(Clothing)	1,471	365	1,400	2,647
3.(House Rent)	0	0	0	0
4.(House Tax)	5	4	6	6
5.(Electricity)	1,082	400	1,082	1,765
6.(Water)	11	10	11	13
7.(Sewerage service)	774	571	709	1,041
8.(Cooking Fuel)	1,086	29	1,141	2,088
9.(Vehicle Fuel)	20	29	29	0
10.(Health/treatment)	1,116	276	1,029	2,041
11.(Saving)	2,899	1,269	3,029	4,399
12(Others)	1,320	488	1,353	2,118
(Total)	16,490	7,765	16,235	25,471

Source: JICA Study Team 2015

With regard to how much the individuals are willing to pay (WTP) for the improved water supply service, Mirzapur citizens can pay for the largest (89Rs) among all regions' and especially, the LIG's WTP is extremely high (126Rs). This trend is different from other areas.

Table 12.3.8 WTP for the improved water supply service per month (Rs)

	All	LIG	MIG	HIG
1.Varanasi	59.41	56.00	44.55	86.50
2.Mirzapur	89.00	126.00	52.00	-
3.Ghazipur	16.67	13.33	18.33	-
4.RamNagar	16.75	13.50	19.25	30.00
5.Chunar	12.40	10.00	-	14.00

Source: JICA Study Team 2015

When asked the WTP for the sewer connection to those who answered the present connection is unsatisfactory, in the condition that all issues are solved, Mirzapur people answered the largest amount (80.0Rs) in all regions. In Ghazipur and Chunar, it seems that the sewer connection hasn't been installed yet.

Table 12.3.9 WTP for the improved sewer user charge per month (Rs)

	All	LIG	MIG	HIG
1.Varanasi	56.83	57.50	40.29	84.29
2.Mirzapur	80.00	50.00	87.50	-
3.Ghazipur	-	-	-	-
4.RamNagar	23.33	-	23.33	-
5.Chunar	-	-	-	-

Source: JICA Study Team 2015

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the largest amount of their answer is 955.1Rs in Mirzapur followed by 893.8Rs in Varanasi and the smallest amount is 150.0 Rs in Ramnagar followed by 327.9Rs in Chunar. It can be said that the more income people receive, the more amount of money they are willing to pay for connection of sewer to their houses.

Table 12.3.10 WTP for connection of sewer to your house (Rs)

	All	LIG	MIG	HIG
1.Varanasi	893.75	430.00	1900.00	500.00
2.Mirzapur	955.13	637.50	858.33	1,522.73
3.Ghazipur	547.06	335.29	588.24	717.65
4.RamNagar	150.00	200.00	125.00	150.00
5.Chunar	327.94	125.00	411.76	447.06

Source: JICA Study Team 2015

Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for sewer user charge per month, people in Varanasi and Mirzapur answered the amount of the fee (59.2Rs and 55.0Rs) about 11 times more than in Ramnagar. It can be said that the more income people receive, the more amount of money they are willing to pay for sewer user charge per month.

Table 12.3.11 WTP for monthly sewer user charge (Rs)

	All	LIG	MIG	HIG
1.Varanasi	59.19	58.13	40.00	200.00
2.Mirzapur	55.00	47.50	47.08	73.18
3.Ghazipur	10.40	6.88	10.59	13.53
4.RamNagar	5.00	5.00	5.00	-
5.Chunar	10.30	8.13	10.00	12.65

Source: JICA Study Team 2015

CTC is the complex of the community toilets. Looking at Table 12.3.10, it can be mentioned that the citizens in Mirzapur and Ramnagar pay for CTC usage per time more than in other areas.

Table 12.3.12 Current payment for CTC usage per usage (Rs)

	All	LIG	MIG	HIG
1.Varanasi	3.88	3.64	4.38	3.62
2.Mirzapur	4.52	4.10	5.00	4.33
3.Ghazipur	3.62	2.50	4.00	5.00
4.RamNagar	4.84	5.00	5.00	4.40
5.Chunar	4.09	4.33	4.00	3.50

Source: JICA Study Team 2015

To those who are not very satisfactory, if asked how much they are willing to pay for CTC when the condition of CTC has been improved, the ones in Varanasi answered the largest amount (6.2Rs) and the gap between HIG and LIG was the biggest (7.7Rs) as well.

Table 12.3.13 WTP for the improved CTC per usage (Rs)

	All	LIG	MIG	HIG
1.Varanasi	6.22	2.22	8.39	9.95
2.Mirzapur	4.71	4.40	5.00	5.00
3.Ghazipur	4.64	4.67	4.00	5.00
4.RamNagar	5.00	5.00	5.00	5.00
5.Chunar	5.00	5.00	5.00	5.00

Source: JICA Study Team 2015

When asked to those who know about the city service whether they pay the following taxes, and how much they pay for the tax, they answered the followings. The average of WTP for house tax and water tax in Varanasi is extremely high compared with other areas. On the contrary, the citizens in Ramnagar seem not to be willing to pay for house tax and can pay the smallest amount for water tax among 4 regions.

Table 12.3.14 WTP for House Tax (Rs)

	All	LIG	MIG	HIG
1.Varanasi	1,416.80	741.80	1,138.60	2,370.00
2.Mirzapur	216.35	154.41	223.76	270.88
3.Ghazipur	178.04	116.47	190.00	227.65
4.RamNagar	0.00	0.00	0.00	0.00
5.Chunar	63.29	41.47	71.53	76.88

Source: JICA Study Team 2015

Table 12.3.15 WTP for Water Tax (Rs)

	All	LIG	MIG	HIG
1.Varanasi	1,213.44	522.56	1,433.76	1,684.00
2.Mirzapur	230.67	180.29	257.88	253.82
3.Ghazipur	278.47	187.76	328.82	318.82
4.RamNagar	131.76	112.94	134.12	148.24
5.Chunar	135.12	118.29	132.35	154.71

Source: JICA Study Team 2015

Table 12.3.16 WTP for Sewage Tax (Rs)

	All	LIG	MIG	HIG
1.Varanasi	0.60	-	1.80	-
2.Mirzapur	-	-	-	-
3.Ghazipur	-	-	-	-
4.RamNagar	-	-	-	-
5.Chunar	-	-	-	-

Source: JICA Study Team 2015

12.3.3 Areas except Varanasi

(1) Mirzapur

These citizen survey outcomes were taken in December 2015 and analyzed in January 2016. The next section looks at the results of the questionnaire:

A. basic profile,
B. diseases,
C. water supply,
D. toilet facilities at HHs,
E. CTC usage, and
F. public outreach

a) Basic Profiles of each respondent

The respondents are 86% of male and 14% of female.

Occupations of the respondents are as follows. 52.9% has their own business, 9.8% government job, 11.8% private sector job, 11.8% daily wage, 0.0% family profession, 9.8% vending and 3.9% others. Business owners and government people are mostly found in higher income groups.

Table 12.3.17 Occupations of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	27	4	12	11	52.9	23.5	70.6	64.7
2.Govt job	5	0	2	3	9.8	0.0	11.8	17.7
3.Private job	6	2	2	2	11.8	11.8	11.8	11.8
4.Daily wage	6	6	0	0	11.8	35.3	0.0	0.0
5.Family profession	0	0	0	0	0.0	0.0	0.0	0.0
6.Vending	5	5	0	0	9.8	29.4	0.0	0.0
7. Others	2	0	1	1	3.9	0.0	5.9	5.9
Total	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The family number is about 8.8 per household, contains 3.2 male members, and 2.9 female members, and 2.7 children. The higher the income is the more family members in the house are. The gap is about 3.65 persons between the poorest and the richest.

Table 12.3.18 Average number of family members

	Total	LIG	MIG	HIG
1.Total No. of Family Member	8.8	7.8	7.2	11.5
2.Male Members (more than 18 years) :	3.2	2.7	3.0	4.1
3.Female Members (more than 18 years) :	2.9	2.5	2.2	4.1
4.Child Less than 18 years:	2.7	2.7	1.9	3.4

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are 10+ (College) (25.5 %), followed by Read & Write (23.5%), 10th grade (13.7%) and Grad school (13.7%). As expected, the higher the income, the higher the level of education.

Table 12.3.19 Education Level of the Respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.(Read & Write)	12	7	4	1	23.5	41.2	23.5	5.9
2.(5th grade)	3	1	2	0	5.9	5.9	11.8	0.0
3.(10th grade)	7	0	4	3	13.7	0.0	23.5	17.7
4.10+ (College)	13	3	3	7	25.5	17.7	17.7	41.2
5.(Grad school)	7	0	3	4	13.7	0.0	17.7	23.5
6.(Post-grad school)	4	1	1	2	7.8	5.9	5.9	11.8
	51	17	17	17	100.0	100.0	100.0	100.0

Looking at the religion of the respondents, 82.4% are Hindu and 17.7% are Muslims. More Muslims are found in higher income families.

Table 12.3.20 Religion of the respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Hindu)	42	15	14	13	82.4	88.2	82.4	76.5
2.(Muslim)	9	2	3	4	17.7	11.8	17.7	23.5
3.(Christian)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Others)	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The question of how long they have lived in the area, average is 42.4 years, and the higher income is, the longer settled years of the respondents are.

Table 12.3.21 Settled years of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	42.4	38.4	41.4	47.4

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is 22,098 Rs. The richest families has as much as third times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 12.3.22 Average monthly income of the respondents (Rs)

Type	All	LIG	MIG	HIG
Amount	22,098	8,471	17,824	40,000

Source: JICA Study Team 2016

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, LIG spend on cooking fuel secondly and electricity thirdly. MIG's second and third spending items are clothing and education. HIG's thirdly and fourthly spending items are clothing and education.

Table 12.3.23 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.(Food)	7,637	3,676	6,412	12,824
2.(Clothing)	2,312	318	2,206	4,412
3.(House Rent)	0	0	0	0
4.(House Tax)	18	13	19	22
5.(Electricity)	863	512	918	1,159
6.(Water/Sewerage service)	19	15	21	21
7.(Cooking Fuel)	724	535	800	835
8.(Vehicle Fuel)	1,086	29	1,035	2,194
9.(Health/treatment)	125	218	71	88
10.(Education)	1,600	488	1,312	3,000
11.(Saving)	4,755	1,494	3,386	9,386
12.(Others)	2,959	1,172	1,645	6,059
(Total)	22,098	8,471	17,824	40,000

Source: JICA Study Team 2016

b) Disease

The question to see whether any of the family members had disease in the last one year, 15.7 percent answered yes, and 84.3 % no. The higher income they earn, the less disease incident rate is.

Table 12.3.24 Disease incident rate for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Yes)	8	15.7	35.3	5.9	5.9
2.(No)	43	84.3	64.7	94.1	94.1

Source: JICA Study Team 2016

Those who answered yes in the disease question, they showed the specific diseases they had and the most frequent one is paratyphoid (25.0%).

Table 12.3.25 Type of disease for the past one year

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1. (Paratyphoid).	2	2	0	0	25.0	33.3	0.0	0.0
2.(Cholera)	0	0	0	0	0.0	0.0	0.0	0.0
3.(Typhoid/Typhus)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Dysentery)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Dengue)	0	0	0	0	0.0	0.0	0.0	0.0
6.(Malaria)	0	0	0	0	0.0	0.0	0.0	0.0
7.(Flue)	0	0	0	0	0.0	0.0	0.0	0.0
8.Others	6	4	1	1	75.0	66.7	100.0	100.0
	8	6	1	1	100.0	100.0	100.0	100.0

c) Water supply service

Regarding the possession of the water supply service, 64.7% answered they have some type of water supply service. Looking at the income group, 70.6% LIG have water supply services, 52.9% for MIG and 70.6% for LIG.

Table 12.3.26 Possession of the water supply service

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes (go to 16)	33	64.7	70.6	52.9	70.6
2.No (go to 20)	18	35.3	29.4	47.1	29.4
3.Other sources					
1) Private source	10	55.6	55.6	25.0	25.0
2) Ground water	8	44.4	44.4	75.0	75.0

Source: JICA Study Team 2016

In regard to the amount of the water supply charge, the following results are acquired. 68.6% of them pay around 800* and 29.4% pay for nothing.

Table 12.3.27 Amount of the water supply charge

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Around 800*)	35	10	10	15	68.6	58.8	58.8	88.2
2.(Around 1000)	1	1	0	0	2.0	5.9	0.0	0.0

3.(Around 1500)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Around 2000)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Around 2500)	0	0	0	0	0.0	0.0	0.0	0.0
6.(More than 2500)	0	0	0	0	0.0	0.0	0.0	0.0
7. Not paying	15	6	7	2	29.4	35.3	41.2	11.8
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

*Note: *Units are in Indian Rupees.*

As for the question to see how you rate the water services you are mainly using, 76.5% answered very satisfactory, followed by relatively satisfactory (13.7%), average (3.9%).

Table 12.3.28 Rate of the water supply services

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Very satisfactory)	39	76.5	70.6	64.7	94.1
2.(Relatively satisfactory)	7	13.7	29.4	5.9	5.9
3.(Average)	2	3.9	0.0	11.8	0.0
4.(Relatively unsatisfactory)	1	2.0	0.0	5.9	0.0
5.(Very unsatisfactory)	2	3.9	0.0	11.8	0.0
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Regarding the questions which types of problems on the present main water supply, 15.7% claims that there is no transparency of water and 7.8% bad taste, 5.9% lack of water and 3.9% frequent interruption.

Table 12.3.29 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Bad taste (smell))	4	7.8	5.9	11.8	5.9
2.(Water is dirty (not transparent))	8	15.7	23.5	17.7	5.9
3.(Frequent stop of water service)	2	3.9	0.0	11.8	0.0
4.(Water amount is not enough)	3	5.9	5.9	11.8	0.0
5.(Insufficient water pressure)	0	0.0	0.0	0.0	0.0
6.(High Tariff)	0	0.0	0.0	0.0	0.0
7.(Others (please specify))	0	0.0	0.0	0.0	0.0
	17	33.3	11.8	17.7	3.9

Source: JICA Study Team 2016

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered 89.0 Rs per month. LIG and MIG are about the same, 126.00

Rs and 52.00 Rs respectively.

Table 12.3.30 WTP for the water supply services

	All	LIG	MIG	HIG
Rs/month	89.00	126.00	52.00	-

Source: JICA Study Team 2016

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 84.3% answered yes. While HIG answered 100.0% of them have a toilet in their houses, 58.9 % of LIG answered yes.

Table 12.3.31 Toilet possessions

	All	LIG	MIG	HIG
Yes	43	10	16	17
No	8	7	1	0
Yes (%)	84.3	58.8	94.1	100.0
No (%)	15.7	41.2	5.9	0.0
	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The questions asked which disposal system was connected to their home toilets, 51.2 % of them answered that they are connected to a soak pit or trench, followed by direct discharge into ditch (25.6%), and sewer connection (23.3%).

Note: “Rate of Connection to the Existing Sewage System (Existing Connection Rate)” comes from this questioner survey. As it note before, in EIRR calculation, this the percentage in which the number of Sewer system owners is divided by total surveyors, not divided by who answered they have toilets, so this number is conservative. But here the percentage shows that the number of Sewer system owners is divided by who answered they have toilets. The same procedure is also adopted in other areas.

Table 12.3.32 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Sewer connection)	10	23.3	10.0	31.3	23.5
2.Septic tank (connecting with a soak pit or trench)	22	51.2	30.0	56.3	58.8
3.Pit latrine (not using water)	0	0.0	0.0	0.0	0.0
4.(Direct discharge into ditch, drain or river)	11	25.6	60.0	12.5	17.7

5.Others	0	0.0	0.0	0.0	0.0
	43	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked how they evaluate the pit latrine to those who answered sewer connection, 69.2% answered very satisfactory and 30.8% relatively unsatisfactory.

Table 12.3.33 Evaluation of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Very satisfactory	9	69.2	100.0	42.9	100.0
2.Relatively satisfactory	4	30.8	0.0	57.1	0.0
3.Average	0	0.0	0.0	0.0	0.0
4.Relatively unsatisfactory	0	0.0	0.0	0.0	0.0
5.Very unsatisfactory	0	0.0	0.0	0.0	0.0
	13	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered 80.0 Rs.

Table 12.3.34 WTP for the sewer connection

	All	LIG	MIG	HIG
Rs/month	80.0	50.0	87.5	-

Source: JICA Study Team 2016

When asked to all persons who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, the answers are as follows. Most of them want to have sewer connection.

Table 12.3.35 Sewage demand in non-sewer HHs

	All	All (%)	LIG	MIG	HIG
1.Yes	39	97.5	100.0	100.0	91.7
2.No	1	2.5	0.0	0.0	8.3
	40	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the average of their answer is 955.1 Rs.

Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much are you willing to pay for sewer user charge per month, they answer that they pay average 55.0 Rs/month.

Table 12.3.36 WTP for connection and monthly fee (Rs)

	All	LIG	MIG	HIG
WTP for connection(Rs)	955.1	637.5	858.3	1522.7
WTP for monthly fee (Rs).	55.0	47.5	47.1	73.2

Source: JICA Study Team 2016

e) CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the respondents answered that they are willing to pay for 4.5Rs.

Table 12.3.37 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.5	4.1	5.0	4.3

Source: JICA Study Team 2016

Q estion asked that how they evaluate the present public/community toilet service in the community, 17.7% answered relatively satisfactory, 11.8% relatively satisfactory and average.

Table 12.3.38 CTC's satisfaction rate of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Very satisfactory)	6	11.8	0.0	17.7	17.7
2.(Relatively satisfactory)	9	17.7	11.8	23.5	17.7
3.(Average)	6	11.8	23.5	11.8	0.0
4.(Relatively unsatisfactory)	2	3.9	5.9	5.9	0.0
5.(Very unsatisfactory)	4	7.8	17.7	5.9	0.0
6.(I don't know)	24	47.1	41.2	35.3	64.7
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the reason that CTCs are not "very satisfactory", 45.7% answered that it is dirty, 23.9% overflow of wastewater is not good and 10.9% claims congestion.

Table 12.3.39 Reasons for dissatisfaction of the CTCs

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Dirty)	21	10	8	3	45.7	38.5	50.0	75.0
2.(Overflow of wastewater)	11	6	4	1	23.9	23.1	25.0	25.0
3.(Congestion)	5	4	1	0	10.9	15.4	6.3	0.0
4.(Long distance to the toilet)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Charge is too high)	4	1	3	0	8.7	3.9	18.8	0.0
6.(I do not want to pay)	4	4	0	0	8.7	15.4	0.0	0.0
7. (Facility that we want to use is not installed (please specify :)	1	1	0	0	2.2	3.9	0.0	0.0
8.Others (please specify:)	0	0	0	0	0.0	0.0	0.0	0.0
	46	26	16	4	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the WTP for CTC per usage, the average is 4.7 Rs for all income groups.

Table 12.3.40 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.7	4.4	5.0	5.0

Source: JICA Study Team 2016

f) Public outreach

Question asked if there are any community-based activities on sanitary programs in your community, 92.2 % of them answered that they know the activities, and 7.8 % of them says that they do not know whether the activities are existing or not. It can be said that the higher the income is, the more they know about these activities.

Table 12.3.41 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	47	92.2	88.2	94.1	94.1
2.No	4	7.8	11.8	5.9	5.9

Source: JICA Study Team 2016

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 12.3.42 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax	216.4	154.4	223.8	270.9
2. Water tax	230.7	180.3	257.9	253.8
3. Sewage tax	0.0	0.0	0.0	0.0
4. E. P. E. tax	0.0	0.0	0.0	0.0
5. Education, Petroleum, and Environment	0.0	0.0	0.0	0.0

(2) Ghazipur

These citizen survey outcomes were taken in December 2015 and analyzed in January 2016. The next section looks at the results of the questionnaire:

A. basic profile,
B. diseases,
C. water supply,
D. toilet facilities at HHs,
E. CTC usage, and
F. public outreach

a) Basic Profiles of each respondent

The respondents are 92% of male and 8% of female.

Occupations of the respondents are as follows. 37.3% has their own business, 23.5% government job, 13.7% private sector job, 11.8% daily wage 9.8% vending and 3.9% others. Government and private job people are mostly found in higher income groups.

Table 12.3.43 Occupation of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	19	4	10	5	37.3	23.5	58.8	29.4
2.Govt job	12	1	4	7	23.5	5.9	23.5	41.2
3.Private job	7	0	3	4	13.7	0.0	17.7	23.5
4.Daily wage	6	6	0	0	11.8	35.3	0.0	0.0
5.Family profes-sion	0	0	0	0	0.0	0.0	0.0	0.0
6.Vending	5	5	0	0	9.8	29.4	0.0	0.0
7. Others	2	1	0	1	3.9	5.9	0.0	5.9
Total	51	17	17	17	0.0	0.0	0.0	0.0

Source: JICA Study Team 2015

The family number is about 8.8 per household, contains 3.5 male members, and 2.7 female members, and 2.6 children. The higher the income is the more family members in the house are. The gap is about 3.8 persons between the poorest and the richest.

Table 12.3.44 Average number of family members

	Total	LIG	MIG	HIG
1.Total No. of Family Member	8.8	6.5	9.5	10.3
2.Male Members (more than 18 years) :	3.5	2.5	3.9	4.2
3.Female Members (more than 18 years) :	2.7	1.7	3.2	3.2
4.Child Less than 18 years:	2.6	2.4	2.4	2.9

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are 5th grade (29.4 %), followed by 10th grade (21.5%), grad school (15.7%) and post-grad school (15.7%) and college (10+) (11.8%). As expected, the higher the income, the higher the level of education.

Table 12.3.45 Education level of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.(Read & Write)	3	3	0	0	5.9	17.7	0.0	0.0
2.(5th grade)	15	7	7	1	29.4	41.2	41.2	5.9
3.(10th grade)	11	2	6	3	21.6	11.8	35.3	17.7
4.10+ (College)	6	3	0	3	11.8	17.7	0.0	17.7
5.(Grad school)	8	1	2	5	15.7	5.9	11.8	29.4
6.(Post-grad school)	8	1	2	5	15.7	5.9	11.8	29.4
	51	17	17	17	100.0	100.0	100.0	100.0

Looking at the religion of the respondents, 92.2% are Hindu and 7.8% are Muslims. More Muslims are found in higher income families.

Table 12.3.46 Religion of the respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Hindu)	47	15	16	16	92.2	88.2	94.1	94.1
2.(Muslim)	4	2	1	1	7.8	11.8	5.9	5.9
3.(Christian)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Others)	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The question of how long they have lived in the area, average is 43.6 years. The higher income is the longer settled years are.

Table 12.3.47 Settled years of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	43.6	39.6	44.2	46.7

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is 20,824 Rs. The richest families has as much as third times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 12.3.48 Average monthly income of the respondents (Rs)

Type	All	LIG	MIG	HIG
Amount	20,824	10,353	21,353	30,765

Source: JICA Study Team 2016

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, LIG spend on cooking fuel secondly and clothing thirdly. MIG's second and third most spending items are clothing and electricity. HIG's secondly, and thirdly spending items are vehicle fuel and clothing.

Table 12.3.49 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.(Food)	8,127	5,088	8,647	10,647
2.(Clothing)	1,598	647	1,735	2,412
3.(House Rent)	0	0	0	0
4.(House Tax)	15	10	16	19
5.(Electricity)	1,275	529	1,259	2,035
6.(Water/Sewerage service)	23	16	27	26
7.(Cooking Fuel)	875	671	924	1,029
8.(Vehicle Fuel)	1,245	147	1,118	2,471
9.(Health/treatment)	59	0	176	0
10.(Education)	1,218	476	1,088	2,088
11.(Saving)	4,964	2,181	4,999	7,714
12.(Others)	1,480	588	1,529	2,324
(Total)	20,863	10,353	21,471	30,765

Source: JICA Study Team 2016

b) Disease

The question to see whether any of the family members had disease in the last one year, 3.9 percent answered yes, and 96.1 % no.

Table 12.3.50 Disease incident rate for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Yes)	2	3.9	0.0	11.8	0.0
2.(No)	49	96.1	100.0	88.2	100.0

Source: JICA Study Team 2016

Those who answered yes in the disease question, they showed the specific diseases they had and the most frequent one is malaria (2.0%).

Table 12.3.51 Type of disease for the past one year

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1. (Paratyphoid).	0	0	0	0	0.0	0.0	0.0	0.0
2.(Cholera)	0	0	0	0	0.0	0.0	0.0	0.0
3.(Typhoid/Typhus)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Dysentery)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Dengue)	0	0	0	0	0.0	0.0	0.0	0.0
6.(Malaria)	1	0	1	0	2.0	0.0	5.9	0.0
7.(Flue)	0	0	0	0	0.0	0.0	0.0	0.0
8.Others	0	0	0	0	0.0	0.0	0.0	0.0
	1	0	1	0	2.0	0.0	5.9	0.0

c) Water supply service

Regarding the possession of the water supply service, 100.0% answered they have some type of water supply service.

Table 12.3.52 Possession of the water supply service

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes (go to 16)	51	100.0	100.0	100.0	100.0
2.No (go to 20)	0	0.0	0.0	0.0	0.0
3.Other sources					
1) Private source	9.80	17.7	0.0	11.8	9.8
2) Ground water	0.00	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

In regard to the amount of the water supply charge, the following results are acquired. Overall, there are 100% for around 800.

Table 12.3.53 Amount of the water supply charge

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Around 800*)	51	17	17	17	100.0	100.0	100.0	100.0
2.(Around 1000)	0	0	0	0	0.0	0.0	0.0	0.0
3.(Around 1500)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Around 2000)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Around 2500)	0	0	0	0	0.0	0.0	0.0	0.0
6.(More than 2500)	0	0	0	0	0.0	0.0	0.0	0.0
7. Not paying	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

*Note: *Units are in Indian Rupees.*

As for the question to see how you rate the water service you are mainly using, 82.4% answered very satisfactory, followed by average (13.7%).

Table 12.3.54 Rate of the water supply services

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.(Very satisfactory)	42	82.4	82.4	64.7	100.0
2.(Relatively satisfactory)	1	2.0	5.9	0.0	0.0
3.(Average)	7	13.7	11.8	29.4	0.0
4.(Relatively unsatisfactory)	1	2.0	0.0	5.9	0.0
5.(Very unsatisfactory)	0	0.0	0.0	0.0	0.0
	51	100.0	33.3	33.3	33.3

Source: JICA Study Team 2016

Regarding the questions which types of problems on the present main water supply, 11.8% claims that there is bad smell or taste.

Table 12.3.55 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.(Bad taste (smell))	6	11.8	11.8	23.5	0.0
2.(Water is dirty (not transparent))	1	2.0	0.0	5.9	0.0
3.(Frequent stop of water service)	1	2.0	0.0	5.9	0.0
4.(Water amount is not enough)	1	2.0	5.9	0.0	0.0
5.(Insufficient water pressure)	0	0.0	0.0	0.0	0.0
6.(High Tariff)	0	0.0	0.0	0.0	0.0
7.(Others (please specify))	0	0.0	0.0	0.0	0.0
	9	17.7	17.7	35.3	0.0

Source: JICA Study Team 2016

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered 16.67 Rs per month.

Table 12.3.56 WTP for the water supply services

	All	LIG	MIG	HIG
Rs/month	16.7	13.3	18.3	-!

Source: JICA Study Team 2016

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 88.2% answered yes. While both HIG answered 100.0% of them have a toilet in their houses, 82.4 % of MIG and LIG answered no.

Table 12.3.57 Toilet possessions

	All	LIG	MIG	HIG
Yes	45	14	14	17
No	6	3	3	0
Yes (%)	88.2	82.4	82.4	100.0
No (%)	11.8	17.7	17.7	0.0
	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The questions asked which disposal system is connected to their home toilets; nobody is connected to sewer, followed by septic tanks (82.2%), and direct discharges to ditch, drain or river (17.8%).

Table 12.3.58 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Sewer connection)	0	0.0	0.0	0.0	0.0
2.Septic tank (connecting with a soak pit or trench)	37	82.2	71.4	85.7	88.2
3.Pit latrine (not using water)	0	0.0	0.0	0.0	0.0
4.(Direct discharge into ditch, drain or river)	8	17.8	28.6	14.3	11.8
5.Others	0	0.0	0.0	0.0	0.0
	45	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked how they evaluate the pit latrine to those who answered sewer connection, 100.0% answered very satisfactory.

Table 12.3.59 Evaluation of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Very satisfactory	45	100.0	100.0	100.0	100.0
2.Relatively satisfactory	0	0.0	0.0	0.0	0.0
3.Average	0	0.0	0.0	0.0	0.0
4.Relatively unsatisfactory	0	0.0	0.0	0.0	0.0
5.Very unsatisfactory	0	0.0	0.0	0.0	0.0
	45	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked to all people who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, the answers are as follows. They all want to have sewer connection.

Table 12.3.60 Sewage demand in non-sewer HHs

	All	All (%)	LIG	MIG	HIG
1.Yes	51	100.0	100.0	100.0	0.0
2.No	0	0.0	0.0	0.0	0.0
	51	100.0	100.0	100.0	0.0

Source: JICA Study Team 2016

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the average of their answer is540.1 Rs.

Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much are you willing to pay for sewer user charge per month, they answer that they pay average 10.4 Rs/month.

Table 12.3.61 WTP for connection and monthly fee (Rs)

	All	LIG	MIG	HIG
WTP for connection (Rs)	547.1	335.3	588.2	717.7
WTP for monthly fee (Rs).	10.4	6.9	10.6	13.5

Source: JICA Study Team 2016

e) CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the average of their answer is 3.6Rs.It can be said that the less income is, the less WTP for CTC is.

Table 12.3.62 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	3.6	2.5	4.0	5.0

Source: JICA Study Team 2016

Question asked that how they evaluate the present public/community toilet service in the community, When asked the reason that CTCs are not "very satisfactory", 19.6% answered that it is dirty, 9.8% overflow of wastewater is not good.

Table 12.3.63 Reasons for dissatisfaction of the CTCs

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Dirty)	10	4	3	3	19.6	23.5	17.7	17.7
2.(Overflow of wastewater)	5	3	1	1	9.8	17.7	5.9	5.9
3.(Congestion)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Long distance to the toilet)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Charge is too high)	0	0	0	0	0.0	0.0	0.0	0.0
6.(I do not want to pay)	0	0	0	0	0.0	0.0	0.0	0.0
7. (Facility that we want to use is not installed (please specify :)	0	0	0	0	0.0	0.0	0.0	0.0
8.Others (please specify:)	0	0	0	0	0.0	0.0	0.0	0.0
	15	7	4	4	29.4	13.7	7.8	7.8

Source: JICA Study Team 2016

When asked the WTP for CTC per usage, the average is 4.6 Rs for all income groups.

Table 12.3.64 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.6	4.7	4.0	5.0

Source: JICA Study Team 2016

f) Public outreach

Question asked if there are any community-based activities on sanitary programs in your community, 100.0 % of them answered that they know the activities.

Table 12.3.65 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	51	100.0	100.0	100.0	100.0
2.No	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 12.3.66 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax	178.0	116.5	190.0	227.7
2. Water tax	278.5	187.8	328.8	318.8
3. Sewage tax	0.0	0.0	0.0	0.0
4. E. P. E. tax	0.0	0.0	0.0	0.0
5. Education, Petroleum, and Environment	0.0	0.0	0.0	0.0

(3) Ramnagar

These citizen survey outcomes were taken in December 2015 and analyzed in January 2016. The next section looks at the results of the questionnaire:

A. basic profile,
B. diseases,
C. water supply,
D. toilet facilities at HHs,

E. CTC usage, and
F. public outreach

a) Basic Profiles of each respondent

The respondents are 88% of male and 12% of female.

Occupations of the respondents are as follows. 51.0% has their own business, 21.6% government job, 2.0% private sector job, 9.8% daily wage, 2.0% family profession, 7.8% vending, 5.9% others. Business owners and government people are mostly found in higher income groups.

Table 12.3.67 Occupations of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	26	6	13	7	51.0	35.3	76.5	41.2
2.Govt job	11	0	2	9	21.6	0.0	11.8	52.9
3.Private job	1	1	0	0	2.0	5.9	0.0	0.0
4.Daily wage	5	4	1	0	9.8	23.5	5.9	0.0
5.Family profession	1	1	0	0	2.0	5.9	0.0	0.0
6.Vending	4	4	0	0	7.8	23.5	0.0	0.0
7. Others	3	1	1	1	5.9	5.9	5.9	5.9
Total	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The family number is about 8.2 per household, contains 3.27 male members, and 2.45 female members, and 2.47 children. The higher the income is the more family members in the house are. The gap is about 3.85 persons between the poorest and the richest.

Table 12.3.68 Average number of family members

	Total	LIG	MIG	HIG
1.Total No. of Family Member	8.2	6.5	8.0	10.1
2.Male Members (more than 18 years) :	3.3	2.7	3.4	3.8
3.Female Members (more than 18 years) :	2.5	1.9	2.5	2.9
4.Child Less than 18 years:	2.5	1.9	2.2	3.4

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are the read & write (39.2 %), followed by

10th grade (23.5%), 5th grade (11.76%) and 10+ (College) (11.76%). As expected, the higher the income, the higher the level of education.

Table 12.3.69 Education Level of the Respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.(Read & Write)	20	13	6	1	39.2	76.5	35.3	5.9
2.(5th grade)	6	1	3	2	11.8	5.9	17.7	11.8
3.(10th grade)	12	1	5	6	23.5	5.9	29.4	35.3
4.10+ (College)	6	1	2	3	11.8	5.9	11.8	17.7
5.(Grad school)	3	0	1	2	5.9	0.0	5.9	11.8
6.(Post-grad school)	4	1	0	3	7.8	5.9	0.0	17.7
	51	17	17	17	100.0	100.0	100.0	100.0

Looking at the religion of the respondents, 76.5% are Hindu and 23.5% are Muslims. More Muslims are found in higher income families.

Table 12.3.70 Religion of the respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Hindu)	39	14	14	11	76.5	82.4	82.4	64.7
2.(Muslim)	12	3	3	6	23.5	17.7	17.7	35.3
3.(Christian)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Others)	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The question of how long they have lived in the area, average is 42.5 years, and the income doesn't relate to the settled years.

Table 12.3.71 Settled years of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	42.5	41.6	45.2	40.6

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is 19,765 Rs. The richest families has as much as three times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 12.3.72 Average monthly income of the respondents (Rs)

Type	All	LIG	MIG	HIG
Amount（Rs）	19,765	9,588	18,941	30,765

Source: JICA Study Team 2016

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings, all 3 income groups spend on clothing in the second most money and LIG spend on cooking fuel thirdly. MIGs' third most spending items is vehicle fuel. HIG's thirdly spending item is vehicle fuel.

Table 12.3.73 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.(Food)	7,980.4	4,882.4	7,529.4	11,529.4
2.(Clothing)	2,068.6	911.8	2,117.7	3,176.5
3.(House Rent)	0.0	0.0	0.0	0.0
4.(House Tax)	0.0	0.0	0.0	0.0
5.(Electricity)	1,205.9	482.4	1,123.5	2,011.8
6.(Water/Sewerage service)	10.6	9.4	11.2	11.2
7.(Water)	-	-	-	-
8.(Sewerage service)	-	-	-	-
9.(Cooking Fuel)	998.0	694.1	823.5	1,476.5
10.(Vehicle Fuel)	1,552.9	88.2	1,600.0	2,970.6
11.(Health/treatment)	19.6	29.4	0.0	29.4
12.(Education)	1,151.0	305.9	1,070.6	2,076.5
13.(Saving)	3,446.3	1,543.5	3,224.1	5,571.2
14.(Others)	1,370.6	758.8	1,441.2	1,911.8
(Total)	19,803.9	9,705.9	18,941.2	30,764.7

Source: JICA Study Team 2016

b) Disease

The question to see whether any of the family members had disease in the last one year, 3.9 percent answered yes, and 96.1 % no. The income doesn't relate to the disease incident rate.

Table 12.3.74 Disease incident rate for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Yes)	2	3.9	5.9	0.0	3.9
2.(No)	49	96.1	94.1	100.0	96.1

Source: JICA Study Team 2016

Those who answered yes in the disease question, they showed the specific diseases they had and the most frequent one is malaria (50.0%) and others (50.0%).

Table 12.3.75 Type of disease for the past one year

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1. (Paratyphoid).	0	0	0	0	0.0	0.0	-	0.0
2.(Cholera)	0	0	0	0	0.0	0.0	-	0.0
3.(Typhoid/Typhus)	0	0	0	0	0.0	0.0	-	0.0
4.(Dysentery)	0	0	0	0	0.0	0.0	-	0.0
5.(Dengue)	0	0	0	0	0.0	0.0	-	0.0
6.(Malaria)	1	0	0	1	50.0	0.0	-	100.0
7.(Flue)	0	0	0	0	0.0	0.0	-	0.0
8.Others	1	1	0	0	50.0	100.0	-	0.0
	2	1	0	1	100.0	100.0	-	100.0

c) Water supply service

Regarding the possession of the water supply service, 98.0% answered they have some type of water supply service. Looking at the income group, 94.1% LIG have water supply services, 100.0% for MIG and HIG.

Table 12.3.76 Possession of the water supply service

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes (go to 16)	50	98.0	94.1	100.0	100.0
2.No (go to 20)	1	2.0	5.9	0.0	0.0
3.Other sources					
1. Private source	1	100.0	100.0	0.0	0.0
2. Ground water	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

In regard to the amount of the water supply charge, the following results are acquired. Overall, there are 100% for around 800.

Table 12.3.77 Amount of the water supply charge

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Around 800*)	50	16	17	17	100.0	100.0	100.0	100.0
2.(Around 1000)	0	0	0	0	0.0	0.0	0.0	0.0
3.(Around 1500)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Around 2000)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Around 2500)	0	0	0	0	0.0	0.0	0.0	0.0
6.(More than 2500)	0	0	0	0	0.0	0.0	0.0	0.0
7. Not paying	50	16	17	17	100.0	100.0	100.0	100.0
	50	16	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

*Note: *Units are in Indian Rupees.*

As for the question to see how you rate the water services you are mainly using, 80.0% answered very satisfactory, followed by relatively satisfactory (16.0%), average (4.0%).

Table 12.3.78 Rate of the water supply services

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.(Very satisfactory)	40	80.0	81.3	76.5	82.4
2.(Relatively satisfactory)	8	16.0	18.8	11.8	17.7
3.(Average)	2	4.0	0.0	11.8	0.0
4.(Relatively unsatisfactory)	0	0.0	0.0	0.0	0.0
5.(Very unsatisfactory)	0	0.0	0.0	0.0	0.0
6. Don't know	0	0.0	0.0	0.0	0.0
	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Regarding the questions which types of problems on the present main water supply, 15.7% claims that there is bad smell or taste and 9.8% no transparency of water.

Table 12.3.79 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.(Bad taste (smell))	8	15.7	11.8	23.5	11.8
2.(Water is dirty (not transparent))	5	9.8	5.9	11.8	11.8
3.(Frequent stop of water service)	0	0.0	0.0	0.0	0.0
4.(Water amount is not enough)	0	0.0	0.0	0.0	0.0
5.(Insufficient water pressure)	0	0.0	0.0	0.0	0.0

6.(High Tariff)	0	0.0	0.0	0.0	0.0
7.(Others (please specify))	0	0.0	0.0	25.5	17.7
	13	25.5	17.7	25.5	17.7

Source: JICA Study Team 2016

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered 16.75 Rs per month. The average of individual income group is 13.50 Rs for LIG, 19.25 Rs for MIG and 30.00 Rs for HIG.

Table 12.3.80 WTP for the water supply services

	All	LIG	MIG	HIG
Rs/month	16.8	13.5	19.3	30.0

Source: JICA Study Team 2016

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 98.0% answered yes. While both MIG and HIG answered 100.0% of them have a toilet in their houses, 5.9% of LIG answered no.

Table 12.3.81 Toilet possessions

	All	LIG	MIG	HIG
Yes	50	16	17	17
No	1	1	0	0
Yes (%)	98.0	94.1	100.0	100.0
No (%)	2.0	5.9	0.0	0.0
	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The questions asked which disposal system is connected to their home toilets, 96.0 % of them answered that they are connected to sewer, followed by septic tanks (2.0%), and direct discharges to ditch, drain or river (2.0%).

Table 12.3.82 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Sewer connection)	48	96.0	100.0	88.2	100.0
2.Septic tank (connecting with a soak pit or trench)	1	2.0	0.0	5.9	0.0
3.Pit latrine (not using water)	0	0.0	0.0	0.0	0.0

4.(Direct discharge into ditch, drain or river)	1	2.0	0.0	5.9	0.0
5.Others	0	0.0	0.0	0.0	0.0
	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked how they evaluate the pit latrine to those who answered sewer connection, 95.8% answered very satisfactory, 2.0% relatively unsatisfactory and 2.0% average. The lower the income is, the more the satisfaction exists.

Table 12.3.83 Evaluation of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Very satisfactory	46	95.8	100.0	93.3	94.1
2.Relatively satisfactory	1	2.1	0.0	6.7	0.0
3.Average	1	2.1	0.0	0.0	5.9
4.Relatively unsatisfactory	0	0.0	0.0	0.0	0.0
5.Very unsatisfactory	0	0.0	0.0	0.0	0.0
	48	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered 17.5 Rs.

Table 12.3.84 WTP for the sewer connection

	All	LIG	MIG	HIG
Rs/month	17.5	-	23.3	0.0

Source: JICA Study Team 2016

When asked to all people who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, the answers are as follows. They all want to have sewer connection.

Table 12.3.85 Sewage demand in non-sewer HHs

	All	All (%)	LIG	MIG	HIG
1.Yes	3	100.0	100.0	100.0	0.0
2.No	0	0.0	0.0	0.0	0.0
	3	100.0	100.0	100.0	0.0

Source: JICA Study Team 2016

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the average of their answer is 150.0 Rs. Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much are you willing to pay for sewer user charge per month, they answer that they pay average 5.0 Rs/month.

Table 12.3.86 WTP for connection and monthly fee (Rs)

	All	LIG	MIG	HIG
WTP for connection (Rs)	150.0	200.0	125.0	-
WTP for monthly fee (Rs).	5.0	5.0	5.0	-

Source: JICA Study Team 2016

e) CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the respondents answered that 4.8Rs, and LIG and MIG is willing to pay higher than HIG.

Table 12.3.87 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.8	5.0	5.0	4.4

Source: JICA Study Team 2016

Question asked that how they evaluate the present public/community toilet service in the community, 19.6% answered very satisfactory, 15.7% relatively satisfactory and 2.0% average.

Table 12.3.88 CTC's satisfaction rate of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Very satisfactory)	10	19.6	23.5	23.5	11.8
2.(Relatively satisfactory)	8	15.7	23.5	5.9	17.7
3.(Average)	1	2.0	0.0	5.9	0.0
4.(Relatively unsatisfactory)	0	0.0	0.0	0.0	0.0
5.(Very unsatisfactory)	0	0.0	0.0	0.0	0.0
6.(I don't know)	32	62.8	52.9	64.7	70.6
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the reason that CTCs are not "very satisfactory", 15.7% answered that it is dirty, 3.9% overflow of wastewater is not good and 2.0% claims congestion.

Table 12.3.89 Reasons for dissatisfaction of the CTCs

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Dirty)	8	3	2	3	15.7	17.7	11.8	17.7
2.(Overflow of wastewater)	2	2	0	0	3.9	11.8	0.0	0.0
3.(Congestion)	1	0	0	1	2.0	0.0	0.0	5.9
4.(Long distance to the toilet)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Charge is too high)	0	0	0	0	0.0	0.0	0.0	0.0
6.(I do not want to pay)	0	0	0	0	0.0	0.0	0.0	0.0
7. (Facility that we want to use is not installed (please specify :)	0	0	0	0	0.0	0.0	0.0	0.0
8.Others (please specify:)	0	0	0	0	0.0	0.0	0.0	0.0
	11	5	2	4	21.6	29.4	11.8	23.5

Source: JICA Study Team 2016

When asked the WTP for CTC per usage, the average is 5.0 Rs for all income groups.

Table 12.3.90 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	5.0	5.0	5.0	5.0

Source: JICA Study Team 2016

a) Public outreach

Question asked if there are any community-based activities on sanitary programs in your community, 98.0 % of them answered that they know the activities, and 2.0 % of them says that they do not know whether the activities are existing or not. It can be said that the higher the income is, the more they know about these activities.

Table 12.3.91 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	50	98.0	94.1	100.0	100.0
2.No	1	2.0	5.9	0.0	0.0

Source: JICA Study Team 2016

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 12.3.92 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax	0.0	0.0	0.0	0.0
2. Water tax	131.8	112.9	134.1	148.2
3. Sewage tax	0.0	0.0	0.0	0.0
4. E. P. E. tax	0.0	0.0	0.0	0.0
5. Education, Petroleum, and Environment	0.0	0.0	0.0	0.0

(4) Chunar

These citizen survey outcomes were taken in December 2015 and analyzed in January 2016. The next section looks at the results of the questionnaire:

A. basic profile,
B. diseases,
C. water supply,
D. toilet facilities at HHs,
E. CTC usage, and
F. public outreach

a) Basic Profiles of each respondent

The respondents are 98% of male and 2% of female.

Occupations of the respondents are as follows. 43.1% has their own business, 17.7% government job, 5.9% private sector job, 13.7% daily wage, 3.9% family profession, 13.7% vending and 2.0% others. Business owners and government people are mostly found in higher income groups.

Table 12.3.93 Occupations of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	22	2	11	9	43.1	11.8	64.7	52.9
2.Govt job	9	0	2	7	17.7	0.0	11.8	41.2
3.Private job	3	1	2	0	5.9	5.9	11.8	0.0
4.Daily wage	7	7	0	0	13.7	41.2	0.0	0.0
5.Family profession	2	1	1	0	3.9	5.9	5.9	0.0
6.Vending	7	6	1	0	13.7	35.3	5.9	0.0
7. Others	1	0	0	1	2.0	0.0	0.0	5.9

Total	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The family number is about 7.47 per household, contains 3.10 male members, and 2.37 female members, and 2.00 children. The higher the income is the more family members in the house are. The gap is about 1.24 persons between the poorest and the richest.

Table 12.3.94 Average number of family members

	Total	LIG	MIG	HIG
1.Total No. of Family Member	7.5	6.5	7.2	8.7
2.Male Members (more than 18 years) :	3.1	2.5	3.3	3.5
3.Female Members (more than 18 years) :	2.4	1.8	2.3	3.0
4.Child Less than 18 years:	2.0	2.2	1.6	2.2

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are 5th grade (27.5 %), followed by Read & Write (23.5%), 10th grade (13.7%) and 10+ (College) (13.7%) and Grad school (13.7%). As expected, the higher the income, the higher the level of education.

Table 12.3.95 Education Level of the Respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.(Read & Write)	12	8	0	4	23.5	47.1	0.0	23.5
2.(5th grade)	14	5	8	1	27.5	29.4	47.1	5.9
3.(10th grade)	7	1	4	2	13.7	5.9	23.5	11.8
4.10+ (College)	7	3	1	3	13.7	17.7	5.9	17.7
5.(Grad school)	7	0	2	5	13.7	0.0	11.8	29.4
6.(Post-grad school)	4	0	2	2	7.8	0.0	11.8	11.8
	51	17	17	17	100.0	100.0	100.0	100.0

Looking at the religion of the respondents, 82.4% are Hindu and 17.7% are Muslims. More Muslims are found in higher income families.

Table 12.3.96 Religion of the respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Hindu)	42	13	15	14	82.4	76.5	88.2	82.4
2.(Muslim)	9	4	2	3	17.7	23.5	11.8	17.7
3.(Christian)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Others)	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The question of how long they have lived in the area, average is 46.1 years, and the income doesn't relate to the settled years.

Table 12.3.97 Settled years of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	46.1	45.4	47.7	45.3

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is 16,490 Rs. The richest families has as much as third times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 12.3.98 Average monthly income of the respondents (Rs)

Type	All	LIG	MIG	HIG
Amount（Rs）	16,490	7,765	16,235	25,471

Source: JICA Study Team 2016

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all categories. Apart from savings and others, all 3 income groups spend on health/treatment in the second most money and LIG spend on water thirdly. MIGs' third most spending item is clothing. HIG's thirdly spending item is clothing.

Table 12.3.99 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.(Food)	6,696	4,324	6,412	9,353
2.(Clothing)	1,471	365	1,400	2,647

3.(House Rent)	0	0	0	0
4.(House Tax)	5	4	6	6
5.(Electricity)	1,082	400	1,082	1,765
6.(Water/Sewerage service)	11	10	11	13
7.(Cooking Fuel)	774	571	709	1,041
8.(Vehicle Fuel)	1,086	29	1,141	2,088
9.(Health/treatment)	20	29	29	0
10.(Education)	1,116	276	1,029	2,041
11.(Saving)	2,899	1,269	3,029	4,399
12.(Others)	1,320	488	1,353	2,118
(Total)	16,490	7,765	16,235	25,471

Source: JICA Study Team 2016

b) Disease

The question to see whether any of the family members had disease in the last one year, 5.9 percent answered yes, and 94.1 % no. The higher income they earn, the less disease incident rate is.

Table 12.3.100 Disease incident rate for the past one year

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.(Yes)	3	5.9	11.8	5.9	0.0
2.(No)	48	94.1	88.2	94.1	100.0

Source: JICA Study Team 2016

Those who answered yes in the disease question, they showed the specific diseases they had and the most frequent one is malaria (33.3%) and others (66.7%).

Table 12.3.101 Type of disease for the past one year

	All	LIG	MIG	HIG	All (%)	LIG （%）	MIG (%)	HIG (%)
1. (Paratyphoid).	0	0	0	0	0.0	0.0	0.0	-
2.(Cholera)	0	0	0	0	0.0	0.0	0.0	-
3.(Typhoid/Typhus)	0	0	0	0	0.0	0.0	0.0	-
4.(Dysentery)	0	0	0	0	0.0	0.0	0.0	-
5.(Dengue)	0	0	0	0	0.0	0.0	0.0	-
6.(Malaria)	1	1	0	0	33.3	50.0	0.0	-
7.(Flue)	0	0	0	0	0.0	0.0	0.0	-
8.Others	2	1	1	0	66.7	50.0	100.0	-
	3	2	1	0	100.0	100.0	100.0	-

Source: JICA Study Team 2016

c) Water supply service

Regarding the possession of the water supply service, 98.0% answered they have some type of water supply service. Looking at the income group, 94.1% LIG have water supply services, 100.0% for MIG and LIG.

Table 12.3.102 Possession of the water supply service

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes (go to 16)	50	98.0	94.1	100.0	100.0
2.No (go to 20)	1	2.0	5.9	0.0	0.0
3.Other sources					
1) Private source	0	0.0	0.0	0.0	0.0
2) Ground water	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

In regard to the amount of the water supply charge, the following results are acquired. Overall, there are 100% for around 800.

Table 12.3.103 Amount of the water supply charge

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Around 800*)	50	16	17	17	100.0	100.0	100.0	100.0
2.(Around 1000)	0	0	0	0	0.0	0.0	0.0	0.0
3.(Around 1500)	0	0	0	0	0.0	0.0	0.0	0.0
4.(Around 2000)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Around 2500)	0	0	0	0	0.0	0.0	0.0	0.0
6.(More than 2500)	0	0	0	0	0.0	0.0	0.0	0.0
7. Not paying	0	0	0	0	0.0	0.0	0.0	0.0
	50	16	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Note: *Units are in Indian Rupees.

As for the question to see how you rate the water service you are mainly using, 90.0% answered very satisfactory, followed by average (6.0%).

Table 12.3.104 Rate of the water supply services

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Very satisfactory)	45	90.0	87.5	100.0	82.4
2.(Relatively satisfactory)	1	2.0	6.3	0.0	0.0
3.(Average)	3	6.0	6.3	0.0	11.8
4.(Relatively unsatisfactory)	1	2.0	0.0	0.0	5.9
5.(Very unsatisfactory)	0	0.0	0.0	0.0	0.0
	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Regarding the questions which types of problems on the present main water supply, 5.9% claims that there is bad smell or taste and 3.9% no transparency of water.

Table 12.3.105 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Bad taste (smell))	3	5.9	5.9	0.0	11.8
2.(Water is dirty (not transparent))	2	3.9	5.9	0.0	5.9
3.(Frequent stop of water service)	0	0.0	0.0	0.0	0.0
4.(Water amount is not enough)	0	0.0	0.0	0.0	0.0
5.(Insufficient water pressure)	0	0.0	0.0	0.0	0.0
6.(High Tariff)	0	0.0	0.0	0.0	0.0
7.(Others (please specify))	0	0.0	0.0	0.0	0.0
	5	9.8	11.8	0.0	17.7

Source: JICA Study Team 2016

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered 12.40 Rs per month.

Table 12.3.106 WTP for the water supply services

	All	LIG	MIG	HIG
Rs/month	12.40	10.00	-	14.00

Source: JICA Study Team 2016

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 90.2% answered yes. While both MIG and HIG answered 100.0% of them have a toilet in their houses, 29.4% of LIG answered no.

Table 12.3.107 Toilet possessions

	All	LIG	MIG	HIG
Yes	46	12	17	17
No	5	5	0	0
Yes (%)	90.2	70.6	100.0	100.0
No (%)	9.8	29.4	0.0	0.0
	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The questions asked which disposal system was connected to their home toilets, nobody answered that they are connected to sewer. 54.4% of people directly discharge into ditch followed by septic tanks (45.7%).

Table 12.3.108 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.(Sewer connection)	0	0.0	0.0	0.0	0.0
2.Septic tank (connecting with a soak pit or trench)	21	45.7	41.7	41.2	52.9
3.Pit latrine (not using water)	0	0.0	0.0	0.0	0.0
4.(Direct discharge into ditch, drain or river)	25	54.4	58.3	58.8	47.1
5.Others	0	0.0	0.0	0.0	0.0
	46	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked how they evaluate the pit latrine to those who answered sewer connection, 100% answered very satisfactory.

Table 12.3.109 Evaluation of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Very satisfactory	46	100.0	100.0	100.0	100.0
2.Relatively satisfactory	0	0.0	0.0	0.0	0.0
3.Average	0	0.0	0.0	0.0	0.0
4.Relatively unsatisfactory	0	0.0	0.0	0.0	0.0
5.Very unsatisfactory	0	0.0	0.0	0.0	0.0
	46	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked to all persons who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, the answers are as follows. They all want to have sewer connection.

Table 12.3.110 Sewage demand in non-sewer HHs

	All	All (%)	LIG	MIG	HIG
1.Yes	51	100.0	100.0	100.0	100.0
2.No	0	0.0	0.0	0.0	0.0
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the average of their answer is 327.9 Rs. Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much are you willing to pay for sewer user charge per month, they answer that they pay average 10.3 Rs./month.

Table 12.3.111 WTP for connection and monthly fee (Rs.)

	All	LIG	MIG	HIG
WTP for connection (Rs)	327.9	125.0	411.8	447.1
WTP for monthly fee (Rs).	10.3	8.1	10.0	12.7

Source: JICA Study Team 2016

e) CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the respondents answered that 4.1Rs, and the less income is the higher WTP for CTC is.

Table 12.3.112 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.1	4.3	4.0	3.5

Source: JICA Study Team 2016

Question asked that how they evaluate the present public/community toilet service in the community, 9.8% answered very satisfactory, 3.9% relatively satisfactory and 7.8% average.

Table 12.3.113 CTC's satisfaction rate of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Very satisfactory)	5	9.8	23.5	5.9	0.0
2.(Relatively satisfactory)	2	3.9	0.0	5.9	5.9

3.(Average)	4	7.8	11.8	5.9	5.9
4.(Relatively unsatisfactory)	0	0.0	0.0	0.0	0.0
5.(Very unsatisfactory)	0	0.0	0.0	0.0	0.0
6.(I don't know)	40	78.4	64.7	82.4	88.2
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the reason that CTCs are not "very satisfactory", 7.8% answered that it is dirty, 5.9% overflow of wastewater is not good and 2.0% claims congestion.

Table 12.3.114 Reasons for dissatisfaction of the CTCs

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.(Dirty)	4	1	1	2	7.8	5.9	5.9	11.8
2.(Overflow of wastewater)	3	1	1	1	5.9	5.9	5.9	5.9
3.(Congestion)	1	1	0	0	2.0	5.9	0.0	0.0
4.(Long distance to the toilet)	0	0	0	0	0.0	0.0	0.0	0.0
5.(Charge is too high)	0	0	0	0	0.0	0.0	0.0	0.0
6.(I do not want to pay)	0	0	0	0	0.0	0.0	0.0	0.0
7. (Facility that we want to use is not installed (please specify :)	0	0	0	0	0.0	0.0	0.0	0.0
8.Others (please specify:)	0	0	0	0	0.0	0.0	0.0	0.0
	8	3	2	3	15.7	17.7	11.8	17.7

Source: JICA Study Team 2016

When asked the WTP for CTC per usage, the average is 5.0 Rs for all income groups.

Table 12.3.115 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	5.0	5.0	5.0	5.0

Source: JICA Study Team 2016

f) Public outreach

Question asked if there are any community-based activities on sanitary programs in your community, 100.0 % of them answered that they know the activities.

Table 12.3.116 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.Yes	51	100.0	100.0	100.0	100.0
2.No	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 12.3.117 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax	63.3	41.5	71.5	76.9
2. Water tax	135.1	118.3	132.4	154.7
3. Sewage tax	0.0	0.0	0.0	0.0
4. E. P. E. tax	0.0	0.0	0.0	0.0
5. Education, Petroleum, and Environment	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

12.4 Economic Evaluation

12.4.1 Identification of Economic Benefits

1) Summary of Economic Benefits

Economic benefits that can be expected in this kind of project are (1) An amount of willingness of people to pay (WTP), (2) A saving amount of medical expenditure of people and saving in the subsidy amount spent by the Government on such medical institutions such as hospitals, clinics health centers etc. (3) Saving in the amount of salaries/wages of the people, etc. The latter two benefit categories will be derived as a result of decrease of suffering rate of water borne diseases due to improvement of water environment. (4) Increasing of agricultural productivity because of improved water quality.

Furthermore, there may be a lot of other kinds of socio-economic and/or environmental benefits like those which may be derived from increase of tourism since better environmental condition of Ganga review will attract more tourist in Varanasi and from conservation of Bio-diversity from clean water, but those benefits are considered as tangible here and are excluded in the calculation.

2) Willingness of people to pay (WTP) for improved water supply.

As noted in the previous chapter, JICA study team conducted economic and financial surveys in five cities. The amount of WTP is not a basic unit for setting up a tariff system, but the basic unit for the socio-economic benefit. According the surveys, WTP for improved water supply varies upon each area due to its income/expenditure level and existence/nonexistence of sewage system. Each WTP data is used in EIRR calculation. As noted later, individual EIRR of Ramnagar and Chuar become rather low since those WPT are low amount.

Table 12.4.1 WTP for Water supply

Area / Income Group	Rate of Connection to the Existing Water Supply System (Existing Connection Rate)	Rate of Connection to the Existing Sewerage System (Existing Connection Rate)	Water Supply WTP for Improved Water Supply
	(%)	(%)	(Rs./year)
Varanasi			
Low Income Group	52.00%	63.33%	672
Medium Income Group	86.00%	88.00%	535
High Income Group	86.00%	98.00%	1,038
Overall Average	70.67%	74.70%	713
Mirzapur			
Low Income Group	70.59%	5.88%	1,512
Medium Income Group	52.94%	29.41%	624
High Income Group	70.59%	23.53%	-
Overall Average	64.71%	19.61%	1,068
Ghazipur			
Low Income Group	100.00%	0.00%	160
Medium Income Group	100.00%	0.00%	220
High Income Group	100.00%	0.00%	
Overall Average	100.00%	0.00%	200
Ramnagar			
Low Income Group	94.12%	94.12%	162
Medium Income Group	100.00%	88.24%	231
High Income Group	100.00%	100.00%	360
Overall Average	98.04%	94.12%	201
Chunar			
Low Income Group	94.12%	0.00%	120
Medium Income Group	100.00%	0.00%	-
High Income Group	100.00%	0.00%	168
Overall Average	98.04%	0.00%	149

Similarly, JICA study team surveyed waste water treatment service regarding its economics and financial views. The same can be mentioned that its WTP of Ramnagar and Chunar become rather low.

Table 12.4.2 WTP for Waste water treatment service

Area / Income Group	Waste Water Treatment Services Average Amount Paid for the Existing Sewerage Treatment Services (Average Existing Charge) (Rs./year)	Amount of Willingness to Pay (WTP) for **Improved** Sewerage Treatment Services (Rs./year)	Amount of Willingness to Pay (WTP) for **newly established** Sewerage Treatment Services (Rs./year)	Amount of Willingness to Pay (WTP) for Sewerage Treatment Services (Rs./year)	Amount of Willingness to Pay (WTP) for **New** Sewerage Connection (Rs.)
Varanasi					
Low Income Group	527	690	698	693	408
Medium Income Group	1,434	483	480	483	1,900
High Income Group	1,704	1,011	2,400	1,039	500
Overall Average	1,222	682	710	689	660
Mirzapur					
Low Income Group	179	600	570	572	638
Medium Income Group	256	1,050	565	708	858
High Income Group	251	-	878	878	1,523
Overall Average	229	960	660	719	955
Ghazipur					
Low Income Group	186	N/A	81	81	335
Medium Income Group	324	N/A	127	127	588
High Income Group	314	N/A	162	162	718
Overall Average	275	N/A	124	124	547
Ramnagar					
Low Income Group	113	0	2,400	141	200
Medium Income Group	134	280	1,500	424	125
High Income Group	134	-	0	0	0
Overall Average	127	280	1,800	369	150
Chunar					
Low Income Group	118	N/A	99	99	125
Medium Income Group	132	N/A	120	120	412
High Income Group	154	N/A	152	152	447
Overall Average	135	N/A	124	124	328

3) Saving of Medical Expenditure

This kind of project may contribute to improve the people's living environment. If water quality is improved by a project, water borne diseases may decrease and, people's burden on medical expenditure and saving of the subsidy allocated by the Government for Hospitals operations and other medical center services will also decrease. This is an indirect socio economic benefit. In other words, it can be expected that the purchasing power or capability of the people could be increased due to improvement of water quality.

The social survey data, The Cost of Public sector is taken from the actual expenditure incurred by the state of Uttar Pradesh UP Finance account 2013-14, shows that expenditure of Health & Family Welfare is Rs. 547,094 lakhs and Family Welfare is Rs. 252,668 lakhs, so the total is about Rs. 79,976 million. As the total population of UP in 2011 census is 199 million, the public cost of annual medical service is estimated at Rs. 440.26.

Table 12.4.3 Detailed Statement of Revenue Expenditure by Minor Heads

(Rs. In lakhs)

Decription	Non Plan	Plan		Total
		State Plan	CSS/CP	
(b) Health & Family Welfare				
Urban Health Services	154,903.96	709.43	0.12	155,613.51
Urban Health Services Others	13,492.99	-	-	13,492.99
Rural Health Services Allopathy	167,779.71	2,032.47	-	169,812.18
Rural Health Services Other	46,024.19	0.67	-	46,024.86
Medical Education, Training & Research	94,627.14	29,780.41	-	124,407.55
Public Health	33,110.41	3,794.53	-	36,904.94
General	738.37	100.24	-	838.61
Sub Total (A)				**547,094.64**
Family Welfare - Sub Total (B)	**350.22**	**0.11**	**252,318.11**	**252,668.44**
Total				**799,763.08**
Actual Revenue Expenditure for FY 2013-14			Rs	**79,976,308,000.00**
Total Polulation as per 2011 census				199,812,341.00
Public Cost for Annual Medical Service per Person				**400.26**

Source: Uttar Pradesh UP Finance account 2013-14

4) Saving of Salaries/Wages

People suffering from water borne diseases have to keep off their work for long span of time. This results in loss of salary/wage for the number of days absent from work. The actual amount of saving after implementation of the project can be estimated with the average income per capita and the medical data discussed in the above paragraph. Water borne disease results in a loss of either earnings of an individual or would affect the productive output of an organization. This kind of losses concerning the salaries/wages could be mitigated if the water borne disease can be reduced.

The survey report "Economic Impacts of Inadequate Sanitation in India (2011) says the "Occurrence Number" is 750 million cases and "Time loss" due to water-borne diseases in whole India is 10,453 million years. (Water-borne diseases are Diarrhea, Helminthes, Trachoma, ALRI, Measles, Malaria and other water borne). As the total population in India (world-bank data) was 1,295,291,543 in 2014, the annual number and time loss of water borne disease case per person are estimated 0.58 cases/person/year and 2.96 days/person/year.

"The daily production value" is estimated by dividing GDP per capita (US$ 1,582 in 2014) by annual working days (250 days). Adopting the exchange rate of Rs. and US$ is Rs. 63.33 of 31th December in 2014, the "daily production value" is estimated to be Rs. 400.76. The "employment rate" is assumed to be 80% considering the economic condition of the project area. Therefore, the benefit of saved production value is calculated at Rs. 944 /year/person.

Table 12.4.4 Calculation of Annual number of cases/person/year & Time Lost

Step 1	**Calculation of Annual number of cases/person/year & Time Lost days/person/year**		
Source:-Report 38/128	Occurrence Number	750.00	million cases
Source:-Report 38/128	Time Lost	10,453,000.00	years
Source:-(World Bank Data)	Total Population of India in 2014	1,295.00	million
		1,295,291,543	
	Annual Number	0.58	cases/person/year
	Time Lost	2.95	days/person/year
		2.9455	
Step 2:-	**Selection of Report**		
	Both reports compared as second result has limitation the former (first)study is adopted.		
Step 3:-	**Actual Formula for Calculation Benefit of reduction of production loss**		
	=saved time lost * daily production value * employment rate		
As per World Bank	i.e. GDP per Capita in Rs./year	GDP per capita (US $ 1582) in 2014, Annual working days 25(	
	Exchange rate Dec 2014 (US $)	63.33	
	GDP per Capita per Day	100,190.43	
		400.76	
Step 4:-	**Daily Production Value**	**400.76**	**i.e. (Rs 400.76)**
	Employment Rate	**80%**	
	Time Lost as per Step 1	**2.95**	days/person/year
	Calculation	**944.37**	

5) Contribution to Increase the Productivity of Agricultural Crops

The new STP in each area will be able to discharge around 167.5 MLD of additional water in total which means additional 2,512.5 ha of irrigated land because one MLD of water can irrigate 15ha(*) of agricultural land. The additional agricultural benefit has been calculated as below:

15 ha x 149.5 MDL = 2,242.5 ha

(*: "An estimated based on this data shows that to irrigate 1000 hectares of land, a STP of 74.3 MLD capacity is needed" quoted from "Cleaning-up the Ganges", OXFORD book)

Table 12.4.5 Additional Agriculture benefit

	Capacity of New STP (MLD)	Incremental cropped area can be irrigated per MLD (ha)	Additional ha
1) Varanasi District 1		15	
2) Varanasi District 2		15	
3) Varanasi Ramana STP	50	15	750.0
4) Varanasi District 3 (A) Sewer (District 3 Comprehensive)		15	0.0
5) Dinapur & Bhagwanpur Rehabilitation&Upgrade of STPs	60	15	900.0
6) Mirzapur Part1 ID&T	18	15	270.0
7) Mirzapur Part2 Alternative 1	2	15	30.0
8) Chunar ID&T	6.5	15	97.5
9) Ramnagar ID&T	13	15	195.0
	149.5		2,242.5

Source: Calculation by JICA study team

According to the statistics (Source: Source- Agricultural Statistics at a Glance 2014 GOI, Ministry of Agriculture), the existing yields of paddy and wheat are the followings;

Table 12.4.6 Basic information about Agriculture (1)

A) Crop Calendar for Wheat & Paddy

State	Activity	Kharif Paddy	Rabi Paddy	Rabi Wheat
Uttar Pradesh	Sowing	Jun-Jul	Nov-Dec	Oct-Dec
	Harvesting	Oct-Nov	Apl- May	Apr-Apr

B) Existing Yields of Paddy and Wheat

According to statistics the existing yields of paddy and wheat are-

For 2013-14

			Unit		
Paddy	India	2,424	kg/hectare	(=24.24 quintals/ha)	Area under Irrigation 58.7%
(For Irrigated area)	Uttar Pradesh	2,447	kg/hectare	(=24.47 quintals/ha)	Area under Irrigation 80.4%

Wheat	India	3,075	kg/hectare	(=30.75 quintals/ha)	Area under Irrigation 92.9%
	Uttar Pradesh	3,038	kg/hectare	(=30.38 quintals/ha)	Area under Irrigation 98.1%

Source: Agricultural Statistics at a Glance 2014 GOI, Ministry of Agriculture

Cost A2 includes all actual expenses in cash and kind incurred in production by owner and rent paid for leased in land. And cost C2 includes all actual expenses in cash and kind incurred in production by owner, interest on value of owned fixed capital assets (including Land). Rental value of owned Land (Net of land revenue), rent paid for leased in land and imputed value of fixed capital assets. FL -Family labor is imputed on the basis of statutory wage rate or the actual market rate whichever is higher.

Table 12.4.7 Basic information about Agriculture (2)

C) Minimum Support Prices (MSP)

FY 2014-15	Rs. per quintal
Paddy	**1,360**
Wheat	**1,400**

D) Cost of Cultivation & Cost of Production

Cost of Cultivation (Rs./Hectare)

Unit	Paddy	Wheat
A2+FL	28,147.45	26,001.27
C2	40,146.68	42,383.57

Cost of Production (Qtl/Hectare)

Unit	(Rs./Quintal)	
C2	957.83	930.55
Yield	39.47	37.52

Source: Agricultural Statistics at a Glance 2014 GOI, Ministry of Agriculture

Regarding Paddy, Minimum Support Price (MSP) of Paddy in 2014-15 is Rs. 1360/quintal and its production cost is Rs. 957.83/quintal, so the net income of Paddy is Rs. 402.17/quintal. Since yield of Paddy is 24.47/quintal/Ha, total income of paddy per ha is Rs. 9,841.1.

Table 12.4.8 Farmers Gross Income estimation of Paddy

Sr.No.	Particulars	Amount	Unit
A)	Paddy MSP	1,360.00	Rs/Quintal
B)	Production Cost of Paddy	957.83	Rs/Quintal
C)	**Net Income (A-B)**	402.17	Rs/Quintal
D)	Yield of paddy	24.47	Quintals/Ha
	Paddy Yield/hectare	(=24.47 quintals/ha)	
	(Table B Data)		
E)	**Total Income (Rs/ha) (C*D)**	9,841.10	
F)	Irrigated Land due to STP)in ha)	2,242.50	Ha
G1	**Total Income for new ha (E*F)**	22,068,666.53	

Regarding Wheat, MSP of Wheat in 2014-15 is Rs. 1450/quintal and its production cost is Rs. 930.55/quintal, so the net income of Wheat is Rs. 519.45/quintal. Since yield of Wheat is 30.38/quintal/Ha, total income of Wheat per ha is Rs. 15,780.89.

Table 12.4.9 Farmers Gross Income estimation of Wheat

Sr.No.	Particulars	Amount	Unit
A)	Wheat MSP	1,450.00	Rs/Quintal
B)	Production Cost of Wheat	930.55	Rs/Quintal
C)	**Net Income (A-B)**	519.45	Rs/Quintal
D)	Yield of Wheat	30.38	Quintals/Ha
	Wheat Yield/Hectare	(=30.38 quintals/ha)	
	(Table B Data)		
E)	**Total Income (Rs/ha) (C*D)**	15,780.89	
F)	Irrigated Land due to STP)in ha)	2,242.50	Ha
G2	**Total Income for new ha (E*F)**	35,388,648.07	

As calculated in the above, the total income of Paddy per ha is Rs. 9,841.1 and that of Wheat is Rs. 15,780.89. Since the additional agricultural area ha is 2,242.5 ha, total income of Paddy and Wheat is about Rs. 57.5 million for all investment areas.

Table 12.4.10 Income Summary of agricultural crops

E)Paddy/ha	9,841.10		G1) Income Paddy	22,068,666.53
E)Wheat/ha	15,780.89		G1) Income Wheat	35,388,648.07
E)Total/ha	**25,621.99**		**Total Income**	**57,457,314.59**

Table 12.4.11 Income Summary of agricultural crops for each area

	Capacity of New STP (MLD)	Incremental cropped area can be irrigated per MLD (ha)	Incremental income from cropped area newly irrigated (Rs. / year)
1) Varanasi District 1		15	0
2) Varanasi District 2		15	0
3) Varanasi Ramana STP	50	15	19,216,493.2
4) Varanasi District 3 (A) Sewer (District 3 Comprehensive)		15	0.0
5) Dinapur & Bhagwanpur Rehabilitation&Upgrade of STPs	60	15	23,059,791.8
6) Mirzapur Part1 ID&T	18	15	6,917,937.5
7) Mirzapur Part2 Alternative 1	2	15	768,659.7
8) Chunar ID&T	6.5	15	2,498,144.1
9) Ramnagar ID&T	13	15	4,996,288.2
	149.5		57,457,314.6

12.4.2 Estimation of Economic Cost

1) The Basic Conditions of Estimation of Economic cost

The Project total cost from DPRs is about Rs. 16,530 million from DPR. Evaluation (EIRR and FIRR) is calculated on the basic conditions of 1) Key information of the submitted DPRs, such as costs and population forecast, 2) Elimination of Comprehensive except Varanasi area (or just adoption of ID&T), 3) Lager “Alternative” is adopted, 4) So the Investments for IRR calculation is nine (mark X in the below table)

Table 12.4.12 Summary of Project Costs from DPR

	Million Rs.	IRR	Capital	O&M	Total (1)	Capital	O&M	Total (2)
Varanasi	District 1	X	3,192.71	94.89	3,287.60	3,192.71	94.89	3,287.60
Varanasi	District 2	X	4,784.34	136.02	4,920.36	4,784.34	136.02	4,920.36
Varanasi	District 3: RAMANA	X	1,240.64	325.54	1,566.17	1,240.64	325.54	1,566.17
Varanasi	District 3 (A)Sewers	X	1,754.39	49.92	1,804.31	1,754.39	49.92	1,804.31
Varanasi	Dinapur &Bhagwanpur	X	770.89	540.54	1,311.43	770.89	540.54	1,311.43
Mirzapur	Comprehensive		3,193.36	295.83	3,489.19			
Mirzapur	Part 1: ID&T	X	884.63	870.37	1,755.00	884.63	870.37	1,755.00
Mirzapur	Part 2: Alternative 1	X	182.85	184.78	367.63	182.85	184.78	367.63
Mirzapur	Part 2: Alternative 2		87.16	111.55	198.71			
Chunar	Comprehensive		1,164.78	90.52	1,255.30			
Chunar	ID&T	X	329.83	206.74	536.57	329.83	206.74	536.57
Ramnagar	Comprehensive		1,550.30	555.47	2,105.77			
Ramnagar	ID&T	X	427.65	553.72	981.37	427.65	553.72	981.37
Ghazipur	Comprehensive		1,763.92	280.33	2,044.25			
Ghazipur	ID&T	Waiting						
Saidpur	ID&T	Waiting						
			21,327.46	**4,296.21**	**25,623.67**	**13,567.93**	**2,962.52**	**16,530.45**

Source: Submitted DPR

2) Estimation of Economic cost and its methodology

a) Construction cost (Capital Cost)

First, Cost is divided into Capital cost and O&M cost from each DPR which includes future O&M cost occurring after each construction based on a certain increase ratio defined in the each DPR. Capital costs are mainly seven items; “Basic Cost of Work”, “Land acquisition Cost”, “Centage Charge”, “Cost of work on which no Centage charge is admissible”, “Labor Cess”, “Engineering Cost” and “Contingency cost”. These seven costs are coming from nine DPR; however “Engineering Cost” is calculated by 15% of “Basic Cost of Work” from DPR.

All Basic Cost of Work occurs from 2017 (when construction begins) to 2019 or three year periods and the cost allocation is 30% for 1st year, 50% for 2nd year and 20% for the 3rd year of its total construction costs based on the assumption of DPR (e.g., Varanasi District 1)

All the sum of those seven costs is Financial Costs Excluding Price escalation, so then Price escalation is calculated by using 0.32% of Foreign(JICA) and 8.11% of Domestic (India). Domestic (India) is applied to Basic cost, land, half of Engineering cost and Administration (Cost of work on which no Centage is admissible) while the other half of Engineering cost is applied by 0.3% of Foreign-JICA. (Notes: Price escalation is not applied to O&M since it uses its own Price Escalation) So the sum of Financial Costs of excluding Price Escalation and Price Escalation is Financial cost including Price Escalation, which is later used when calculation of FIRR.

Table 12.4.13 Consumer price index in Japan from 2006 to2015

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
100.7	100.7	102.1	100.7	100	99.7	99.7	100	102.8	103.6
									0.32%

It is necessary to have Economic Cost excluding Contingency and Price Escalation to have EIRR. This is composed of “Centage Charge”, “Cost of work on which no Centage is admissible”, “Labor Cess”, “Adjusted Basic Construction Cost” and “Adjusted Engineering Costs”. The last two items are Economics costs.

As mentioned above, the economic cost is also to be converted from the financial cost. So the first step is to have “Adjusted Basic Construction Cost (BCC)” from Basic Construction. In this case, a Standard Conversion Factor (SCF) for tradable equipment and materials, shadow price for land acquisition cost and/or housing compensation, and for labors for the construction works, cost of transfer items such as personal income tax and corporate income tax should be taken into account. The original BCC is deduced by certain logic considering tax increase (Beneficial to Economics) incurred by local labors, using certain percentage of Labor (30% or 50%), Material (50% or 70%), Individual Tax Rate (10%), Shadow Wage Rate of Unskilled Labor (50% (or a skilled worker is 100%)), Contactor Profit rate (10%) and Corporate Income tax rate (30.9). The percentage ratio of Labor and Material is 30:70 for STP type and 50:50 for others.

Similarly, "Adjusted Engineering Costs" is an adjustment of Engineering Cost. The original Engineering Cost is deduced by certain logic considering tax increase (Beneficial to Economics) incurred by local construction companies or vendors, using certain percentage of Contactor Profit rate (10%) and Corporate Income tax rate (30.9)

Through the calculation procedures in the above, Construction cost for Capital cost is Rs. 13,047.9 million.

Table 12.4.14 Economic Costs of Construction (Capital)

			30%	50%	20%
	Rs. million	2016	2017	2018	2019
Economic Cost (Excluding Contingency and Price Escalatior	**13,052.3**		4,246.8	6,298.4	2,507.1
1) Varanasi District 1	3,093.2		936.1	1,540.8	616.3
2) Varanasi District 2	4,635.1		1,398.6	2,311.7	924.7
3) Varanasi Ramana STP	1,207.5		618.1	421.0	168.4
4) Varanasi District 3 (A) Sewer (District 3 Comprehensive)	1,670.8		512.6	827.3	330.9
5) Dinapur & Bhagwanpur Rehabilitation&Upgrade of STPs	749.8		232.0	369.9	147.9
6) Mirzapur Part1 ID&T	846.7		285.0	401.2	160.5
7) Mirzapur Part2 Alternative 1	175.0		57.5	83.9	33.6
8) Chunar ID&T	315.2		70.3	183.6	61.2
9) Ramnagar ID&T	359.2		136.6	159.0	63.6

Source: JICA Study team

b) O&M Cost

Regarding O&M (cost), this cost is supposed to start after the construction or since year of 2020. They are mainly Manpower Cost, Annual Repair Cost, Power Consumption Cost, DG Set Maintenance Cost and Chemical Cost for STP. Some of the facilities need 5 years and some for 10 years of its required O&M costs and there are two types of Price Escalation, 6% and 8% from DPRs. Regardless of the required years, each Escalation increase ratio is applied every year until 2050 from 2020. And similar to Capital costs in the above, O&M cost is also to be modified into Economic adjustment basis.

The original O&M Cost is deduced by certain logic considering tax increase (Beneficial to Economics) incurred by local labors, using certain percentage of Labor (0%, 50% or 100%), Material (0%, 50% or 100%), Individual Tax Rate (10%), Shadow Wage Rate (50%), Contactor Profit rate (10%), Corporate Income tax rate (30.9) and Standard Conversion Factor (SCF). The percentage ratio of Labor and Material is 30:70 for STP type and 50:50 for others.

Standard Conversion Factor (SCF) is used here as well to have economics cost of O&M. This is a calculation or the ratio between exports and imports amount which is applied to tradable material expenses and SFC is 96% in this case.

Table 12.4.15 Calculation of Standard Conversion Factor

Year	Import Amount *	Export Amount *	Import Duties (Custom Duties) *	Export Tax **	Export Subsidies **
2005-06	6,604.09	4,564.18	642.01	0.00	
2006-07	8,405.06	5,717.79	854.40	2.86	
2007-08	10,123.12	6,558.64	1,006.35	18.34	
2008-09	13,744.36	8,407.55	945.81	31.83	
2009-10	13,637.36	8,455.34	808.66	10.35	
2010-11	16,834.67	11,429.22	1,301.10	31.40	
2011-12	23,454.63	14,659.59	1,396.11	64.14	
2012-13	26,691.62	16,343.18	1,596.29	28.05	
2013-14	27,154.34	19,050.11	1,668.35	28.05	
	146,649.25	95,185.60	10,219.07	215.01	0.00

SCF=	0.960275945

Source: *: Handbook of Statistics on Indian Economy, Reserve Bank of India, 2015
**: Indian Public Finance Statistics 2013-2014

Through the calculation mentioned in the above, Total O&M cost from 2020 to 2050 is Rs. 24,611.2 million and the first ten years O&M cost is Rs. 3,315.7 million

Table 12.4.16 Economic Costs of O&M

	Million Rs.	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
O&M Cost - Economic Cost Adjustment	**24,611.2**				242.6	259.6	277.9	297.4	318.3	340.8	355.4	380.4	407.3	436.0	…
1) Varanasi District 1	1,338.7				10.9	11.7	12.7	13.7	14.8	15.9	17.2	18.6	20.1	21.7	…
2) Varanasi District 2	1,330.3				16.3	17.7	19.1	20.6	22.2	24.0	16.6	17.9	19.3	20.9	…
3) Varanasi Ramana STP	3,863.5				45.6	48.3	51.2	54.3	57.5	61.0	64.6	68.5	72.6	77.0	…
4) Varanasi District 3 (A) Sewer (District 3 Comprehensive)	640.3				5.2	5.6	6.1	6.5	7.1	7.6	8.2	8.9	9.6	10.4	…
5) Dinapur & Bhagwanpur Rehabilitation&Upgrade of STPs	6,323.1				74.6	79.0	83.8	88.8	94.1	99.8	105.8	112.1	118.8	126.0	…
6) Mirzapur Part1 ID&T	5,623.1				45.6	49.2	53.2	57.4	62.0	67.0	72.3	78.1	84.4	91.1	…
7) Mirzapur Part2 Alternative 1	1,161.8				9.4	10.2	11.0	11.9	12.8	13.8	14.9	16.1	17.4	18.8	…
8) Chunar ID&T	1,214.1				9.8	10.6	11.5	12.4	13.4	14.5	15.6	16.9	18.2	19.7	…
9) Ramnagar ID&T	3,116.2				25.3	27.3	29.5	31.8	34.4	37.1	40.1	43.3	46.8	50.5	…
	3,315.7														

12.4.3 Economics Evaluation of the project

1) The Conditions and premises for Economic valuation

The population is forecasted from the information of each DPR. The population forecast of Varanasi is based on the latest issued DPR and some of them are adjusted to avoid possible duplication of benefits 1) Varanasi District 1: Population project from District 1, 2) Varanasi District 2: Population project from Zone 2A of District 2, 3) Varanasi Ramana STP: Population project from District 3 or the sum of Zone3 and FSA4, 4) Varanasi District-3 (A) Sewer (District 3 Comprehensive): The same population of Ramana STP, 5) Dinapur & Bhagwanpur Rehabilitation &Upgrade of STPs: Population project from its

DPR but is compressed by using 0.35 (since 101.8 MD is to rehabilitation compared to current 288.0 MD, then 0.35 is from 101.8 divided by 288) When DPR has the population of FSA (future service area, including floating population), that number is not used in this report but the population of total its area zone is used because of conservatism.

Table 12.4.17 Population Projection in Varanasi city

	2011	2020	2035	2050
District 1	441,697	479,983	558,728	654,826
District 2				
Zone 2A	472,985	570,252	778,259	1,041,264
Zone 2B	*81,858*	*117,379*	*213,580*	*374,689*
Zone 2C	*108,342*	*146,074*	*237,359*	*369,855*
NSA2	*25,950*	*37,883*	*70,240*	*123,718*
NSA1	*43,146*	*63,255*	*117,226*	*204,966*
FSA1	*22,452*	*26,194*	*29,936*	*33,678*
	754,733	**961,037**	**1,446,600**	**2,148,170**
District 3				
Zone 3	84,984	104,052	144,863	196,337
FSA4	52,374	78,561	141,410	183,309
	137,358	**182,613**	**286,273**	**379,646**
District 4				
FSA2	90,204	106,252	125,579	146,801
FSA3	67,759	101,639	237,157	271,036
	157,963	207,891	362,736	417,837
Grand Total	**1,491,750**	**1,831,523**	**2,654,338**	**3,600,478**

The population forecast of other areas, Mirzapur, Chunar and Ramnagar is also based on their DPR; however the population of Mirzapur is adjusted to avoid possible duplication of benefits. Alternative is for rehabilitation, it is considered that the benefit of the population is under current capacity of 14 MLD. Since people use 135 liter /day/person, the population of this STP is calculated as 103,704 and this number will be the same until 2050. For ID&T of Mirzapur, "MIRZAPUR TOWN WITH FSA" is not used but "TOTAL MIRZAPUR ZONE".

Table 12.4.18 Population Projection of Other Cities

	2020	2030	2035	2050
Mirapur DPR				
MIRZAPUR TOWN WITH FSA	**286,287**	**322,533**	**346,686**	**423,624**
TOTAL MIRZAPUR ZONE	251,262	268,710	287,863	347,938
Mirzapur Part2 Alternative 1	103,704	103,704	103,704	103,704
Chunar DPR	**48,000**	**55,000**	**63,000**	**80,000**
Ranmagar DPR	**64,070**	**78,478**	**87,122**	**118,503**

The number of Served Household is calculated by each population times house connection. Project life is set until the year of 2050 after completion of the construction works.
Discount rate of 10 % is applied.

2) Economic Evaluation

Economic costs and benefits throughout the project life are compared in terms of present values. If the total present value of economic costs equals that of economic benefits (when, B/C=1), the discount rate used to calculate the present value is called as "economic internal rate of return (EIRR)" and used as the main index of project evaluation to judge the project feasibility and/or viability. The other two indices are Net Present Value (NPV) and B/C Ratio.

The EIRR is calculated at 11.19 % and the B/C is 1.09 for 10% discount rate. There can be several other indirect socio-economic benefits of this project. These benefits derive from increase in number of tourists, conservation of the bio-diversity, and sales of treated water, etc. If these intangible benefits could be converted into monetary terms, economic feasibility of the project would become higher.

Regarding effectiveness of the project, the parameters of the evaluation can be those based on the EIRR calculation;

- WTP for Improvement for Water Quality
- WTH for Improvement for Sewage Treatment Services
- Saving Medical Expenditure
- Saving of Salaries Wages

Those target numbers in 2050 is simulated in the table below.

Table 12.4.19 Summary of EIRR

All Total (Unit: Rs. Million)

Year in Order	Fiscal Year	Economic Cost: Construction Cost	Economic Cost: O&M cost	Economic Cost: Replacement cost	Economic Cost: Total	Economic Benefit: WTP for Improvement for Water Quality: Served HHs in Total	WTP for Improvement for Water Quality: Basic unit: Rs./Y per HH	WTP for Sewerage Treatment Services: Connected HHs	WTP for Sewerage Treatment Services: Basic unit: Rs./Y per HH	Saving of Medical Expenditures: Basic unit: Rs./Y per person	Saving of Salaries/ Wages: Basic unit: Rs./Y per person	Agricultural Benefit Due to Treated Water Discharged for Irrigation: 25,622 Rs. /ha per year	Total	Cash Balance
0	2016													
1	2017	4,247			4,247								0	-4,247
2	2018	6,298			6,298								0	-6,298
3	2019	2,507			2,507								0	-2,507
4	2020	0	243		243	211,693	290	198,013	245	1,001	187	57	1,780	1,538
5	2021		260		260	220,992	303	207,789	257	1,015	196	57	1,829	1,569
6	2022		278		278	230,657	316	218,016	269	1,030	206	57	1,879	1,601
7	2023		297		297	240,555	330	228,717	283	1,045	216	57	1,931	1,633
8	2024		318		318	250,842	344	239,915	296	1,059	227	57	1,984	1,666
9	2025		341		341	261,533	359	251,634	311	1,074	238	57	2,039	1,698
10	2026		355		355	272,644	375	263,898	326	1,089	249	57	2,096	1,741
11	2027		380		380	284,190	391	276,735	342	1,103	261	57	2,155	1,774
12	2028		407		407	296,189	408	290,173	358	1,118	274	57	2,216	1,808
13	2029		436		436	308,657	425	304,241	376	1,133	287	57	2,278	1,842
14	2030		467		467	321,613	443	317,868	392	1,148	300	57	2,341	1,874
15	2031		500		500	335,257	462	324,755	401	1,163	307	57	2,391	1,891
16	2032		535		535	347,243	479	331,887	409	1,179	313	57	2,439	1,903
17	2033		573		573	353,073	488	339,286	419	1,195	320	57	2,479	1,906
18	2034		614		614	358,976	497	346,973	428	1,210	328	57	2,520	1,906
19	2035		658		658	365,431	506	355,733	438	1,228	336	57	2,566	1,908
20	2036		705		705	370,529	512	364,576	449	1,246	344	57	2,608	1,904
21	2037		755	0	755	375,640	519	373,804	460	1,263	353	57	2,652	1,897
22	2038		809		809	380,764	526	383,449	472	1,280	362	57	2,697	1,888
23	2039		867		867	385,901	533	393,543	484	1,297	372	57	2,743	1,876
24	2040		929		929	391,052	540	404,126	497	1,314	382	57	2,790	1,861
25	2041		995		995	396,215	547	415,173	510	1,332	392	57	2,838	1,843
26	2042		1,067		1,067	401,393	554	422,955	518	1,349	399	57	2,878	1,811
27	2043		1,143		1,143	406,584	561	430,292	525	1,366	406	57	2,916	1,773
28	2044		1,226		1,226	411,789	567	411,789	525	1,384	389	57	2,923	1,697
29	2045		1,314		1,314	417,008	574	417,008	531	1,401	394	57	2,958	1,644
30	2046		1,409		1,409	422,242	581	422,242	538	1,419	399	57	2,994	1,586
31	2047		1,511		1,511	427,489	589	427,489	544	1,437	404	57	3,031	1,520
32	2048		1,620		1,620	432,752	596	432,752	551	1,454	409	57	3,067	1,447
33	2049		1,737		1,737	438,029	603	438,029	558	1,472	414	57	3,103	1,366
34	2050		1,863		1,863	443,560	610	443,560	564	1,490	419	57	3,141	1,278
Total		13,052	24,611	0	37,664		14,828		13,275	38,294	10,082	1,781	78,261	40,597
Net Present Value (Discount Rate at 10 %)					14,413								15,719	1,305
EIRR:														**11.19%**
B/C														1.09

Table 12.4.20 Effectiveness of the project

	WTP for Improvement for Water Quality: Served HHs in Total	WTP for Improvement for Water Quality: Basic unit: Rs./Y per HH	WTP for Sewerage Treatment Services: Connected HHs	WTP for Sewerage Treatment Services: Basic unit: Rs./Y per HH	Saving of Medical Expenditures: Basic unit: Rs./Y per person	Saving of Salaries/ Wages: Basic unit: Rs./Y per person	Agricultural Benefit Due to Treated Water Discharged for Irrigation: 25,622 Rs. /ha per year	Total
2020	211,693	290	198,013	245	1,001	187	57	1,780
2050	443,560	610	443,560	564	1,490	419	57	3,141
	210%	**210%**	224%	**230%**	**149%**	**224%**	N/A	176%

The EIRR of each detailed projects varies, some are rather higher however two indicate negative mainly due to lower WTP in those areas.

Table 12.4.21 EIRR of all nine detailed projects

All Total (Unit: Rs. Million)

Year in Order	Fiscal Year	Economic Cost: Construction Cost	Economic Cost: O&M cost	Economic Cost: Replacement cost	Economic Cost: Total	Economic Benefit: WTP for Improvement for Water Quality: Served HHs in Total	WTP for Improvement for Water Quality: Basic unit: Rs./Y per HH	WTP for Sewerage Treatment Services: Connected HHs	WTP for Sewerage Treatment Services: Basic unit: Rs./Y per HH	Saving of Medical Expenditures: Basic unit: Rs./Y per person	Saving of Salaries/Wages: Basic unit: Rs./Y per person	Agricultural Benefit Due to Treated Water Discharged for Irrigation: 25,622 Rs. /ha per year	Total	Cash Balance
All Total		13,052	24,611	0	37,664		14,828		13,275	38,294	10,082	1,781	78,261	40,597
Net Present Value (Discount Rate at 10 %)					14,413								15,719	1,305
EIRR:														**11.19%**
B/C														1.09
Varanasi 1														(Unit: Rs. Million)
Total		2,691	1,339	0	4,029		2,661		2,504	6,975	1,886	0	14,026	9,996
Net Present Value (Discount Rate at 10 %)					2,427								2,901	474
EIRR:														12.00%
B/C														1.20
Varanasi 2														(Unit: Rs. Million)
Total		4,037	1,330	0	5,367		3,777		3,549	9,833	2,672	0	19,831	14,464
Net Present Value (Discount Rate at 10 %)					3,569								3,832	263
EIRR:														10.71%
B/C														1.07
Varanasi Ramana STP														(Unit: Rs. Million)
Total		992	3,864	0	4,856		1,356		1,273	3,519	959	596	7,704	2,848
Net Present Value (Discount Rate at 10 %)					1,433								1,470	37
EIRR:														10.43%
B/C														1.03
Varanasi 3														(Unit: Rs. Million)
Total		1,445	640	0	2,085		1,356		1,273	3,519	959	0	7,108	5,023
Net Present Value (Discount Rate at 10 %)					1,293								1,333	41
EIRR:														10.30%
B/C														1.03
Dinapur & Bhagwanpur Rehab														(Unit: Rs. Million)
Total		646	6,323	0	6,969		2,903		2,737	7,668	2,061	715	16,086	9,116
Net Present Value (Discount Rate at 10 %)					1,497								3,574	2,077
EIRR:														40.38%
B/C														2.39
Mirzapur Part1 ID&T														(Unit: Rs. Million)
Total		699	5,623	0	6,322		1,903		1,249	3,620	650	214	7,637	1,315
Net Present Value (Discount Rate at 10 %)					1,328								1,447	120
EIRR:														12.57%
B/C														1.09
Mirzapur Part2 Alternative 1														(Unit: Rs. Million)
Total		146	1,162	0	1,308		669		424	1,287	221	24	2,624	1,316
Net Present Value (Discount Rate at 10 %)					276								535	259
EIRR:														28.25%
B/C														1.94
Chunar ID&T														(Unit: Rs. Million)
Total		267	1,214	0	1,481		73		113	775	171	77	1,209	(272)
Net Present Value (Discount Rate at 10 %)					381								228	-154
EIRR:														#NUM!
B/C														0.60
Ramnagar ID&T														(Unit: Rs. Million)
Total		277	3,116	0	3,393		128		152	1,098	503	155	2,036	(1,357)
Net Present Value (Discount Rate at 10 %)					643								398	-245
EIRR:														#NUM!
B/C														0.62

Source: JICA study team

As noted before, the total cost of the nine DPR is about Rs.16.530 million, 82% of it is total capital cost or 18 % is its O&M. Capital cost of STP is about 60% (its O&M is 40%) among those total SPT costs and the one of non-STP (sewage network) is about 97% (its O&M is 3%). EIRR of nine DPR is 11.19% composing of negative ones and higher ones (40.38%). The calculated EIRR of Dinapur & Bhagwanpur in Varanasi is rather high since lower investment amount while larger populations while it is vise-verse in Ramnagar and Chunar area.

Table 12.4.22 The evaluation summary of nine DPR

		Rs. million	Capital	O&M	Total		2020	2035	2050		
All nine DPR			Rs. 13,568	Rs. 2,963	Rs. 16,530					NPV	1,305
										EIRR	11.19%
										B/C	1.09
Varanasi	District 1	N/W 228.5km	Rs. 3,193	Rs. 95	Rs. 3,288	Population	479,983	558,728	654,826	NPV	474
						SW Connection	74.70%	100.00%	100.00%	EIRR	12.00%
						Avg. HH	8.37	8.37	8.37	B/C	1.20
Varanasi	District 2	N/W 275.4km	Rs. 4,784	Rs. 136	Rs. 4,920	Population	570,252	778,259	1,041,264	NPV	263
						SW Connection	74.70%	100.00%	100.00%	EIRR	10.71%
						Avg. HH	8.37	8.37	8.37	B/C	1.07
Varanasi	District 3: RAMANA	STP 50 MLD	Rs. 1,241	Rs. 326	Rs. 1,566	Population	182,613	286,273	379,646	NPV	37
						SW Connection	74.70%	100.00%	100.00%	EIRR	10.43%
						Avg. HH	8.37	8.37	8.37	B/C	1.03
Varanasi	District 3 Sewers	N/W 120.3km	Rs. 1,754	Rs. 50	Rs. 1,804	Population	182,613	286,273	379,646	NPV	41
						SW Connection	74.70%	100.00%	100.00%	EIRR	10.30%
						Avg. HH	8.37	8.37	8.37	B/C	1.03
Varanasi	Dinapur & Bhagwanpur	80MLD 9.8MLD	Rs. 771	Rs. 541	Rs. 1,311	Population	618,016	618,016	618,016	NPV	2,077
						SW Connection	74.70%	100.00%	100.00%	EIRR	40.38%
						Avg. HH	8.37	8.37	8.37	B/C	2.39
Mirzapur	Part 1: ID&T	18MLD, 2MLD N/W, PS	Rs. 885	Rs. 870	Rs. 1,755	Population	251,262	287,863	347,938	NPV	120
						SW Connection	19.61%	62.21%	100.00%	EIRR	12.57%
						Avg. HH	8.82	8.82	8.82	B/C	1.09
Mirzapur	Part 2: Alternative 1	Exisiting 14MLD 4MLD	Rs. 183	Rs. 185	Rs. 368	Population	103,704	103,704	103,704	NPV	259
						SW Connection	19.61%	62.21%	100.00%	EIRR	28.25%
						Avg. HH	8.82	8.82	8.82	B/C	1.94
Chunar	ID&T	6.5 MLD 43km ITC MPS, IPS	Rs. 330	Rs. 207	Rs. 537	Population	48,000	63,000	80,000	NPV	-154
						SW Connection	20.00%	63.44%	100.00%	EIRR	#NUM!
						Avg. HH	7.47	7.47	7.47	B/C	0.60
Ramnagar	ID&T	10 MLD (STP) 32 MLD (MPS) xx km	Rs. 428	Rs. 554	Rs. 981	Population	64,070	87,122	118,503	NPV	-245
						SW Connection	94.12%	195.66%	100.00%	EIRR	#NUM!
						Avg. HH	8.20	8.20	8.20	B/C	0.62

12.4.4 Sensitivity analysis

We performed two types of sensitivity analysis, first one is to analyze the impact on change in economic benefit and economic cost (Table 12.4.27), the other is to analyze extension of construction period, change in economic cost and benefit (Table 12.4.28).

If economic cost increases with 10%, EIRR will be less than 10%, on the other hand, if economic benefit decreases with 10%, EIRR will also fall below 10%.

Table 12.4.23 Sensitivity analysis of EIRR: Change in Economic Benefit and Economic Cost

		Change in Economic Benefit						
		-15%	-10%	-5%	0%	+5%	+10%	+15%
Change in Economic Cost	+15%	7.08%	7.86%	8.59%	9.28%	9.95%	10.58%	11.19%
	+10%	7.68%	8.46%	9.19%	9.89%	10.55%	11.19%	11.81%
	+5%	8.32%	9.09%	9.82%	10.52%	11.19%	11.84%	12.47%
	0%	8.98%	9.75%	10.49%	11.19%	11.87%	12.53%	13.16%
	-5%	9.67%	10.45%	11.19%	11.91%	12.60%	13.26%	13.91%
	-10%	10.41%	11.19%	11.95%	12.67%	13.37%	14.05%	14.71%
	-15%	11.19%	11.99%	12.76%	13.49%	14.21%	14.90%	15.58%

According to sensitivity analysis we performed, one year of extension of construction period will result in 0.9% of negative impact to EIRR (EIRR with no change in base economic cost and benefit is 10.29% while base EIRR is 11.19%).
In addition, under this condition, if economic cost increases with 5%, EIRR will be less than 10%, on the other hand, if economic benefit decreases with 5%, EIRR will also fall below 10%.

Table 12.4.24 Sensitivity analysis of EIRR: Change in Economic Cost, Benefit and One Year Extension of Construction Period

		Change in Economic Benefit						
		-15%	-10%	-5%	0%	+5%	+10%	+15%
Change in Economic Cost	+15%	6.49%	7.22%	7.90%	8.54%	9.15%	9.73%	10.29%
	+10%	7.05%	7.78%	8.46%	9.10%	9.70%	10.29%	10.84%
	+5%	7.64%	8.36%	9.04%	9.68%	10.29%	10.87%	11.43%
	0%	8.26%	8.97%	9.65%	10.29%	10.90%	11.49%	12.05%
	-5%	8.90%	9.61%	10.29%	10.93%	11.55%	12.14%	12.71%
	-10%	9.57%	10.29%	10.97%	11.62%	12.24%	12.84%	13.42%
	-15%	10.29%	11.00%	11.69%	12.35%	12.98%	13.59%	14.17%

12.4.5 Revised Estimation of Economic cost and Economics evaluation

As a result of technical part of our survey, JICA survey team completed the final estimation of construction cost as documented on **17.7.2 Construction costs**. Therefore, we updated our economic analysis on feasibility of this program, based on input from **Table 17.7.1 Total Project Cost**. From economic analysis standpoint, EIRR is determined as 8.3%, which is slightly lower than hurdle rate of 10%. And net economic present value of the program is -3,537 JPY under 10% discount rate. Thus, the program is also not economically feasible under updated final construction cost estimation.

Table 12.4.25 Updated program level economic feasibility analysis

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Capital and Operational Cost	**552**	**401**	**11,679**	**12,074**	**7,392**	**625**	**557**	**555**	**594**	**636**	**636**	**636**	**636**	**636**	**636**
Initial Investment	552	401	11,679	12,074	7,392	141	39								
Eligible portion	476	382	11,123	11,499	6,824	134	38								
Non-Eligible portion	76	19	556	575	568	7	2								
O&M Cost						**484**	**518**	**555**	**594**	**636**	**636**	**636**	**636**	**636**	**636**
Economic benefit						**3,302**	**3,393**	**3,487**	**3,584**	**3,685**	**3,789**	**3,896**	**4,003**	**4,088**	**4,170**
Net economic value	**-552**	**-401**	**-11,679**	**-12,074**	**-7,392**	**2,677**	**2,835**	**2,932**	**2,990**	**3,048**	**3,152**	**3,260**	**3,367**	**3,452**	**3,534**

EIRR 8.3% NPV -3,537 million JPY 10.0% at discount rate of

	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	Total
Capital and Operational Cost	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**47,796**
Initial Investment																
Eligible portion																
Non-Eligible portion																
O&M Cost	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**636**	**15,517**
Economic benefit	**4,239**	**4,310**	**4,387**	**4,460**	**4,535**	**4,612**	**4,690**	**4,771**	**4,853**	**4,921**	**4,986**	**4,998**	**5,059**	**5,121**	**5,182**	**108,520**
Net economic value	**3,603**	**3,673**	**3,751**	**3,824**	**3,899**	**3,975**	**4,054**	**4,134**	**4,216**	**4,284**	**4,350**	**4,361**	**4,423**	**4,484**	**4,546**	**60,724**

12.4.6 Revised sensitivity analysis

We revised abovementioned two sensitivity analysis, first one is to analyze the impact on change in economic benefit and economic cost, and the other is to analyze extension of construction period, change in economic cost and benefit.

To reach 10% of EIRR, 10% increase of economic benefit and 5% decrease of economic cost are required.

Table 12.4.26 Updated program level economic feasibility analysis (1)

		Change in Economic Benefit						
		-15%	-10%	-5%	0%	+5%	+10%	+15%
Change in Economic Cost	+15%	5.07%	5.66%	6.23%	6.77%	7.30%	7.81%	8.31%
	+10%	5.53%	6.12%	6.70%	7.25%	7.79%	8.31%	8.81%
	+5%	6.01%	6.62%	7.20%	7.76%	8.31%	8.83%	9.35%
	0%	6.53%	7.14%	7.73%	8.31%	8.86%	9.40%	9.92%
	-5%	7.08%	7.70%	8.31%	8.89%	9.45%	10.00%	10.53%
	-10%	7.67%	8.31%	8.92%	9.51%	10.09%	10.65%	11.20%
	-15%	8.31%	8.95%	9.58%	10.19%	10.78%	11.35%	11.91%

In addition, under the case that construction period delays one year, EIRR will fall to 7.81%. According to updated analysis of this case, to reach 10% of EIRR, 15% increase of economic benefit or 15% decrease of economic cost is required.

Table 12.4.27 Updated program level economic feasibility analysis (2)

		Change in Economic Benefit						
		-15%	-10%	-5%	0%	+5%	+10%	+15%
Change in Eco-nomic Cost	+15%	4.79%	5.35%	5.89%	6.40%	6.89%	7.36%	7.81%
	+10%	5.23%	5.79%	6.33%	6.84%	7.34%	7.81%	8.27%
	+5%	5.69%	6.25%	6.80%	7.31%	7.81%	8.29%	8.76%
	0%	6.17%	6.74%	7.29%	7.81%	8.32%	8.80%	9.27%
	-5%	6.68%	7.26%	7.81%	8.34%	8.85%	9.34%	9.82%
	-10%	7.23%	7.81%	8.37%	8.91%	9.42%	9.92%	10.41%
	-15%	7.81%	8.40%	8.97%	9.51%	10.04%	10.55%	11.04%

12.4.7 Financial Evaluation of the project

The financial Capital cost of all is Rs. 15,285.5 million. The construction is from 2017 to 2019, supposed to take three years.

Table 12.4.28 Financial Capital Cost

	Rs.million	2017	2018	2019
	15,316.1	4,992.0	7,384.7	2,939.4
1) Varanasi District 1	3,613.1	1,092.0	1,800.8	720.3
2) Varanasi District 2	5,415.1	1,632.6	2,701.8	1,080.7
3) Varanasi Ramana STP	1,395.2	708.3	490.6	196.3
4) Varanasi District 3 (A) Sewer (District 3 Comprehensive)	1,980.1	605.6	981.8	392.7
5) Dinapur & Bhagwanpur Rehabilitation&Upgrade of STPs	871.4	268.5	430.7	172.3
6) Mirzapur Part1 ID&T	993.5	329.1	474.6	189.8
7) Mirzapur Part2 Alternative 1	205.6	66.7	99.2	39.7
8) Chunar ID&T	371.4	81.6	217.4	72.5
9) Ramnagar ID&T	470.8	207.7	187.9	75.2

Financial O&M cost is Rs. 34,392.4 million after the construction or will star from 2020 until 2050.

Table 12.4.29 Financial O&M Cost

	Rs. Million	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	34,392.4				326.8	349.9	374.7	401.2	429.6	460.1	492.8	527.9	565.5	605.8	…
1) Varanasi District 1	1,995.0				16.2	17.5	18.9	20.4	22.0	23.8	25.7	27.7	29.9	32.3	…
2) Varanasi District 2	2,859.8				23.2	25.0	27.0	29.2	31.5	34.1	36.8	39.7	42.9	46.3	…
3) Varanasi Ramana STP	4,897.2				57.7	61.2	64.9	68.8	72.9	77.3	81.9	86.8	92.0	97.6	…
4) Varanasi District 3	1,049.7				8.5	9.2	9.9	10.7	11.6	12.5	13.5	14.6	15.8	17.0	…
5) Dinapur & Bhagwanpur	8,131.6				95.9	101.6	107.7	114.2	121.1	128.3	136.0	144.2	152.8	162.0	…
6) Mirzapur Part1 ID&T	7,410.8				60.1	64.9	70.1	75.7	81.7	88.3	95.3	103.0	111.2	120.1	…
7) Mirzapur Part2 Alternative 1	1,573.3				12.8	13.8	14.9	16.1	17.4	18.7	20.2	21.9	23.6	25.5	…
8) Chunar ID&T	1,760.3				14.3	15.4	16.6	18.0	19.4	21.0	22.6	24.5	26.4	28.5	…
9) Ramnagar ID&T	4,714.8				38.2	41.3	44.6	48.2	52.0	56.2	60.7	65.5	70.8	76.4	…
10) Ghazipur ID&T					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: JICA Study team

Financial Benefit (Revenue) Due to Charge Collection for Sewerage Treatment Services is Rs. 397.

Table 12.4.30 Actual Amount of Payment in Average for Existing Sewerage Treatment Services

(Unit: Rs./Annum per HH)

	Varanasi	**Mirzapur**	**Ghazipur**	**Ramnagar**	**Chunar**	Saidpur	Total
Income Level/month	292,088	265,176	249,882	237,176	197,882		248,441
Actual Amount of Payment in Average for Existing Sewerage Treatment Services	1,222	229	275	127	135		**397**
Share rate to the Income/HH:	0.42%	0.09%	0.11%	0.05%	0.07%		0.16%

Financial IRR is not obtained since the NPV in itself is negative in this project. However, in this type of the project for development and improvement of public utility or social infrastructure so called as "public works", it may not be adequate to analyze cost recovering ability by financial benefit (revenue from collection of user charge). The required cost for sewerage services is much more than that for water supply services. Nevertheless, the charge for sewerage services is usually lower than that for water supply. Thus, generally sewerage projects cannot recover all O&M costs as well as initial capital outlay.

Table 12.4.31 Financial Evaluation of the project

(Unit: Rs. Million)

Year in Order	Fiscal Year	Financial Cost				Financial Benefit (Revenue) Due to Charge Collection for Sewerage Treatment Services		Cash Balance
		Construction Cost	OM cost	Re-place-ment cost	Total	Connected HHs	Basic unit: **397**	
0	2016							
1	2017	4,992			4,992			-4,992
2	2018	7,385			7,385			-7,385
3	2019	2,939			2,939			-2,939
4	2020	0	327		327	201,227	60	-267
5	2021		350		350	211,315	63	-287
6	2022		375		375	221,885	66	-309
7	2023		401		401	232,963	69	-332
8	2024		430		430	244,574	73	-357
9	2025		460		460	256,746	77	-384
10	2026		493		493	269,508	80	-412
11	2027		528		528	282,891	84	-444
12	2028		565		565	296,927	88	-477
13	2029		606		606	311,652	93	-513
14	2030		649		649	326,001	97	-552
15	2031		695		695	333,666	99	-596
16	2032		745		745	341,652	102	-643
17	2033		799		799	349,986	104	-694
18	2034		856		856	358,697	107	-749
19	2035		918		918	368,580	110	-808
20	2036		984		984	378,653	113	-871
21	2037		1,055		1,055	389,229	116	-939
22	2038		1,131		1,131	400,350	119	-1,011
23	2039		1,212		1,212	412,063	123	-1,090
24	2040		1,300		1,300	424,418	126	-1,174
25	2041		1,394		1,394	437,259	130	-1,264
26	2042		1,495		1,495	445,363	133	-1,363
27	2043		1,604		1,604	453,026	135	-1,469
28	2044		1,720		1,720	434,855	130	-1,591
29	2045		1,846		1,846	440,410	131	-1,714
30	2046		1,980		1,980	445,985	133	-1,847
31	2047		2,124		2,124	451,578	135	-1,990
32	2048		2,280		2,280	457,192	136	-2,143
33	2049		2,446		2,446	462,825	138	-2,308
34	2050		2,625		2,625	468,717	140	-2,486
Total		15,316	34,392	0	49,709		3,311	-46,397
NPV (Discount Rate at 10 %)					17,643		827	-17,021
EIRR:								#NUM!
B/C								0.05

12.4.8 Revised Financial Evaluation of the project

We updated our financial evaluation on feasibility of this program, based on input from **Table 17.7.1 Total Project Cost** as a result of technical part of our survey. From financial evaluation standpoint, FIRR cannot be determined because both total cash flow and net present value of the program less than zero, and thus, the program is not financially feasible under updated project cost estimation.

Table 12.4.32 Revised Financial Evaluation of the project

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Capital and Operational Cost	**669**	**444**	**13,450**	**13,941**	**8,581**	**935**	**868**	**878**	**843**	**903**	**903**	**903**	**903**	**903**	**903**
Initial Investment	669	444	13,450	13,941	8,581	249	134	91							
Eligible portion	500	402	11,685	12,080	7,169	141	39	0							
Non-Eligible portion	104	42	1,731	1,792	1,321	17	3	0							
Interest during construction	0	1	35	70	91	91	91	91							
Front end fee	64	0	0	0	0	0	0	0							
O&M Cost						**686**	**735**	**787**	**843**	**903**	**903**	**903**	**903**	**903**	**903**
Operational Revenue						**119**	**125**	**131**	**137**	**144**	**151**	**159**	**166**	**170**	**174**
Net Cash Flow	**-669**	**-444**	**-13,450**	**-13,941**	**-8,581**	**-816**	**-744**	**-747**	**-705**	**-758**	**-751**	**-744**	**-736**	**-733**	**-729**

FIRR - NPV -30,067 million JPY 10.0% at discount rate of

	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	Total
Capital and Operational Cost	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**59,564**
Initial Investment																37,559
Eligible portion																32,016
Non-Eligible portion																5,010
Interest during construction																470
Front end fee																64
O&M Cost	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**903**	**22,005**
Operational Revenue	**178**	**183**	**188**	**193**	**198**	**204**	**210**	**216**	**223**	**227**	**231**	**222**	**224**	**227**	**230**	**4,631**
Net Cash Flow	**-724**	**-720**	**-715**	**-710**	**-704**	**-699**	**-693**	**-686**	**-680**	**-676**	**-672**	**-681**	**-678**	**-675**	**-672**	**-54,933**

12.4.9 Revenue Increase Measures

To make the project feasible, revenue increase is required to reduce the burden on the Local and State Government finances to O&M cost of the project. Following measures are proposed here to increase the revenue and thus make the operating agency partially self-sustainable.

1) Improvement of billing and bill collections
2) Sale of treated water or utilize the by-products of sewerage system
3) Others such as improvement of accounting system

The basic approach to increase revenue is 1) in the above, and to cover the O&M cost in this project through the billing by citizen, the target billing per year in this project is Rs. 2,550 which is about 6.42 times of the current level (Rs. 397) in all those districts.

Table 12.4.33 Suitable Charge to cover the O&M cost of the project

	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar	Saidpur	Total
Income Level/month	292,088	265,176	249,882	237,176	197,882		248,441
Actual Amount of Payment in Average for Existing Sewerage Treatment Services	1,222	229	275	127	135		**397**
Suitable Charge Level for Sewerage Treatment Services to Be Needed to Balance Necessary Cost for OM/R Cost	7,840	1,468	1,764	815	864	0	**2,550**
Share rate to the Income/HH:	0.42%	0.09%	0.11%	0.05%	0.07%		0.16%

12.5 Economic Analysis

It follows that Economic analysis for Whole India, Uttar Pradesh State and the Districts that are offering DPR for this GANGA Rejuvenation Project in the State of Uttar Pradesh.

12.5.1 Uttar Pradesh State

India has GDP of $2.07 trillion in 2014 (data from World Bank) and the GDP of UP State is the 3rd biggest among India's states, or Cr. 976,297 Rs. in 2014 (the same)

1) Historical Trend of GDP

The economic condition in India and Uttar Pradesh State is examined in this chapter to determine the external conditions of the project. The historical trend of GDP increase rate during 2004-2015 periods is summarized in Table 2.2.1. The GDP of entire India at current prices as of 2015 is Rs125,412 trillion, while that of Uttar Pradesh state is Rs9,763 trillion, which corresponds to 7.8% of that of the entire country. The average increase rate of GDP at current for the last ten years is 14.1% at the national level and 15.5% at the state level, which shows the recent robust economic strength.

Table 12.5.1 Historical Trend of GDP Increase Rate during 2004-2015 Periods

Rs. Trillion	2004-05	2009-10	2014-15	Average increase rate 2004 to 2015
Whole India	29,715	61,089	125,412	15.5%
Uttar Pradesh State	2,608	5,233	9,763	14.1%
Share of Uttar Pradesh State	8.8%	8.6%	7.8%	—

Source: Ministry of Statistics and Program Implementation, on 20 Aug 2015

The sector-wise GDP amount is shown in the following table. The share of the services sector is 56% followed by the industry sector (21%) and manufacturing sector (12%) which is included to industry sector. In the comparison of sector-wise data for the entire country and for Uttar Pradesh State, sectors of Agriculture and Allied (+8%) has comparatively higher share in Uttar Pradesh State. ("Manufacturing" is included in "Industry" in the table)

Table 12.5.2 Historical Trend of Sector-wise GDP

Sector	Entire India		Uttar Pradesh	
	Share in 2013-14	Average Increase Rate, 2004-05 to 2013-14	Share in 2013-14	Average Increase Rate, 2004-05 to 2013-14
Agriculture and Allied	13.9%	3.9%	22.0%	3.2%
Industry	26.1%	6.8%	21.5%	5.8%
Manufacturing	*14.9%*	*7.3%*	*12.0%*	*5.4%*
Services	59.9%	9.1%	56.5%	8.9%
Total	100.0%		100.0%	

Source: Planning Commission of the Government of India, 2014

2) Poverty Condition

The Poverty line and Gini coefficient are summarized in below Tables.

Lorenz Ratio Estimated from MPCE (Monthly per Capita Expenditure) based on MRP (mixed recall period) shows that Lorenz Ratio increased by 1.4 % (or point) for rural area and 1.9 % for urban area in Whole India. In Uttar Pradesh, it is also increased by 1.4% in rural area and 6.6% for urban area from the year 2004-05 to 2011-12. So it shows the significant improvement of live-lihood in the Uttar Pradesh in Urban area. Regarding the Gini coefficient figure, in whole India, rural area decreased 0.6% (point) while urban has increased by 3.1%. In UP state, rural area in-creased 16% (point) while urban has decreased by 0.2%.

Table 12.5.3 Lorenz Ratio Estimated from MPCE

	2004-05		2009-10 (MRP)		2011-12 (MRP)	
	Rural	Urban	Rural	Urban	Rural	Urban
India	0.266	0.348	0.276	0.371	0.280	0.367
Uttar Pradesh	0.234	0.339	0.231	0.395	0.248	0.405

Source: Planning Commission of the Government of India, 2014

Table 12.5.4 Trend of Gini Coefficient

	1993-94		2004-05 (MRP)		2009-10 (MRP)	
	Rural	Urban	Rural	Urban	Rural	Urban
India	0.282	0.34	0.266	0.348	0.276	0.371
Uttar Pradesh	0.278	0.323	0.234	0.339	0.438	0.321

Source: Planning Commission of the Government of India, 2014

12.5.2 Each district

India has GDP of $2.07 trillion in 2014 (data from World Bank) and the GDP of UP State is the 3rd biggest among India's states, or Cr. 976,297 Rs. in 2014 (the same)

1) Uttar Pradesh

Uttar Pradesh is the most populous state in India with a population of almost 200 million, which is 16.5% of total Indian population (2011 census). Most of the state lies in the fertile Indo-Gangetic Plain, with its high natural soil fertility, abundant rainfall, and rich surface and groundwater resources. Despite this endowment, the state however is often characterized as a 'lagging state' with low per-capita income. State growth rates also lag national figures. During the 1990s economic growth faltered and Uttar Pradesh fell behind India's better performing states. Power shortages, low rates of capital formation and low productivity of existing irrigation systems and road networks, were some of the main causes of economic stagnation in the state. Currently, percent of population below poverty line is about 33% to 41% which belongs to the one of the worst states in India (Planning Commission of the Government of India 2014).

Uttar Pradesh also lags behind most Indian states across a number of human development indicators (e.g. literacy, infant mortality). Literacy rate is 67.7% and female literacy rate is 57.2%, which is quite low compared to male literacy rate (77.3%).

Table 12.5.5 Summary of Statistics in Uttar Pradesh State

Uttar Pradesh	2001	2011	Change %
Actual Population	166,197,921	199,812,341	20.2
Male	87,565,369	104,480,510	19.3
Female	78,632,552	95,331,831	21.2
Percentage of total Population	16.20%	16.50%	1.9
Female Sex Ratio (/1000)	898	912	1.6
Child Sex Ratio	916	902	-1.5
Density/km2	690	829	20.1
Area(Km2)	240,928	240,928	
Total Child Population (0-6 Age)	31,624,628	30,791,331	-2.6
Male Population (0-6 Age)	16,509,033	16,185,581	-2.0
Female Population (0-6 Age)	15,115,595	14,605,750	-3.4
Total Literate	75,719,284	114,397,555	51.1
Male Literate	48,901,413	68,234,964	39.5
Female Literate	26,817,871	46,162,591	72.1
Literacy	56.30%	67.70%	20.2
Male Literacy	68.80%	77.30%	12.4
Female Literacy	42.20%	57.20%	35.5

Source: Census of India 2011

2) Varanasi

Varanasi has Varanasi Municipal Corporation (VMC) and other many awards where Ramnagar, one of the DPRs, is included. The area is composed of Rural and Urban, and VMC is part of Urban. The total population in whole Varanasi in 2011 was about 3.7 million and the household was 560,162. Its population increase is almost the same of Uttar Pradesh's. The Density/Km2 of Varanasi is pretty higher than that of Uttar Pradesh.

Table 12.5.6 Summary of Varanasi

Varanasi	2001	2011	Change %
Actual Population	3,138,671.00	3,676,841	17.15
Rural		2,079,790	
Urban		1,597,051	
Male	1,649,187.00	1,921,857	16.53
Female	1,489,484.00	1,754,984	17.82
Percentage of Total Population			
Number of Households		560,162	
Female Sex Ratio (/1000)	903.00	913.00	
Child Sex Ratio	919.00	885.00	
Density/Km2	-	2,395.00	
Area/Km2	1,535.00	1,535.00	
Total Child Population (0-6 Age)	-	497,151.00	-
Male Population (0-6 Age)	-	263,762.00	-
Female Population (0-6 Age)	-	233,389.00	-
Total Literate	1,694,405.00	2,403,903.00	41.87
Male Literate	1,050,613.00	1,389,116.00	32.22
Female Literate	643,792.00	1,014,787.00	57.63
Literacy	66.12	75.60	9.48
Male Literacy	77.87	83.78	5.91
Female Literacy	53.05	66.69	13.64

3) Varanasi Municipal Corporation (VMC) and Ramnagar

VMC has five Zones and 90 awards while Ramnagar has 25 awards, and both are belong to Urban. Ramnagar is a town in India and is administered by the Ramnagar Municipal Board. It is located in the Varanasi district.

Table 12.5.7 Summary of VMC and Ramnagar

Data related to VMC	2011
Actual Population	1,198,491
Male	635,140
Female	536,351
Number of Households	190,835
Total Child Population (0-6 Age)	135,677
Male Population (0-6 Age)	72,442
Female Population (0-6 Age)	63,235
Total Literate	842,497
Male Literate	469,563
Female Literate	372,844
Literacy	70.30
Male Literacy	73.93
Female Literacy	69.51

Data related to Ramnagar NPP	2011
Actual Population	49,132
Male	26,071
Female	23,061
Number of Households	7,729
Total Child Population (0-6 Age)	6,090
Male Population (0-6 Age)	3,206
Female Population (0-6 Age)	2,884
Total Literate	34,400
Male Literate	19,484
Female Literate	14,916
Literacy	70.02
Male Literacy	74.73
Female Literacy	64.68

4) Mirzapur

Mirzapur is a city in Uttar Pradesh, India, roughly 650 km from both Delhi and Kolkata, almost 89 km from Allahabad and 57 km from Varanasi.

The basic data is in Table 13.5.4 aside from some important data in the below. (Those are from Nagar Palika Parishad Mirzapur, interviewed by JIA Study team)

- Total Length of Roads-294.69 km
- Households having Toilets-21,625
- Total Length of Sewerage Lines-14.87 Km
- Required Length of Sewers- 240 Km
- Sewer Suction Machines – 2 Nos.
- STP (2 nos.)- 18 MLD
- Water available for Irrigation purposes after treatment – 30 %
- Matters related to Sewer entrusted to – GPPU, UPJN
- Total number of Sewer Connections - 4,050
- Number of Households having no toilets-16,825

Table 12.5.8 Summary of Mirzapur

Mirzapur	2001	2011	Change %
Actual Population	2,116,042.00	2,496,970	18.00
Rural		2,149,403	
Urban		347,567	
Male	1,115,249.00	1,312,302	17.67
Female	1,000,793.00	1,184,668	18.37
Number of Households		38,185	
Female Sex Ratio (/1000)	897.00	903.00	
Child Sex Ratio	929.00	902.00	
Density/Km2	-	567.00	
Area/Km2	4,405.00	4,405.00	
Total Child Population (0-6 Age)	-	410,621.00	
Male Population (0-6 Age)	-	215,841.00	
Female Population (0-6 Age)	-	194,780.00	
Total Literate	935,101.00	1,428,683.00	52.78
Male Literate	622,631.00	865,837.00	39.06
Female Literate	312,470.00	562,846.00	80.13
Literacy	55.31	68.48	13.17
Male Literacy	69.59	78.97	9.38
Female Literacy	39.26	56.86	17.60

5) Mirzapur Vindhyachal (NPP) and Chunar

Mirzapur Nagar Palika Parishad and Chunar Palika Parishad are part of Mirzapur district. The size of population or household of Mirzapur NPP is about 10% of Mirzapur district.

Table 12.5.9 Summary of Mirzapur (urban) and Chunar

Mirzapur Nagar Palika Parishad	2011
Actual Population	234,871
Male	125,601
Female	109,270
Number of Households	38,185
Total Child Population (0-6 Age)	30,340
Male Population (0-6 Age)	16,151
Female Population (0-6 Age)	14,189
Total Literate	156,408
Male Literate	89,938
Female Literate	66,470
Literacy	66.59
Male Literacy	71.61
Female Literacy	60.83

Chunar Nagar Palika Parishad	2011
Actual Population	37,185
Male	19,647
Female	17,538
Number of Households	5,951
Total Child Population (0-6 Age)	4926
Male Population (0-6 Age)	2519
Female Population (0-6 Age)	2407
Total Literate	24674
Male Literate	14442
Female Literate	10232
Literacy	66.35
Male Literacy	73.51
Female Literacy	58.34

6) Ghazipur

Ghazipur city is governed by Municipal Corporation which comes under Ghazipur Metropolitan Region. The Ghazipur city is located in Uttar Pradesh state of India.

Table 12.5.10 Summary of Ghazipur (1)

Ghazipur	2001	2011	Change %
Actual Population	3,037,582.00	3,620,268	19.18
Rural		3,345,908	
Urban		274,360	
Male	1,537,141.00	1,855,075	20.68
Female	1,500,441.00	1,765,193	17.64
Number of Households		546,664	
Female Sex Ratio (/1000)	976.00	952	
Child Sex Ratio	934.00	908	
Density/Km2	-	1,072	
Area/Km2	3,377.00	3,377	
Total Child Population (0-6 Age)	-	558,559	-
Male Population (0-6 Age)	-	292,774	-
Female Population (0-6 Age)	-	265,785	-
Total Literate	1,444,871.00	2,197,549	52.09
Male Literate	914,230.00	1,293,553	41.49
Female Literate	530,641.00	903,996	70.36
Literacy	59.55	71.78	12.23
Male Literacy	74.87	82.80	7.93
Female Literacy	44.03	60.29	16.26

7) Ghazipur Nagar Palika Parishad

Ghazipur Nagar Palika Parishad is a part of Ghazipur district.

Table 12.5.11 Summary of Ghazipur (2)

Ghazipur Nagar Palika Parishad	2011
Actual Population	121,020
Male	63,513
Female	57,507
Number of Households	19,556
Total Child Population (0-6 Age)	15,139
Male Population (0-6 Age)	8,096
Female Population (0-6 Age)	7,043
Total Literate	88,656
Male Literate	49,359
Female Literate	39,297
Literacy	73.26
Male Literacy	77.71
Female Literacy	68.33

12.6 Case studies on PPP and SPV for HAM (Hybrid Annuity Model) discussion

JICA study team collected information of SPV (Special Purpose Vehicle) PPP in India and analyzed them.

12.6.1 Summary of Case Studies

1) Summary

Table 12.6.1 The reviewed Cases by JICA Study team

Case studies			Project name
No	Sector		
1	Water Supply	WTP	Nagpur WTP Rehabilitation
2	Water Supply	WTP	Mysore Water 24x7
3	Water Supply and Sewerage	WTP and STP	Salt Lake Sector V, Kolkata
4	Water Supply	WTP	Haldia Water Supply
5	Water Supply	WTP	Latur Water Supply
6	Water Supply	WTP	Karnataka Urban Water Supply Improvement
7	Water Supply	WTP	Khandwa Water Supply
8	Water Supply	WTP	Aurangabad Water Supply
9	Sewerage	WTP	Alandur

10	Sewerage	STP	Kolhapur
11	Solid Water Management	Others	Timarpur Okhla Integrated Municipal Solid Waste Management Project
12	Road	Toll Road	Vadodara Halol Toll Road, Gujarat
13	Road	Toll Road	Tuni Anakapalli Annuity Road Project
14	Road	Toll Road	Delhi Gurgaon Expressway
15	Road	Toll Road	Mahua Jaipur BOT Project, NHAI
16	Port	Port	Nhava Sheva International Container Terminal
17	Port	Port	Gangavaram Port
18	Port	Port	Kakinada Deep Water Port
19	Transportation	Subway	Mumbai Metro
20	Transportation	Subway	Hyderabad Metro
21	Transportation	Bus	Amritsar Intercity Bus Terminal
22	Electricity	Plant	Bhiwandi Electricity Distribution

2) Summary Comment

Point 1: Counter measure for future increase of O&M cost

Re-basement of future O&M cost is one of important point for sustainability of SPV and relating financial structure. How should we estimate long term projection of O&M cost, how to deal with future increase of O&M cost and how to share or how to reflect the annuity payment, which is the one of the key for success. In addition, if the user charge or revenue earned from the business which SPV is conceded to operate is linked to SPV's financial revenue, collectivity and affordability of user charge is vital for SPV structure's financial sustainability. In other words, coverage toll or user charge (tariff) collected against O&M cost, how we should manage this coverage, is very important.

Point 2: Lower cost of capital, interest rate

Another key point for successful PPP initiative is cost of capital including interest rate when SPV raise the fund to afford project cost. Every successful project is at least partially supported by lowered or zero rate cost of capital, such as low rate loan from parent company sponsor, or water connection deposit collected from users – general public.

It is recommended that SPV and HAM should be structured considering the most preferable capital structure that enables lowest cost of capital for SPV. Given that GOI is not going to provide sovereign guarantee for SPV's loan, it is really important for SPV to set best interest rate that SPV can afford and also attract lender to provide a loan to SPV, even if the principal and interest of the loan should be covered by upfront capital funding and later annuity payment by GOI.

Point 3: Reduction of Administrative cost for SPV

The more administrative cost increases in SPV, the less financially stable SPV achieve.

12.6.2 Case - Naba Diganta Industrial Township Authority

1) Background

Nabadiganta at Salt Lake Sector – V, the IT hub of Kolkata, has seen major developments over the last decade in sync with the IT boom happening across India. However, it had no organized water supply and sewerage system. In 2006, a water supply and sewerage project was conceived by Urban Development Department of Government of West Bengal, Kolkata Metropolitan Development Authority (KMDA) & Nabadiganta Industrial Township Authority (NDITA) to create infrastructures and provide services on BOT basis in PPP (Public Private Partnership) Model. KMDA and NDITA selected a private developer on a competitive basis. The private developer formed a SPV – the Naba Diganta Water Management Limited (NBWML). The SPV was required to undertake part-financing; design the specified components of the water supply and sewerage system; plan; undertake its construction; and operate and manage the system including the purchase of water, generation of bills and collection for the concession period. The influencing factors necessitating need for the project were I) Indiscriminate abstraction of ground water in Nabadiganta Area causing depletion of natural ground water resources, ii) Use of unhygienic arsenic contaminated ground water drawn from bore-wells and iii) Disposal of untreated sewage polluting environment. This project received approval of Jawaharlal Nehru National Urban Renewal Mission (JNNURM) of Government of India for its clear objectives to provide environmental sustainability and deliver hygienic water to Lakhs of employees working with IT industry. A Consortium Agreement was entered into by the participating private partners, JUSCO and VOLTAS. Under the guidance of the Operations Committee, JUSCO and VOLTAS designed and constructed their respective areas on EPC basis. Land pieces were provided by the State Government free of cost. Construction works started in April, 2008 and were completed in about 2½ years. This was a PPP project in Urban Infrastructure Sector in the state of West Bengal and India. NBWML sources clarified water from Kolkata Municipal Corporation (KMC) through NDITA, distributes clear water to its customers through water distribution network, collects sewage water through its sewer network and treats sewage at Sewage Treatment Plant before disposal. Billing for the services and collection of payments are also carried out directly by NBWML. The terms and conditions of services and payments between NBWML and its Customers are governed by User Agreements. Initially, JUSCO and VOLTAS were given contracts to operate and maintain their respective areas. In a recent move to bring synergy in operations and exercise better control, NBWML took over entire O&M of the plants and became independent. Post completion of the construction works, the SPV was to undertake the operation and maintenance of the water supply system for a concession period of 30 years.

Table 12.6.2 Current infrastructure of Naba Diganta Water Management Limited (NBWML)

Water System
Underground Water Reservoir (1 Million Gallon) – 1 Unit Clear Water Pump House – 1 Unit Rising Water Main – 3.5 KM Elevated Service Water Reservoir (0.5 Million Gallon) – 1 Unit Water Distribution Mains – 20 KM Electrical Substation – 1 Unit
Sewerage System
Sewer Trunk Mains & Laterals – 18 KM Manholes – 700 Units Intermediate Pumping Station – 1 Unit Sewage Treatment Plant (2 Million Gallons per Day) – 1 Unit Electrical Substations – 2 Units

2) PPP Structure

The PPP contract for the project is a Concession Agreement for the development of the project on a BOT basis. The contract involves the following parties, viz., KMDA, NDITA and the consortium of private developers. As per the Concession Agreement, the private developer is required to undertake the development, design, engineering, financing, procurement, construction, completion, commissioning, implementation, management, administration, operation and maintenance of the Water Supply Network, Sewerage Network and the Sewage Treatment Plant (STP) at the site, viz., Sector V. Against the capital investment made, the private developer is permitted to charge the consumers a water supply-cum-sewerage tariff. The Concession Agreement requires the private developer to operate and manage the water supply and sewerage system for a time period of 30 years. As part of the pre-implementation activities, the private developer was required to prepare a Detailed Project Report for the project to be implemented. The detailed design of the capital works to be undertaken was to be provided by the private developer and, subject to approval from KMDA and NDITA; the works were to be implemented by the private developer. The grant under the JNNURM scheme is subject to approval of the DPR by the Ministry of Urban Development (MoUD). The tariff to be levied and the structure of the same will be determined by the private developer in consultation with KMDA, NDITA and the concerned stakeholders which include the representatives of the IT offices located in Sector V. Post completion of the construction phase, the private developer is required to purchase the treated water from NDITA and supply water to all the connected units and collect sewage; the sewage then has to be disposed of following treatment. Further, the generation of bills and its collection is to be managed by the private developer. The private developer will retain the user charges so collected from the consumers. For undertaking the construction works, and for setting up the STP, the private developer will be provided the required land area free of cost. Additionally, the private developer is also not required to make any type of licensee fee payment or annuity payment to the KMDA or NDITA during the period of the contract. At the end of the tenure of the contract, the water supply and sewerage network has to be handed back to NDITA for future operations and maintenance.

3) Project Cost

The project cost was Rs.70.08 Crores in the end and it is said that Equity IRR is 16.4%, Average DSCR is 1.9, Minimum DSCR is 0.9, Debt Equity Ratio is 60.40 and NPV is Rs.1.4 Crore.

Table 12.6.3 Finance

Rs. million	The total project cost			Funnding Arrangement			
	Original Plan		Revise Plan	JNNURM	KMDA	NDITA	NBWML
Water Supply	Rs. 260.60		Rs. 260.60				
		Increase	*Rs. 78.70*	*35.0%*		*32.5%*	*32.5%*
sub total	Rs. 260.60	sub total	Rs. 339.30				
Sewage	Rs. 361.50		Rs. 361.50				
	Rs. 622.10		**Rs. 700.80**	35.0%			65.0%

Source: Information from PPP-Compendium of Case Studies Dec 2010

The construction works for the project commenced by May 2008. The construction activity was to be completed within a time period of 18 months. However, the period of construction activity has extended by another 6 months and is expected to complete by only August 2010. This extension has been due to the delay in handover of the required land area to the JUSCO-Voltas consortium for commencement of the construction works.

4) Project Capital

The equity is Rs. 184 million among Total Balance sheet, Rs.480 million at March 2015. The parent companies, JUSCO and VOLSAS are both of TATA Group.

Table 12.6.4 The Capital of NBWML

Par Value	10.0 Rs.		
Number of authorised shares	18,500,000 Shares		
Number of issued shares	18,450,000 Shares		
Value of paid-up shares	184,500,000 Rs.		
Share of JUSCO	13,653,000 Shares	74.00%	136,530,000 Rs.
Share of VOLTAS	4,797,000 Shares	26.00%	47,970,000 Rs.

Source: Financial Statement of NBMLS

5) Income Statement

It is said that the developer's initial estimate of tariff of Rs. 48/KL was reduced to Rs. 25/KL as the applicable water supply cum sewerage tariff. Of the Rs. 25/KL tariff, Rs. 15/KL was towards the provision of the water supply services and Rs. 10/KL for the sewerage services. And the water supply-cum-sewerage tariff has been estimated to be Rs. 25/KL. This tariff schedule is subject to a 10% increase every five years, so the latest tariff is Rs. 31.2 of FY2015 and the Rs. 33.9 of this year (FY2016). The revenue has been increasing and has turned profitable since FY2013.

Table 12.6.5 Income Statement of NBWML

	FY 2007 Mar-08	FY 2008 Mar-09	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	CAGR	
Revenue from operations				13.96	15.58	40.38	62.83	72.52	51%	22.5
Revenue from Construction Activities								6.00		0.0
Other Income				0.12	0.63	0.82	1.47	1.43	84%	0.7
Total Revenue				**14.09**	**16.21**	**41.19**	**64.30**	**79.95**	54%	23.1
Purchase of Water					2.11	5.18	8.15	8.94	62%	3.0
Purchase of Materials					0.00	0.00	0.00	2.75		0.0
Changes in stock of stock-in-trade					-0.03	0.00	-0.01	-1.76		-0.0
Operation and Maintenance Expenses				4.04	5.88	6.43	12.54	11.70	30%	6.1
Employee benefit expense			0.69	2.80	3.76	3.94	6.30	11.46	76%	2.4
Finance costs				6.36	22.53	17.55	10.18	5.63	-3%	-7.4
Depreciation and amortisation	0.38			5.04	18.54	15.89	21.26	21.32		5.4
Less: Tramsfer from capital reserve for capex							-7.23	-6.27		-7.2
Other Expense	0.06	1.41	0.65	3.35	17.67	19.68	11.98	11.84	115%	-7.7
Total Expense	**0.43**	**1.41**	**1.34**	**21.60**	**70.47**	**68.68**	**63.17**	**65.62**	105%	-5.5
Profit	**-0.43**	**-1.41**	**-1.34**	**-7.51**	**-54.27**	**-27.48**	**1.13**	**14.34**		28.6

Source: NBWML financial report 2008-2014

NBML buys the water from KMC by Rs.5 per KL (kilo litters). As "Purchase of Water" in FY2014 is Rs.8.94 million (Rs. 8,941,232) for example, its usage may be 1,788,246 KL so the Water supply revenue is Rs.32 million and Sewage revenue is Rs.21 million based on the tariff of the year (assuming Rs.29.85) while Revenue from operation is Rs.72.5 million. Some of this deference may come from authorized charge a one-time connection fee of Rs.10/- per sq. ft. of the built up area by NBWML

Table 12.6.6 Revenue simulation of Water/Sewage

		105%	*105%*	*105%*	*105%*	*105%*	
	Rs. 25.00	*Rs. 26.13*	*Rs. 27.32*	*Rs. 28.55*	*Rs. 29.85*	***Rs. 31.20***	***Rs. 33.90***
FY2009	**FY2010**	**FY2011**	**FY2012**	**FY2013**	**FY2014**	**FY2015**	**FY2016**
	Rs. 25.00						
WS	*Rs. 15.00*	***Rs. 6,619,049***	***Rs. 16,975,830***	***Rs. 27,912,901***	***Rs. 32,025,085***		
SW	*Rs. 10.00*	***Rs. 4,412,700***	***Rs. 11,317,220***	***Rs. 18,608,600***	***Rs. 21,350,056***		
		Rs. 11,031,749	***Rs. 28,293,051***	***Rs. 46,521,501***	***Rs. 53,375,141***		
WS	60.0%	*Rs. 15.68*	*Rs. 16.39*	*Rs. 17.13*	*Rs. 17.91*		
SW	40.0%	*Rs. 10.45*	*Rs. 10.93*	*Rs. 11.42*	*Rs. 11.94*		
	Water Usage	Rs. 5.0	Rs. 5.0	Rs. 5.0	Rs. 5.0	/KL	
	Its Volume	422,145	1,035,748	1,629,240	1,788,246	KL	

Source: Calculation by JICA Study team from NBWML financial reports

Regarding the expenses from 2008 to 2014, a major cost is depreciation and finance cost following O&M cost and labor cost. (In EPC model, usually labor cost and labor cost is the major)

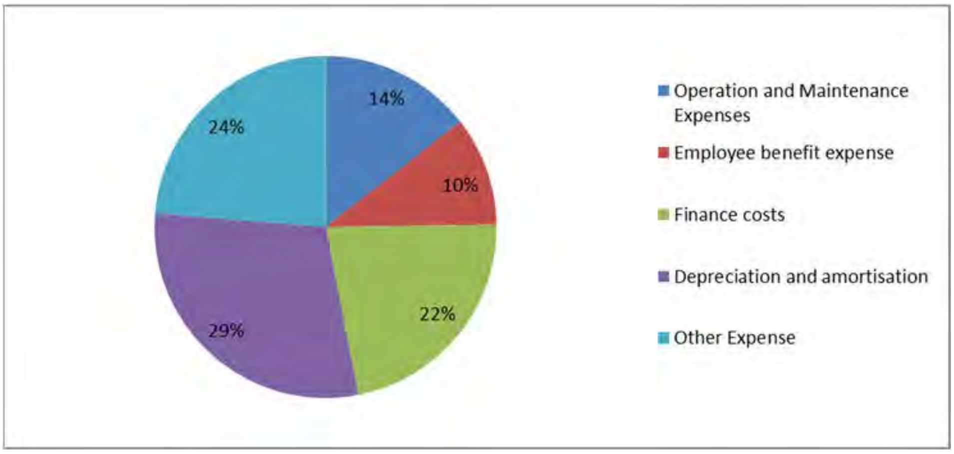


Figure 12.6.1 Expenses of NBWML

6) Balance Sheet

The audited financial report says that Grants-in-aid received from the Government as capital subsidy in the 'Build Operate Transfer' (BOT) project is deducted from the Fixed Assets which is showed the Table 12.6.2. This can explain that “Grants received and connection fee for Capital Expenditure” in Credit side has been increasing with the same proportion of depreciation. Finance cost can be assumed that SPV borrowed the money for the construction, 65% of the project cost.

Table 12.6.7 Balance Sheet of NBWML

Asset	FY 2007 Mar-08	FY 2008 Mar-09	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15
Current Asset								
Cash and Bank Balances	0.50	1.84	11.13	10.95	8.85	8.03	21.30	47.21
Loans and Advances		1.40	1.20	1.28	0.68	1.00	3.62	1.63
Inventories					0.03	0.03	0.03	1.79
Trade receivables				6.83	2.91	4.57	6.17	6.73
Other				0.09	22.74	13.62	17.89	5.95
Non-current Asset								
Capital WIP	36.20	126.70	440.31					
Tangible Fixed assets				486.00	488.90	488.97	489.03	491.16
Accumulated Depreciation				-5.04	-26.25	-47.51	-68.77	-90.09
Long-term loans and advances					1.41	1.44	1.36	0.94
Other					34.07	53.69	49.94	15.00
Total Asset	**36.70**	**129.94**	**452.63**	**500.11**	**533.33**	**523.83**	**520.57**	**480.32**
Liability								
Current Liability								
Trade Payables		29.87	85.19	139.22	13.18	29.62	44.10	52.00
Other Liabilities	36.63	2.64	1.09	0.00	155.47	139.11	122.71	127.09
Short term provision				0.53	0.00	0.00	0.00	0.02
Non-current Liability								
Secured Loan		55.77	183.57	184.52	114.52	74.52	44.52	14.52
Other long-term liabilities			1.46	2.02	11.17	16.58	14.12	15.15
Long-term provisions					0.10	0.15	2.63	3.42
Equity								
Share Capital	0.50	43.50	184.50	184.50	184.50	184.50	184.50	184.50
Accumulated Deficit (Loss)	-0.43	-1.84	-3.18	-10.69	-64.96	-92.44	-91.31	-76.97
Capita Reserve*					119.36	171.79	199.30	160.59
Total Liability and Equity	**36.70**	**129.94**	**452.63**	**500.11**	**533.33**	**523.83**	**520.57**	**480.32**

Capita Reserve (Grants received and connection feefor Capital Expenditure)*

Source: NBWML financial report 2008-2014

It is also noted in the same report that "The Company has so far received an amount of Rs. 184,984,000 (31.03.14) from JNNURM and Rs.39,359,500 (31.03.14) from Naba Diganta Industrial Township Authority till 31st March 2015, which has been reduced from the project cost under Fixed Assets. Grant of Rs. 25,500,000 is yet to be received." So the Government grant is Rs. 249,843,500 in total. At the planning, as the project intimal capital cost was Rs.622,100,000 and 35% of it is to be funded into SPV, and the addition cost Rs.78,700,000 and 67.5% of it is to be funded into SPV, Rs.270,857,500 in totals is to be funded into SPV while the total project cost is around Rs.700,800,000. It can be assumed that actual construction cost was less since this received grant Rs.249 million is less that planned grant Rs.270 million. As the fixed asset shows the range between Rs.486 to 491 million, the difference from Rs.70.08 million (planning construction cost) will be other construction expenses.

7) Summary

This NBWML can be defined as successful case. The first three years after COD (commercial operation date), from 2011 to2013, was negative but from the 4th year, since 2013, it is profitable. The volume of water/sewage get increased while tariff get increased based on the concession agreement, the revenue of operation has surpassed well over its expenses. So the accumulated deficit also started decreasing since 2013.

12.6.3 Case - Nagpur Environmental Services Limited (NESL)

1) Background

Nagpur is located in central India in the western State of Maharashtra. The city is home to 2.5 million13 people with approximately 850,000 (35 percent) living in slums. The city took ownership of the entire water supply value chain and since 2002 has initiated a series of outsourcing contracts for supply of labor, small maintenance activities, etc. The city also built two water treatment plants on a partial financing cum operations basis. The water supply function enjoys a relatively higher level of autonomy as compared to other cities with similar institutional structures, and the city's technical capacity is strong. The city has daily but intermittent supply of 2 to 12 hours. About 80 percent of citizens have access to piped water supply and about 77 percent of connections are metered. The city recovers about two-thirds of its operation and maintenance expenses through water tariffs. The operating losses are met through the general budget of the NMC. The percentage of NRW due to commercial losses alone is at approximately 23 percent. The state government has formally supported the PPP project and provided all the clearances necessary to help facilitate the process. The pilot project also helped build support among a segment of customers and NGOs who did not initially support the project. Concurrent with the PPP, the city incorporated a fully owned company called Nagpur Environmental Services Limited (NESL), a SPV. The water supply functions have been transferred to NESL. Key elected officials and executives of NMC constitute the board of NESL. The PPP contract is signed and supervised by NESL. But the real operation is transferred to the Operator, Orange City Water Ltd, which a 50:50 joint venture SPV company incorporated with stake of Vishwaraj Environment Pvt. Ltd and Veolia Water of France

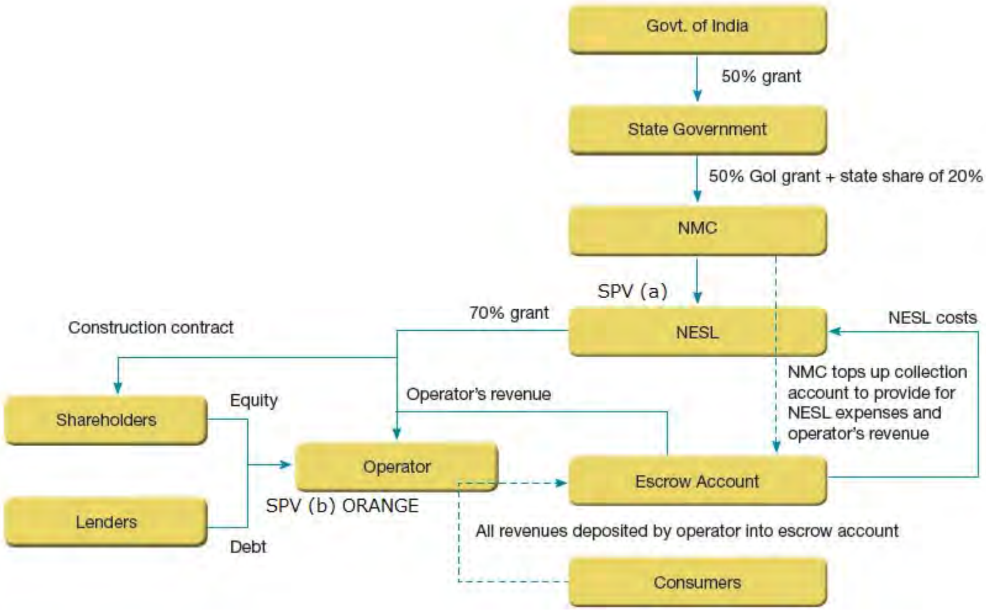


Figure 12.6.2 SPV Structure in Nagpur Water Supply (1)

2) PPP Structure

The contract is a 25 year performance improvement contract with a clause for extension based on mutual consent for up to another 25 years. The operator, Orange City Water Ltd. (another SPV, or OCWL), is responsible for billing and collection of revenue. The project includes the O&M of the existing distribution system and rehabilitation of a significant part of the network, including replacement of customer connections and meters. OCWL is required to implement an initial performance improvement project in five years, under a bill-of-quantities based contract. The revenues from user charges collected by OCWL will be transferred to an escrow account, which is used to make payments for the cost of electricity, raw water etc. and for payments back to OCWL. Any shortfalls in collections, which are anticipated since costs exceed current revenues, are covered by NMC from the general budget. JNNURM funded 70% of the initial capital investments, and the residual 30% were financed by OCWL while municipality is responsible for future capital expenditure. The performance requirements begin only at the end of the performance improvement project period (first five years). OCWL needs to raise 30% of capital cost for IPIP – initial performance improvement program. OCWL receives a fee based on the unit of water billed and collected while Municipal Corporation still have a right to set tariff table. OCWL rate is revised automatically every year for changes in price indices termed as standard adjustment. OCWL is guaranteed minimum revenue in 5 years even if the billed tariff is less than the stipulated threshold of 250 MLD. The rate is also subject to re-basement to deal with unpredicted event or inflation. Triggering event for such adjustment include change in law, force majeure, variance in projected revenue and cost due to overrun or delay in commencement of operations.

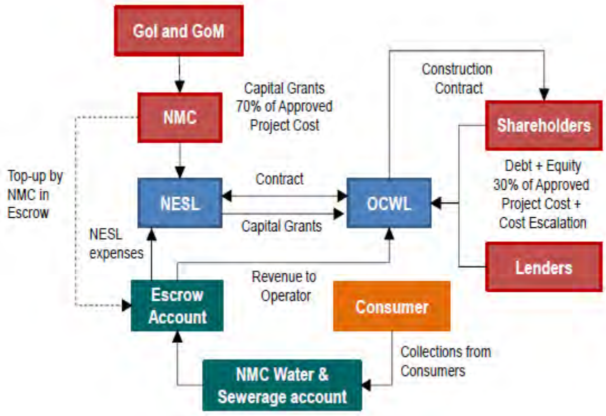


Figure 12.6.3 SPV Structure in Nagpur Water Supply (2)

3) Project Cost

The total investment of this project was Rs. 3,878.6 million. GOI funded 50%, and State Government funded 20% so that up to 70% of capital cost was covered by Government grant under JNNURM scheme. This capital cost was required for replacement of 429 km pipeline and replacement of all 320,000 water connections. In addition, under concession agreement (PPP contract), MNC would reimburse additional costs if the scope of Initial Performance Improvement Program (IPIP) to rehabilitate the facilities increases in order to achieve the performance standards.

4) Income Statement

Nagpur Environmental Service Limited (NESL) is a special purpose vehicle (SPV) fully owned by Nagpur Municipal Corporation (NMC), formed on October 28 2009 to plan, construct, manage and operate water distribution and supply in the areas of Nagpur Metropolitan Region for various household and commercial uses.

After two years of construction period, PPP based Nagpur water supply entered into commercial operation on 2012. There are two major source of revenue in NESL; one is support from NMC, in return for water tariff collected from users through escrow account of NESL by the operator contracted by separate concession agreement. The other is a miscellaneous income including interest received, etc. Tariff rate for Nagpur metropolitan city are frequently updated, tariff for Residential user starts from Rs.63.82/month, Commercial user Rs. 319.07/month, and minimum water charge shall applied to slum area.

Revenue increases by 4.7% from FY2012 to FY2014 whereas expense increases 14.8%, most of the expense comprised of operation fee paid to operator. Tariff rate is finally approved by NMC and support from NMC is very limited amount, and operating fee need to be agreed with operator. Therefore, NESL’s financial stability is relatively weak and operation cost including administrative expense cannot be recovered by its revenue from the beginning of its operation. This was resulted by several clauses which is disadvantageous in the concession agreement, having concession period of 25 years.

Table 12.6.8 Income Statement of NESL (SPV-a)

NESL - PL *Rs. thousand*	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	CAGR '12-'14
Profit and Loss Statement					
(I) Revenue from operations					
Domestic Turnover					
(iii) Sale or supply of services	0	18,544	18,412	18,753	
(II) Other income	742	13,146	16,135	15,989	
(III) Total Revenue (I+II)	742	31,689	34,546	34,742	4.7%
(IV) Expenses					
Payment to Auditors	17	28	28	29	
Finance cost					
Depreciation and amortization expense	6	67	47	81	
Other expenses	1,033	31,556	34,290	41,617	
Total expenses	1,055	31,651	34,365	41,727	14.8%
(V) Profit before exceptional and extraordinary items and tax (III-IV)	-313	38	181	-6,985	
(VII) Profit before extraordinary items and tax (V-VI)	-313	38	181	-6,985	
(IX) Profit before tax (VII-VIII)	-313	38	181	-6,985	
(X) Tax Expense				-2,168	
(1) Current tax					
(2) Deferred tax				-2,168	
(XI) Profit/(Loss) for the period from continuing Operations (IX-X)	-313	38	181	-4,817	
(XV) Profit/ (Loss) (XI+XIV)	-313	38	181	-4,817	
(XVI) Earnings per equity share before extraordinary items					
(1) Basic	0.00	0.76	3.63	-96	
(2) Diluted	0.00	0.00	3.63	-96	
(XVII) Earnings per equity share after extraordinary items					
(1) Basic	0.00	0.76	3.63	-96	
(2) Diluted	0.00	0.00	3.63	-96	

Source: NESL financial report 2011-2014

Orange City Water Private Limited is the SPV formed by Veolia Water (India) Private Limited and Vishwaraj Limited to perform water treatment service under PPP based concession agreement. The revenue from user charges collected by the operator will be transferred to an escrow account, which is used to make payments for the cost of electricity, raw water, etc. and for payments back to the operator. Any shortage in collection of water tariff, which would happen because operational costs, is larger than water charge revenue. It should be recovered by NMC from its general account. Operator's revenue increase year by year with CAGR of 8.0%, however, operating expense especially HR expense increased much larger than revenue and thus net profit of the operator increased two times. Some of the water service requires not only electricity and machinery but also skilled man power labor. So HR expense inevitably increases if the operator would not manage it effectively so that operator maintains their service level to fulfill service standard.

Table 12.6.9 Income Statement of Orange City Water (SPV-b)

Orange - PL	FY 2011	FY 2012	FY 2013	
Rs. thousand	Mar-12	Mar-13	Mar-14	CAGR
Profit and Loss Statement				
(I) Revenue from operations				
Domestic Turnover				
(iii) Sale or supply of services		802,610	866,440	8.0%
(II) Other income		8,670	5,400	-37.7%
(III) Total Revenue (I+II)		**811,280**	**871,840**	7.5%
(IV) Expenses				
Operation Expense		668,030	663,020	-0.7%
Employee benefit Expenses		131,530	188,930	43.6%
Finance cost		2,520	7,080	181.0%
Depreciation and amortization expense		7,910	38,540	387.2%
Other expenses		44,080	62,880	42.6%
Total expenses		**854,070**	**960,450**	12.5%
(V) Profit before exceptional and extraordinary items and tax (III-IV)		-42,790	-88,610	107.1%
(VII) Profit before extraordinary items and tax (V-VI)		-42,790	-88,610	107.1%
(IX) Profit before tax (VII-VIII)		-42,790	-88,610	107.1%
(X) Tax Expense		-12,470	-23,720	90.2%
(2) Deferred tax		-12,470	-23,720	90.2%
(XI) Profit/(Loss) for the period from continuing Operations (IX-X)		-30,320	-64,890	114.0%
(XV) Profit/ (Loss) (XI+XIV)		**-30,320**	**-64,890**	114.0%
(1) Basic		-3,030	-6,490	114.2%

Source: Orange City Water Pvt. Ltd. financial report 2013-2014

According to recent report, NMC pays a higher rate of water cost to the operator for water treatment plant which the operator have a right to operate as defined by the contract and it has also handed over additional favors by not recovering the amount of exemption on import paid for plant equipment imported from abroad. MNC's losses after PPP scheme started have kept increasing to more than Rs. 10 Crore. However, cost coverage ratio increased by 9.9% and it kept improved. MNC implemented a tariff revision along with improved cost recovery levels. The operator's revenue model is per unit fee, which is different from user charges. MNC bears the cost of raw water supply, electricity, and water supply tariff retained with the MNC. User charges would not recover cost, and the city will need to provide a recovery payment through the general account without limitation of the recovery amount. In addition, project plan was not designed to address financing needs for change in scope or future expansion.

Table 12.6.10 Income Statement of NMC (ULB)

	Rs. thousand	2012-2013	2013-2014	2014-2015	CAGR
Revenue					
Water Dept		**956,270.00**	**1,069,846.00**	**1,194,794.00**	11.8%
Water rate	Arrears	94,928.00	106,539.00	114,518.00	9.8%
	Current	46,573.00	52,258.00	56,172.00	9.8%
Water by meter		814,769.00	911,049.00	1,024,104.00	12.1%
Sewer Dept		195,175.00	218,144.00	235,723.00	9.9%
Revenue Total		1,151,445.00	1,287,990.00	1,430,517.00	11.5%
Expense					
Water dept		**1,698,494.00**	**1,611,057.00**	**1,756,490.00**	1.7%
Capital expenditure		339,477.00	20,547.00	54,989.00	-59.8%
Payment to NESL		720,000.00	956,765.00	1,000,461.00	17.9%
Contingency		639,017.00	633,745.00	701,040.00	4.7%
Sewerage dept		**457,759.00**	**577,654.00**	**857,763.00**	36.9%
Salary for drainage staff		8,687.00	8,944.00	9,840.00	6.4%
Capital expenditure		53,695.00	75,799.00	130,572.00	55.9%
Contingency (Drainage)		3,091.00	3,593.00	10,424.00	83.6%
O&M drainage		14,496.00	13,448.00	33,207.00	51.4%
Salary for STP staff		6,470.00	4,470.00	5,894.00	-4.6%
Contingency (STP)		25,261.00	29,102.00	37,047.00	21.1%
Salary for conservancy		346,059.00	442,298.00	630,779.00	35.0%
Expense Total		**2,156,253.00**	**2,188,711.00**	**2,614,253.00**	10.1%
Profit/Loss		-1,004,808.00	-900,721.00	-1,183,736.00	8.5%
Cost Recovery Ratio					
Water		56.3%	66.4%	68.0%	9.9%
Sewerage		42.6%	37.8%	27.5%	-19.7%

Source: NMC Financial report 2012 - 2015

(2) Balance Sheet

NESL formed and owned by NMC has relatively small balance sheet compared to operator SPV because this SPV serves as a conduit in between NMC – executing agency and Operator- concessionaire and it should have small balance sheet and no significant financial resource should be retained in the conduit. As the balance in the Escrow account is ultimately owned by MNC, the SPV does not have significant amount of cash and cash equivalent.

Table 12.6.11 Balance Sheet of NESL (SPV-a)

NESL - BS *Rs. thousand*	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	CAGR '12-'14
I. Liability and Equity							
(1) Shareholders' funds							
(a) Share Capital	500	500	500	500	500	500	
(b) Reserves and surplus			-313	-275	-120	-4,980	325.20%
(c) Other current liabilities	36	42	314,509	339,198	665,928	388,732	7.05%
TOTAL Liability and Equity	**536**	**542**	**314,696**	**339,422**	**666,308**	**384,252**	6.40%
II. ASSETS							
(1) Non-current assets							
(a) Fixed assets							
(i) Tangible assets			201	134	127	149	5.49%
(ii) Intangible assets						2,168	
(e) Other non-current assets	36	106					
(2) Current assets							
(a) Current investments			10,211	180,000	180,000	180,000	0.00%
(b) Inventories							
(d) Cash and cash equivalents			4,938	1,020	982	17,190	310.48%
(f) Other current assets	500	436	299,345	158,268	485,199	184,744	8.04%
TOTAL Assets	**536**	**542**	**314,696**	**339,422**	**666,308**	**384,252**	6.40%

Source: NESL financial report 2009-2014

Operator SPV has significant amount of non-current liability and asset amounts to Rs. 3364 Million. This is the existing asset which is allowed to be used by the operator but ownership of these assets is not transferred to the operator. The project cost relating to rehabilitation of water service facility – IPIP are recorded on the Capital Work in Progress account and Intangible asset account which should be reverted to MNC when contract terminate.

Table 12.6.12 Balance Sheet of Orange City Water Supply (SPV-b)

Orange - BS	FY 2011	FY 2012	FY 2013	
Rs. thousand	Mar-12	Mar-13	Mar-14	CAGR
I. Liability and Equity				
(1) Shareholders' funds				
(a) Share Capital	100,000	100,000	100,000	0.0%
(b) Reserves and surplus	-1,681	488,374	1,023,510	109.6%
Profit (loss) for period		-30,317	-64,887	114.0%
Other additions to reserves (Government Grants)		520,372	600,023	15.3%
(a) Long-term borrowings		1,404,981	1,821,577	29.7%
(c) Other long term liabilities		2,796,700	3,364,055	20.3%
(d) Long term provisions		2,237	4,044	80.8%
(a) Short-term borrowings		86,169	132,227	53.5%
(b) Trade payables		495,866	697,269	40.6%
(c) Other current liabilities		246,373	132,222	-46.3%
(d) Short-term provisions		38	126	232.0%
TOTAL Liability and Equity	**98,319**	**5,620,738**	**7,275,029**	29.4%
II. ASSETS				
(1) Non-current assets				
(a) Fixed assets				
(i) Tangible assets		30,032	50,179	67.1%
(ii) Intangible assets		293,519	1,160,350	295.3%
(iii) Capital work-in progress		632,380	832,315	31.6%
(c) Deferred tax assets (net)		13,226	36,945	179.3%
(d) Long-term loans and advances		228,797	372,762	62.9%
(e) Other non-current assets		2,798,800	3,364,800	20.2%
(2) Current assets				
(a) Current investments		8,293	12,216	47.3%
(b) Inventories		0	0	
(c) Trade receivables		198,099	419,145	111.6%
(d) Cash and cash equivalents		246,338	21,166	-91.4%
(e) Short-term loans and advances		1,171,253	1,005,151	-14.2%
(f) Other current assets		0	0	
TOTAL Assets		**5,620,738**	**7,275,029**	29.4%

Source: Orange financial report 2008-2014

In addition to capital grant received from NMC, the Operator borrowed Term Loans of Rs. 1,08,33,00,000 in total referred below which is secured against mortgage of Building, hypothecation of all the movable assets & current assets of the company, Assignment/first charge on all rights, title, interest, benefits under material project documents, all insurance proceeds. Major conditions of the Term Loans are, quarterly instalments payable from October 2014 to July 2025 and Interest rate: bank base rate plus 275 bps per annum = 13.00% during the year 2013-14. On the other hand, annual interest at 13.17 % to 13.53% is applied to the capital lease contract to procure automobile and it is to be repaid in 48 monthly installments.

Table 12.6.13 Borrowing of Orange (SPV-b)

Rs.thousand	FY 2012 Mar-13	FY 2013 Mar-14
Short term borrowing		
Cash Credit from IDBI Bank Limited	86,169	132,227
Total	86,169	132,227
Long term borrowing		
IDBI Bank Limited	490,700	698,180
Central Bank Of India	84,000	119,500
IIFCL	68,900	242,600
Shareholders	760,000	760,000
Vehicle Loan From L&T Finance Limited	1,381	1,297
Total	1,404,981	1,821,577
Other Current Liability		
IDBI Bank Limited (Current maturity of long term borrowing)	0	17,520
Central Bank Of India (Current maturity of long term borrowing)	0	3,000
IIFCL (Current maturity of long term borrowing)	0	2,500
Vehicle Loan From L&T Finance Limited	389	591
Mobilization advance received towards IPIP project	225,936	75,312
Liabilities towards purchase of Fixed Assets	1,036	1,578
Other	19,011	31,721
	246,373	132,222

According to the PPP contract, there are three types of fixed asset on operator's balance sheet, Return Asset, Optional Take-Back Asset and Own Asset. Return Asset is existing water facilities which is allowed operator to use for their water service and all of fixed assets built and constructed under IPIP program. Return Asset must be returned to NMC when concession period terminated. Return asset is recorded as intangible asset on the B/S, O&M Right - IPIP Acquisition, which amounts Rs. 1141million as on Mar 31, 2014. This asset should be amortized over concession period – 25 years from commencement date of its operation. Optional take back asset is recorded as tangible fixed asset, Furniture and fixtures, Vehicles, Computer Equipment, Other Equipment. For optional take back asset, NMC can decide if they have operator to return such asset to NMC after concession period. The other one is the owned asset, which is not directly relevant to water service and is not funded by capital cost contribution from government. Operator does not need to return such owned asset after concession period. Owned asset on the B/S are; Office Building (Owned), Other Building (Owned), Plant and equipment (Owned).

Table 12.6.14 Fixed Assets of Orange (SPV-b)

FY2013 - Orange Fixed Asset	Acquisition Cost (Gross)				Accumulated Depreciation				Net Book Value			
Rs.thousand	Begin	Addition	Deduction	End	Begin	Addition	Deduction	End	Begin	Addition	Deduction	End
Tangible assets												
Office Building (Owned)	821			821	3	13		16	818	-13		**805**
Other Building (Owned)	53			53	31	22		53	22	-22		**0**
Plant and equipment (Owned)	13,371	10,769		24,139	192	1,283		1,476	13,178	9,485		**22,664**
Furniture and fixtures	2,190	1,300		3,491	399	1,141		1,540	1,791	159		**1,950**
Vehicles	2,797	4,902		7,699	90	403		493	2,708	4,499		**7,206**
Computer Equipment	12,119	8,008		20,126	1,447	2,725		4,172	10,672	5,283		**15,954**
Other Equipment	1,075	1,329	76	2,329	232	532	35	728	843	797	40	**1,600**
Sub Total	32,426	26,308	76	58,658	2,393	6,121	35	8,479	30,032	20,187	40	**50,179**
Intangible Asset												
Computer Software	13,107	17,115		30,221	3,549	8,224		11,773	9,558	8,890		**18,448**
Other Intangible Asset (O&M Right - IPIP Acquisition)	286,288	882,134		1,168,422	2,327	24,194		26,521	283,961	857,941		**1,141,902**
Sub Total	299,395	899,249		1,198,644	5,876	32,418		38,294	293,519	866,831		**1,160,350**

Under concession agreement, Operator is able to call for adjustment rate of operating fee so that Operator can recover unfavorable material cost escalation within every five years. Operator calculates and recognizes long term receivable to recover negative impact of price escalation, which amounts Rs. 233million as on Mar 31, 2014.

Also, operator has significant amount of advance payment to related party constructor called Orange City Hydraulic Works Private Limited, Rs. 901 million as on Mar 31, 2014 for IPIP program construction work. It indicates that not only operator but also ULB need to have a right and co-obligation of monitoring to ensure construction is performed as intended on DPR, when concessionaire itself does not execute construction work and procure/outsource build work.

Table 12.6.15 Receivables of Orange (SPV-b)

Rs. thousand	FY 2011	FY 2012	FY 2013	
Long term loans and advances				
Security deposit (unsecured)		33,499	51,824	
Capital advance (unsecured)		7,516	15,086	
Loans and advances to related parties (Veolia Water (India) Private Limited)		54,181	35,059	
Prepaid expense		745	735	
Advance income tax paid		25,649	36,406	
Loans to NESL - Escalation against rehabilitation		107,208	233,652	63%
Sub Total		228,797	372,762	
Current		0	0	
Security deposit (unsecured)		2,175	3,762	
Loans and advances to related parties (Veolia Water (India) Private Limited)		19,123	19,123	
Loans and advances to related parties (Orange City Hydraulic Works Private Limited)		1,105,000	901,403	90%
Prepaid expense		2,018	1,673	
VAT receivables		1,770	4,059	
Advance recoverable		41,000	74,577	
Accrued interest		168	555	
Sub Total		1,171,253	1,005,151	

1) Summary

On this PPP structure, it is doubtful that the value for money is realized. As we analyzed above, there are several issues which keep this project from success, including irregularities in concession agreement which is too advantageous to operator.

- Low non-performing revenue reduction

  The maximum revenue that can be withheld through liquidated damages for failure to perform is only 5% of annual revenues. In addition, first five years of operation this non-performing revenue reduction shall not be applied.

- Subsequent adjustment of capital expenditure

  Operator is compensated for rehabilitation works based on the concession agreement which includes cost rate per item of the works and materials, which provides for future price escalation in costs linked to price index. In addition, capital expenditure during the time of bidding is subject to revision by the operator, in order to fulfill performance standard.

- Periodic operating fee "re-base" clause

  Operator has the right for a rate revision if it finds excessive cost are required to achieve or maintain performance parameters, in addition to the periodic rate rebasing. The rate is subject to periodic rebasing every five years, which takes into account all costs and expenditure and revision of performance standards as determined by the operator. Therefore, due to rebasing clause, operator has the right to update operating fee rate for their cost recoverable level. And commercial risk is not completely transferred to operator.

12.6.4 Case - GTAEPL (GMR Tuni Anakapalli Expressways Private Limited)

1) Background

The project, Anakapalli-Tuni Road, is widening of Tuni-Anakapalli section of NH-5 from km 300.0 to km 359.2 (Golden Quadrilateral Corridor) in Andhra Pradesh. This was amongst the first set of projects considered for the BOT (Annuity) model. This project is a road expansion project undertaken by the National Highways Authority of India (NHAI) as one of the several projects under the Golden Quadrilateral program. The project's scope was to strengthen the existing two lanes and widen it to a four lane dual carriageway of an aggregate 59 km stretch between Tuni and Anakapalli on National Highway (NH) 5 (Chennai to Kolkata) in Andhra Pradesh on PPP basis. Keeping in mind the lack of attractiveness in tolling the road, NHAI decided to take up the project on the Build Own Transfer (BOT) Annuity model. The toll is collected by NHAI.

2) PPP Structure

The Project was awarded by NHAI on a BOT (Annuity) basis. The annuity model involves the payment (Rs.294.8 million) of a fixed semi-annual sum by the NHAI to the concessionaire during the concession period to compensate him for the capital cost and operational and O&M expenses of the project plus a certain percentage of returns thereon. (Details in the chart later)

Table 12.6.16 PPP information of GTAEPL (Ministry of Finance, Government of India)

Sector	Transport
Sub-Sector	Roads and bridges
Project Capacity	58.947 KM (Kilometer)
Location	Andhra Pradesh
Type of PPP	Build-Operate-Transfer (BOT) Annuity
Project Status	Operational
Nodal Authority	Centre
Concession Duration (In Months)	210
Bid Parameter	Not Available
Government/Non Government	Government
Any Other Information	Not Applicable
Name Of Authority	National Highways Authority of India (NHAI)
Project Concessionaire	GMR Tuni - Anakapalli Expressways Private Limited

Table 12.6.17 Timeline of GTAEPL (Ministry of Finance, Government of India)

Concession Agreement Signing Date	9-Oct-01
Financial Closure Date	1-Jun-02
Apointed Date	9-May-02
Construction Completion Date (as per Concession Agreement)	8-Nov-04
Construction Completion Date (Actual)	24-Dec-04
Date to Start of Commercial Operation (as per Concession Agreement)	8-Nov-04
Date to Start of Commercial Operation (Actual)	24-Dec-04
Concession End Date (as per Concession Agreement)	9-Nov-19

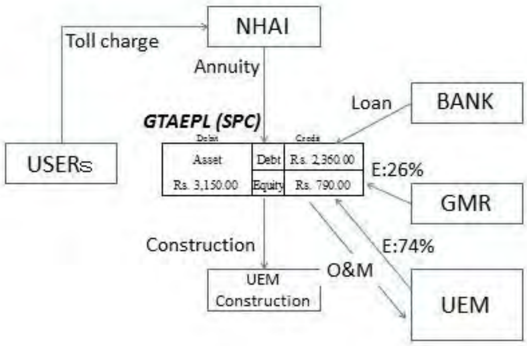


Figure 12.6.3 SPV Structure of GTAEPL

3) Project cost

The estimated project cost of the project was Rs. 3,150 million. O&M fee is Rs.1.25 million per month and a periodic fee of Rs.75 million. The O&M fee and the periodic fee are escalated by 1.5% per annum, 1 year from the date of commencement of operations. But the actual project cost became Rs. 2,950 million.

4) Project cost

The estimated project cost was Rs.3150 million. The term loan component was Rs.1540 million, non-convertible debentures component was Rs.820 million and the equity Rs.790 million or Rs.10-/share time 7.9 million issues. The project was funded on a debt-equity ratio of 3:1. ICICI Bank was the lead banker and the lending consortium included several public sector banks such as State Bank of India, Union Bank of India, Indian Overseas Bank, Jammu & Kashmir Bank, Bank of India, Punjab National Bank, and Industrial Investment Bank of India, State Bank of Mysore. The average spread of the loan ranged from 12.5% to 12.75%. The loan tenure was 13.5 years, including a construction period of 2.5 years. NHAI also gave an irrevocable revolving letter of credit for

Rs.294.8 million throughout the concession period. This provided comfort to the bankers.

Table 12.6.18 Financing of GTAEPL

Rs.million

Loan	Term loan	Rs. 1,540.00		Rs. 2,360.00	75%
	debenture	Rs. 820.00			
Equity	GMR	Rs. 584.60	74%	Rs. 790.00	25%
	UEM*	Rs. 205.40	26%		
				Rs. 3,150.00	

UEM: United Engineers Malaysia (UEM) BerhadGroup

1) Financial planning model

From the information of the collected document (including audited financial report), it is assumed that the concession model may show the following tables, three patterns:

The condition of Table (A) is the project cost of Rs.3150 million as original estimation, O&M expense noted before, and installment repayment of Rs.3150 million for 13.5 years with the interest rate from 12.5% to 12.75%. In this case, cost surpasses the revenue or total annuity payment.

Table 12.6.19 Cost Annuity Simulation (A)

Rs.million						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Concession		**Oct (agreement)*																		**Nov (end)*	
Construction			**May (start)*		**Dec (end)*																
O&M					**Dec (start)*															**Nov (end)*	
	Construction	3,150.00																			
		1,050.00	1,050.00	1,050.00																	3,150.00
1.5%	O&M/month				1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	
	Month				*2*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*11*	
	Monthly O&M cost				2.50	15.23	15.45	15.69	15.92	16.16	16.40	16.65	16.90	17.15	17.41	17.67	17.93	18.20	18.48	18.75	256.49
	Periodic fee				75.00	76.13	77.27	78.43	79.60	80.80	82.01	83.24	84.49	85.75	87.04	88.35	89.67	91.02	92.38	93.77	1,344.93
	O&M Total				77.50	91.35	92.72	94.11	95.52	96.96	98.41	99.89	101.38	102.91	104.45	106.02	107.61	109.22	110.86	112.52	1,601.41
12.63%																				Construction and OM cost	**4,751.41**
	Repayment	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44	505.44						6,570.68
		1,555.44	1,555.44	1,632.94	596.79	598.16	599.55	600.96	602.39	603.85	605.32	606.82	608.34	609.89	106.02	107.61	109.22	110.86	112.52		**11,322.09**
	Annuity Semi annual (1st)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
	Annuity Semi annual (2nd)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
Loan rate						**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**8,844.00**
12.50%																					
12.75%																					

The condition of Table (B) is the project cost of Rs.2950 million as actual construction cost, O&M expense noted before, and installment repayment of Rs.2950 million for 13.5 years with the interest rate from 12.5% to 12.75%. (In this model cost surpasses the revenue or total annuity payment). Still in this model, cost surpasses the revenue or total annuity payment.

Table 12.6.20 Cost Annuity Simulation (B)

Rs.million					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Concession	**Oct (agreement)*																		**Nov (end)*	
Construction		**May (start)*		**Dec (end)*																
O&M				**Dec (start)*															**Nov (end)*	
Construction		2,950.00																		
		983.33	983.33	983.33																2,950.00
1.5% O&M/month				1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	
Month				*2*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*11*	
Monthly O&M cost				2.50	15.23	15.45	15.69	15.92	16.16	16.40	16.65	16.90	17.15	17.41	17.67	17.93	18.20	18.48	18.75	256.49
Periodic fee				75.00	76.13	77.27	78.43	79.60	80.80	82.01	83.24	84.49	85.75	87.04	88.35	89.67	91.02	92.38	93.77	1,344.93
O&M Total				77.50	91.35	92.72	94.11	95.52	96.96	98.41	99.89	101.38	102.91	104.45	106.02	107.61	109.22	110.86	112.52	1,601.41
12.63%																	Construction and OM cost			**4,551.41**
Repayment		473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35	473.35						6,153.49
		1,456.68	1,456.68	1,534.18	564.70	566.07	567.46	568.87	570.30	571.76	573.23	574.73	576.25	577.79	106.02	107.61	109.22	110.86	112.52	**10,704.91**
Annuity Semi annual (1st)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
Annuity Semi annual (2nd)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
Loan rate					**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**8,844.00**
12.50%																				
12.75%																				

It is told that "In May 2005, GTAEPL raised further debt of about Rs.3720 million from a consortium of lenders through securitization of future annuity receivables (68% of annuity receivables) to be received from NHAI over a period of fifteen years. These funds were raised at a cost lower than the cost of project debt by about 3% and were used for prepayment of the project debt." And also, the audited financial report in 2015 says, "Indian rupee loan from back carries interest is 8.25%" So the condition of Table (C) is the project cost of Rs.2950 million as actual construction cost, but payback condition from 2002 to 2004 was about the interest rate of 12.63% (mathematical average of 12.5% and 12.75%.) but from 2005 to 2019 was 8.25% for the remaining 15 years. O&M expense is noted before. In this case, the revenue or total annuity finally surpasses the total cost (construction, OM and finance cost).

And Table (C) shows that 34% is construction cost, 18% is O&M cost and 48% is finance cost among all costs.

Table 12.6.21 Cost Annuity Simulation (C)

Rs.million					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Concession	**Oct (agreement)*																		**Nov (end)*	
Construction		**May (start)*		**Dec (end)*																
O&M				**Dec (start)*															**Nov (end)*	
Construction		2,950.00																		
		983.33	983.33	983.33																2,950.00
1.5% O&M/month				1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	
Month				*2*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*11*	
Monthly O&M cost				2.50	15.23	15.45	15.69	15.92	16.16	16.40	16.65	16.90	17.15	17.41	17.67	17.93	18.20	18.48	18.75	256.49
Periodic fee				75.00	76.13	77.27	78.43	79.60	80.80	82.01	83.24	84.49	85.75	87.04	88.35	89.67	91.02	92.38	93.77	1,344.93
O&M Total				77.50	91.35	92.72	94.11	95.52	96.96	98.41	99.89	101.38	102.91	104.45	106.02	107.61	109.22	110.86	112.52	1,601.41
12.63%																	Construction and OM cost			**4,551.41**
Repayment		473.35	473.35	473.35	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	181.48	4,142.28
		1,456.68	1,456.68	1,534.18	272.83	274.20	275.59	277.01	278.44	279.89	281.37	282.87	284.39	285.93	287.50	289.09	290.70	292.34	294.00	**8,693.69**
Annuity Semi annual (1st)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
Annuity Semi annual (2nd)					294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	294.8	
Loan rate					**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**589.6**	**8,844.00**
12.50%																				
12.75%																				

2) Income Statement

The annuity per year is the sum of semi-annual annuity (Rs.294.8 million) or Rs.589. The revenue contains fairly amount of Interest Income as well. Since total expense is less than total revenue, the SPV is profitable and has taxable profit. On FY2014, O&M expense increased from Rs. million to Rs. 139.16 million, with more than 30 crores comparing to FY2013. According to Credit rating report issued by ICRA India, during 2013, one of GTAEPL's shareholder and O&M contractors for the project - United Engineers (Malaysia) Berhad (UEM) exited from this PPP scheme and terminated the fixed price O&M and major maintenance contract entered into with UEM group from the beginning of the project. As per observation, it was noted that the gearing of GTAEPL is high – fixed cost which cannot be reduced evenly if the level of production or service decreases. Therefore, revenue is stable but it is difficult to pursuit additional revenue opportunity besides annuity payment, controlling O&M expense not rising too high without lowering the service level is vital for the GTAEPL to earn predetermined amount of annuity payment. Generally, periodic maintenance expenditure will become larger as the carriage way – concession fixed asset gets old.

Table 12.6.22 Income Statement of GTAEPL (SPV)

Rs.million	FY 2013 Mar-14	FY 2014 Mar-15	Growth ('13-'14)	% of Total Revenue ('13)	% of Total Revenue ('14)
Incomet statement					
Annuity income from expressways	589.72	589.72	0.0%	86.5%	83.9%
Interest Income	90.91	110.30	21.3%	13.3%	15.7%
Other Income	1.35	2.71	100.9%	0.2%	0.4%
Total Revenue	**681.97**	**702.72**			
Operation and Maintenance Expenses	108.71	139.16	28.0%	15.9%	19.8%
Employee benefit expense	32.69	48.30	47.8%	4.8%	6.9%
Finance cost	186.29	161.15	-13.5%	27.3%	22.9%
Depreciation and amortisation	199.12	199.40	0.1%	29.2%	28.4%
Admin and Other Expense	85.24	80.37	-5.7%	12.5%	11.4%
Total Expense	**612.05**	**628.39**	2.7%	89.7%	89.4%
Profit before tax	**69.92**	**74.33**	6.3%	10.3%	10.6%
Profit on redemption of preference shares	31.25	0.00	-100.0%	4.6%	0.0%
Current tax expense	21.80	15.16	-30.4%	3.2%	2.2%
Profit after tax	**79.37**	**59.17**	-25.5%	11.6%	8.4%

Source: Financial statement of GTAEPL, period ended March 31, 2015

3) Balance sheet

The two years balance sheet, from 2013 to 2014 shows that accumulated depreciation in Debit and secured load from bank has largely decreased. Loan and advances in Debit and Trade payable in Credit has largely increased. And accumulated profit has increased. Cash and bank balance are increased on FY2014 with 107.8 Crore supported by sufficient amount of annuity payment. Excessive money is deposited to intercorporate deposit which would be operated by GTAEPL's related party – GMR group.

Indian Rupee loan from banks carries interest rate at 7.5% plus fixed spread of 8.25% and thus 15.75% per annum in total. The loan is repayable in 29 unequal half yearly installments commencing from November 25, 2005. The loan is secured by way of mortgage of all the present and future immovable fixed asset of the company, hypothecation of movable fixed assets of the company and the annuity receivables, investments and so forth.

Most of the tangible fixed asset is comprised of carriage way, which in scope of the concession agreement. Carriageway is depreciated over the period of the 15 years from commercial operation date until the end of concession period on a straight line method. Any additions to the carriageway if any is also depreciated from the date of capitalization till the end of the concession period uniformly.

GTAEPL borrows a loan from two related parties, GMR Highway Limited – parent of the GTAEPL a Rs. 114.14 Million term loan with 1% of annual interest rate, and fellow subsidiary of GTAEPL a Rs. 324.8 million with 1% of annual interest rate, which is recorded as a non-current liability. 1% loan is extremely low rate and GTAEPL rely on such a favorable financial support to continue its operation.

Table 12.6.23 Balance Sheet of GTAEPL (SPV)

	Rs.million	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	Growth ('13-'14)
Asset					
Current Asset	Cash and Bank Balances		39.42	147.26	107.8
	Inventory		0.00	0.50	0.5
	Loans and Advances		251.40	862.08	610.7
	Other		314.80	385.07	70.3
Non-current Asset	Tangible Fixed assets		2,970.18	2,970.20	0.0
	Accumulated Depreciation		-1,843.71	-2,043.78	-200.1
	Non current investment		765.11	765.11	0.0
	Long term loans and advance		913.29	336.48	-576.8
	Other		135.93	0.00	-135.9
Total Asset			**3,546.42**	**3,422.92**	-123.5
			0.00	0.00	0.0
Liability			0.00	0.00	0.0
Current Liability	Trade Payables		50.02	293.94	243.9
	Other Liabilities		313.11	307.33	-5.8
	Short term provision		186.57	48.83	-137.7
Non-current Liability	Secured loan from bank		1,591.62	1,307.03	-284.6
	Loan from GMR Energy Ltd.		324.86	324.86	0.0
	Loan from GMR Highway Ltd.		114.14	114.14	0.0
	Other Liabilities		1.61	1.84	0.2
	Long term provision		2.60	4.56	2.0
Equity	Share Capital		10.00	10.00	0.0
	Accumulated Profit (Surplus)		951.88	1,010.39	58.5
Total Liability and Equity			**3,546.42**	**3,422.92**	-123.5
	Equity		*961.88*	*1,020.39*	*58.5*

4) Summary

The project plan in financial point of views seems to be fine and the current financial statements also shows that this SPV runs well, so the business model of GTAEPL looks well. It seems it has been progressing well without any financial issues.

12.6.5 Case - Haldia Water Management Limited

1) Background

Haldia is a municipality in West Bengal State which one of a major industrial center spreading about 125 km southwest of Kolkata adjacent to river mouth of the Hooghly River, one of the distributaries of the Ganges. The population in 2011 was 200,762.

Haldia is being developed as a major trade port for Kolkata, intended mainly for bulk cargoes. The industrial city has several major factories, including South Asian Petrochemicals Ltd, Indian Oil Corporation Limited (IOCL), Exide, Shaw Wallace, Tata Chemicals, Haldia Petrochemicals and Hindustan Lever, in addition to various light industries. The port has attracted Major International Petrochemicals Companies, like Mitsubishi Chemical Corporation (MCC). Mitsubishi Chemicals has the second largest terephthalic acid producing plant in Haldia.

The Haldia Township is bordered by the Haldi River an offshoot of the Ganges River. Haldia is served by rivers like Rupnarayan, Haldi and Hooghly that ensure abundant water supply for irrigation of the agricultural farms. Due to increasing water demand of industries, Haldia Development Authority augmented new Water Treatment Plant. For fulfillment of future demand, a new Water Treatment Plant was commissioned on BOT basis.

2) PPP Structure

Haldia Water Management won a global tender in 2008 to take over the then existing system, which now handles 25 million gallons daily, and build a similar facility within two years to cater to both industrial and domestic customers.

Jamshedpur Utilities and Services Co Ltd (JUSCO, Tata group) and Ranhill Utilities Berhard of Malaysia have jointly incorporated the Haldia Water Management Limited which is a joint venture and started the management of civic facility in Jamshedpur to provide water at Bengal's IT hub. Ranhill is one of the largest water distribution players in Malaysia.

When Haldia Water Management Ltd was incorporated, it was promoted by IDFC Projects Ltd which has signed a concession agreement with Haldia Development Authority for the project. The project was expected to meet the unfulfilled demand of large industrial units operating in the region aiming to be the first end-to-end, river-to-tap water project to be implemented in public-private partnership in India. Project work is expected to start on September 2009, with the first module scheduled to commission on

March 1, 2010. Expected to cost more than Rs 90 crore, the project was to be financed on a 70:30 debt-equity ratio.

The 25-year concession agreement involves construction, operation and maintenance of a 113.5 MLD water treatment plant on design-build-finance-operate (DBFO) basis.

Alongside, it also entails operation and maintenance of the existing 113.5 MLD WTP and of the entire distribution network that currently serves consumer in Haldia. Ranhil and Jusco will execute the EPC and O&M works based on the contract.

3) Project Cost

Jusco and Ranhill spent Rs 88 crore on building the new plant at Geonkhali, Haldia.

4) Project Capital

JUSCO has 60% of shares in capital and the remaining 40% is held by Ranhill, JUSCO's JV partner. Paid up capital has been increased as the project progressed.

Table 12.6.24 Balance Sheet of Haldia Water Management

	31-Mar-09	31-Mar-10	31-Mar-11	31-Mar-12	31-Mar-13	31-Mar-14	31-Mar-15
Par Value (Rs.)	10	10	10	10	10	10	10
Number of authorised shares	30,000,000	30,000,000	30,000,000	30,000,000	30,000,000	30,000,000	30,000,000
Number of issued shares	5,090,000	17,255,100	24,925,100	27,773,683	27,773,683	27,773,683	27,773,683
Number of paid-up shares	2,540,000	15,524,500	24,925,100	27,773,683	27,773,683	27,773,683	27,773,683
Value of paid-up shares (Rs.)	25,400,000	155,245,000	249,251,000	277,736,830	277,736,830	277,736,830	277,736,830
Shares capital held by JUSCO (60%)	15,240,000	93,147,000	149,550,600	166,642,100	166,642,100	166,642,100	166,642,100
Shares capital held by others (40%)	10,160,000	62,098,000	99,700,400	111,094,730	111,094,730	111,094,730	111,094,730

5) Income Statement

As on 2015, JUSCO and its Ranhill had giving up a water distribution contract in Haldia, due to lack of water demand in West Bengal's industrial sector. Haldia Water Management Ltd will hand over a pre-existing water distribution facility and a new one to the Haldia Development Authority (HDA) by March 30 2016, 20 years before the term's expiry, after suffering heavy losses in the past five years.

Haldia Water Management is foregoing the BOT contract not because the volume of business has not kept pace with expectations. The company has promised smooth transition to the HDA without any disruption in water supply. Around 220 people picked by contractors of the firm will work for the HDA. HAD has already floated a tender seeking a contractor to maintain the system for three months during which it intends to find another operator.

The company was supposed to pay around Rs 1,220 crore to the Haldia authority over the 25-year concession period and make a profit by supplying water to its customers.

Although Jusco and Ranhill spent Rs 88 crore on building the new plant at Geonkhali, the facility has been lying idle for almost two years as there are no takers for the water.

The situation was aggravated by the central environment ministry's ban on new industry because of the high level of pollution at the port town from end-2009. The company has suffered losses of Rs 50 crore to Rs 60 crore running the existing unit. The unit was processing 14 to 15 million gallons of water a day when Haldia Water Management took over operations. As a result, on none of operation year Haldia water could not recover O&M expense from its water revenue.

Table 12.6.25 Balance Sheet of Haldia Water Management

Incomet statement	FY 2008 Mar-09	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	CAGR ('08-'14)	Growth ('13-'14)
Water Charges	131	356	431	463	458			-100%	0.0
Interest Income	0	1	0					-100%	0.0
Other Income			0	2	0	1	0		-0.9
Total Revenue	131	356	432	465	459	1	0	-66%	-0.9
Purchase of Water									0.0
Power Expense	26	78	98	109	163			-100%	0.0
License Fee	88	210						-100%	0.0
Preliminary Expense	2							-100%	0.0
Operation and Maintenance Expenses	23	84						-100%	0.0
Employee benefit expense	2	3	3	3	4	4	5	19%	0.3
Interest Expense		0	3	6	85	98	111		13.5
Depreciation and amortisation	0	0	0	0	0	0	0	48%	0.0
Impairment of Capital Asset			75	774	26	11	0		-10.9
Other Expense	13	12	345	450	552	5	2	-29%	-2.9
Total Expense	153	387	524	1,343	831	118	118	-4%	0.1
Profit before tax	-21	-31	-92	-878	-372	-117	-118	33%	-1.0
Current tax expense	0							-100%	0.0
Deferred tax expense	7	9	-16					-100%	0.0
Profit after tax	-14	-22	-109	-878	-372	-117	-118	42%	-1.0

6) Balance Sheet

As a result of consecutive fiscal deficit and decision to dismiss from this PPP structure, Haldia Water recognized impairment on its 88 crore intangible fixed asset on its balance sheet, rights to operate the water treatment plant. And its liability exceeds its asset from FY 2012, reflecting the provision for dissolution of the company and terminating the business once the court decision will be made. At the time Haldia Water returned the operation of WTP to HDA, Water Management sought to renegotiate the contract to make the project viable. But, as on June 2016, no such contract renewal or settlement of the dispute has been made.

Table 12.6.26 Balance Sheet of Haldia Water Management

Balance sheet		FY 2008 Mar-09	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Mar-12	FY 2012 Mar-13	FY 2013 Mar-14	FY 2014 Mar-15	CAGR ('08-'14)	Growth ('13-'14)
Asset										
Current Asset	Cash and Bank Balances	11	51	69	5	28	4	2	-26%	-2.5
	Loans and Advances	5	40	31	58	115	113	110	66%	-2.9
	Trade receivables	57	81	94	140	626	27	26	-12%	-0.6
Non-current Asset	Capital WIP	19	199	726	849	875	886	886	90%	0.3
	Capital WIP impairment			-75	-849	-875	-886	-886		-0.3
	Tangible Fixed assets	0	0	0	0	0	0		-100%	-0.1
	Accumulated Depreciation	0	0	0	0	0			-100%	0.0
	Other	7	16	11	1				-100%	0.0
Total Asset		99	388	856	204	770	145	139	6%	-6.0
	Fixed asset netted against grant received									
Liability										
Current Liability	Trade Payables	88	139	81	133	411	413	414	29%	1.1
	Short term borrowing					165	165	165		0.0
	Current Maturity of long term borrowing						496	496		0.0
	Interest Payable						90	200		110.0
	Other Liabilities			184	321	1,310	213	214		0.5
Non-current Liability	Secured Loan		130	486	495					0.0
Equity	Share Capital	25	155	249	278	278	278	278	49%	0.0
	Accumulated Deficit (Loss)	-14	-36	-145	-1,022	-1,394	-1,511	-1,628	120%	-117.6
										0.0
										0.0
Total Liability and Equity		99	388	856	204	770	145	139	6%	-6.0

7) Summary

One of the reason why Haldia Water exited out from the PPP structure was, revenue has not been increased as HDA projected before inception, which taken into account by the company. As a result, cash flow forecast was also inaccurate because number of company newly settled to that area has not been increased that much due to sudden change (strengthened) in government's regulation around pollution and the general business situation.

While water treatment capacity increased to 30 million gallons a day, demand did not go beyond 24 to 25 million gallons a day, resulting significant under-utilization and short fall of revenue derived from water treatment operation.

Under the PPP agreement, the HDA was to have a predetermined annual guaranteed income of Rs 1,220 crore.

12.6.6 Case - Alandur Sewerage Project, Chennai, Tamil Nadu

1) Background

The Alandur Sewerage Project (ASP) was started on 1996 by the Alandur Municipality (AM). AM is located adjacent to Chennai, which forms a part of the Chennai Metropolitan Area. AM has population of approximately 165,000 on Census 2011 and is one of suburban area of Chennai, most of the area is utilized as residential building and commercial industries.

At the time the project was commenced, Alandur did not have an underground sewerage system and most of the sewage disposal relied on individual septic tanks. AM announced a plan to construct an underground sewerage system and waste water treatment facility with the participation of the private sector, contribution from the public, and payment to be provided by the city. The proposal was 'trans-formational' as it involved a service never before made available by the municipality, with financial and management responsibilities being shared by the municipality, the residents, the private sector, and state government bodies.

Alandur project is characterized as following key points which distinguishes among other water and sewerage project; participation of residents sector not only Private and Public sector for sharing financial and management responsibilities.

2) PPP Structure

It was the first time for Indian Municipal water and sewerage sector to implement a project with the form of Public Private Partnership. STP was constructed on a BOT (Build, Operate and Transfer) basis. In addition to the construction of STP, the contractor was also responsible for operation and maintenance of the sewerage system for a period of five years from the date of completion of the construction with a fixed O&M fee, which is called BOQ (Bill of Quantities) basis. Besides construction, the contractor was required to undertake the O&M of the sewerage system for a period of years from date of completion of the project on a fixed fee basis. On the other hand, AM still had a right and responsibility around tariff collection and providing new connections even in the five years O&M phase.

PPP structure of the Alandur project was structured by three separate contracts as follows; EPC contract for STP, Works Contract for construction of the sewage network and O&M contract. For Works and O&M contract, World Bank's National Competitive Bidding (NCB-W2) was used as the template.

Land Lease Contract (in the nature of a BOT Agreement) for the STP, guidelines from the International Federation of Consulting Engineers (FIDIC) was used. Through this Agreement, the contractor would finance, build and operate the STP and would be required to recover the investment on the STP on the basis of a per unit rate payment from the municipality for treatment of sewage delivered. The munici-pality agreed to provide a minimum payment level per annum regardless of the volume of sewage actu-ally delivered. It was designed to cover the company's minimum fixed operating cost and capital invest-ment. Therefore, Alandur project's PPP structure was BOT-Annuity and annuity payment borne by AM. The project comprised of three contracts; 1) A Works Contract for Sewerage Network, 2) O&M Contract - 5 years on Fixed Fee basis, 3) Lease Contract (BOT Agreement). Successful bidder was consortium of IVRCL Infrastructures and Projects Ltd and Va Tech Wabag Technologies Ltd. They incorporated a SPV named First Sewerage Treatment Plant Pvt Ltd (First STP) as the concessionaire company to sign BOT Agreement. First STP also signed contracts with its parents companies to implement the works for the project and for O&M of STP for 14 years. Also, AM leased the land on which STP was built to First STP.

3) Project Cost

Loans: The majority of financing to the municipality (59%) was made through loans provided by the Tamil Nadu Urban Infrastructure Development Corporation (TUFIDCO) and TNUIFSL (State Asset Management Co.). The loan provided by TUFIDCO was payable over eight years (after a two-year moratorium) at an interest rate of 5% per annum (as against prevailing market rates of 15% at that time). TNUIFSL's loan was set at a rate of 16% per annum payable over a period of 15 years with a five year moratorium. The term loan conditions resulted in the municipality assuming significant financial.

Table 12.6.27 Finance source of Alandur Project

	Rs. Million
Grant from TNUIFSL	30
Loan from TNUIFSL	60
Loan from TUFIDCO	160
Grant from TUFIDCO	10
Deposit from public	124
Interst from deposit	24.6
Total	408.6

Source: PPP - Compendium of Case Studies Dec 2010

The required capacity of sewerage system and STP to serve about 300,000 of estimated population was to start with 12 MLD and then maximum capacity was to be 24 MLD.

The cost of the project was estimated as Rs. 40.86 crore. To finance the municipality's portion of the capital cost, a package of loans (22Crores) and grants (4Crores) was structured with the loans from Tamil Nadu State Government organization. One of the key characteristic of this project financing was the initiative of collecting citizen's money totaling up to 12.4 Crores as connection deposit with inspiring citizen's awareness. On the other hand, the STP was financed entirely by the contractor.

One-time deposits for sewerage connection were charged to users with three categories (domestic, commercial, industrial). The connection charges for different categories of users were fixed as follows: Connection Charges, Domestic) 5,000 per house connection, Commercial) 10,000, Industrial) 10,000. A loan program to finance this connection deposit was offered by the bank. State government agreed to provide gap funding to bridge any shortfall in domestic connection payments. The public was also expected to contribute towards monthly sewer maintenance charges.

Grants: As no funds were available either with the municipality or with TNUIFSL to oversee and monitor the progress of the project, TUFIDCO provided a special grant from the Tamil Nadu urban development grant fund for this purpose, which worked out to nearly three per cent of the total project cost. GoTN agreed in principle to bridge the gap in the sewer account during the life of the project, after providing for operations and maintenance (O&M) expenses, debt servicing and contribution to the sinking fund. In addition to the above, GoTN also agreed to fund the monthly operating costs of the system above the ` 150 per household sewer charge to a maximum of ` 30 per connection per month.

4) Project Capital

The equity of the SPV is Rs. 30 million among Total Balance sheet, Rs.151 million at March 2014. The parent companies, IVRCL and VA Tech Wabag Limited as engineering and mechanical area of servicer in the structure of PPP. As per the operation and maintenance contract, the STP facility is under direct control and supervision of VA Tech Wabag Limited for Operation and maintenance that have 5% stake in the Company.

Table 12.6.28 The Capital of First STP

Par Value (Rs.)	10
Number of authorized shares	3,000,000
Number of issued shares	3,000,000
Number of paid-up shares	3,000,000
Value of paid-up shares (Rs.)	30,000,000
Shares capital held by IVRCL Limited (95%)	28,500,000
Shares capital held by VA Tech Wabag Limited (5%)	1,500,000

5) Income Statement

Operating result of the First STP is stable and records a profit every year. One of the reasons of the periodic operational surplus is that, STP facility on their book has been already fully depreciated and the depreciation expense is not incurred anymore. The other reason is, their revenue is sufficient to cover O&M cost including power and fuel. In addition, on AMC's annual account for FY2014-2015, AMC would earn a financial surplus on their general fund account besides depreciation, and thus, entire O&M cost recovery rate is not low even though not all the sewerage service cost is recovered by user charges collected from individual and commercial/industrial users.

Table 12.6.29 The Income statement of First STP

Incomet statement of First STP Ltd	FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Jun-12	FY 2012 Mar-13	FY 2013 Mar-14	CAGR ('08-'14)
Revenue of sale of product	17	17	20	12	16	-1%
Interest Income			1	0	0	
Other Income		0				
Total Revenue	17	17	21	13	16	0%
MFG and Service cost	0	0				-100%
Power and Fuel	3	3	4	2	4	11%
Contract Cost	4	4				-100%
Administrative expense						
Operation and Maintenance Expenses	0					-100%
Employee benefit expense				0	0	
Interest Expense	0					-100%
Depreciation and amortisation	8	8	5			-100%
Other Expense	0	0	4	3	4	150%
Total Expense	15	14	13	5	8	-14%
Profit before tax	2	2	8	8	8	42%
Current tax expense	0	0	2	1	2	50%
Deferred tax expense						
Profit after tax	2	2	6	6	7	41%

6) Balance Sheet

Depreciation of fixed asset; The fixed assets are amortized equally over a period of 9 years from the date of commencement of commercial operations, being the period of operation of the project on BOOT basis. Nature of other non-current assets are, Land held for development, Advance tax, Deposit with tax statutory authority.

Due to restructuring of the parent company, the financial statements of First STP on FY2011 have been prepared for the fifteen months period commencing from April 1, 2011 to June 30, 2012, with due effect being given to the said restructuring. Thus P/L figures on these years are not comparable with those of the previous year.

One thing that makes First STP's balance sheet complicated is, intercompany transaction relating to land acquisition amounts 35.47 Acres not for construction of STP but for commercial/residential development. The economic development rights of the land have been vested with IVR Hotels and Resorts Limited for 11.67 Acres and RIHIM Developers Private Limited for 23.80 Acres , against Earnest Money Deposited of Rs.3,49,22,345 and Rs.4,27,34,273 respectively to these companies, subcontractors of build and construction of STP, totalling Rs. 77,656,618 which is the same amount of land account. In General, SPV should not have such an asset that does not relate to its primary business objective, development, operation and maintenance of STP system.

Table 12.6.30 The Balance sheet of First STP

(Amounts in million Rupee)

Balance sheet of First STP Ltd		FY 2009 Mar-10	FY 2010 Mar-11	FY 2011 Jun-12	FY 2012 Mar-13	FY 2013 Mar-14	CAGR ('08-'14)
Asset							
Current Asset	Cash and Bank Balances	0	5	11	6	1	21.2%
	Loans and Advances (to related party)					10	
	Loans and Advances (Prepaid)	16	0	0	0	0	-82%
	Loans and Advances (Other)				0	0	
	Trade receivables	21	0	0	40	42	19%
Non-current Asset	Capital WIP						
	Capital WIP impairment						
	Building	1	1	1	1	1	0%
	Acc. Depreciation: Building	-1	-1	-1	-1	-1	7%
	Plant and Machinery	54	54	54	54	54	0%
	Acc. Depreciation: Plant and Machinery	-41	-49	-54	-54	-54	7%
	Other tangible Fixed assets	1	1	1	1	1	0%
	Acc. Depreciation: Other	0	0	-1	-1	-1	7%
	Land held for development	78	78	78	78	78	0%
	Other	0	39	46	19	21	437%
Total Asset		128	127	135	143	151	4%
	Fixed asset netted against grant received						
Liability							
Current Liability	Trade Payables	3					-100%
	Short term borrowing						
	Current Maturity of long term borrowing						
	Interest Payable						
	Short term Provision		0	0	0	0	
	Other Liabilities	0	0	0	0	0	4%
Non-current Liability	Secured Loan						
	Earnest Money Deposit for land develop	78	78	78	78	78	0%
	Other Long term liability		0	2	4	5	
Equity	Share Capital	30	30	30	30	30	0%
	Accumulated Deficit (Loss)	17	19	25	31	38	23%
Total Liability and Equity		128	127	135	143	151	4%

7) Summary

Alandur Sewerage project can be considered as successful so far and financially sustainable. There would be several key factors for success:

Discipline of Municipality

Contractual obligations between AMC and the BOT operator forced AMC to ensure timely payment for fixed rate fee of management and waste water treatment services.

Thus, the loan as well as contractual obligations ensured strong fiscal discipline by the municipal body, by making it take difficult decisions on capital priorities, closely oversee the sewer system

Implementing an effective fee system

Despite the willingness to pay survey that indicated that public willingness was far below the tariff requirement to meet the capital and operational cost of the project, the municipal council, through its rigorous public outreach measures, managed to impose reasonable levels of connection charges and sewer fee on the public. The municipality also managed to collect the connection charges fairly well in time to pre-empt the need for the loan provided by State governmental organization. Also, the connection deposits were collected in two instalments to meet the financial needs for most of citizens.

Assurances on payment to the Private Sector Participant

AMC agreed to provide the BOT operator a minimum level of income by accepting the 'take or pay' condition in the Agreement. Thus, AMC assumed the risk of minimum payment to the operator while the private partner assumed all other responsibilities and risks of financing, constructing and operating the STP for a period of 14 years.

12.6.7 Case - Mahua Jaipur BOT Project, NHAI

1) Background

India has a National Highways network of 65,569 km which was 1.7 per cent of the total road network of the country, and it carried over 40 per cent of total traffic. The role of developing, maintaining and managing National Highways in India has been entrusted to the National Highways Authority of India (NHAI) which was established in 1988 by an Act of Parliament, namely NHAI Act 1988, as a body corporate to discharge its functions on business principles. NHAI is mandated to implement the National Highways Development Program (NHDP) which is the amongst the world's largest road development programs covering 55,225 km (as on 31 March 2013). The Action Plan for NHDP involves a total investment of 2,200 billion on concessions/contracts to be awarded by 2012.

NHDP projects are financed primarily from the following sources: 1) CESS levied on petrol and high speed diesel (Central Road Fund), 2) funds received for externally aided projects, 3) additional budgetary support, 4) market borrowings and plough back of revenue

Under the PPP arrangement, two main modes of execution were followed by NHAI:

- Build Operate and Transfer (BOT) - Toll basis.
- Build Operate and Transfer (BOT) - Annuity basis.

Source: Union Government (Commercial) Ministry of Road Transport & Highways No. 36 of 2014

2) PPP Structure

JMTPL (I) Corporation Project is a company who engaged NHAI road as PPP model, BOT toll basis. JMTPL is a public Ltd company in India & incorporated under the provisions of the Companies Act, 1956. The Company is a SPV created by IJN Rajasthan (Mauritius) Ltd. in pursuance of

NHAI, for BOT basis. Its takes reconstruction, strengthening, widening, rehabilitation, O&M of existing Mahua-Jaipur Highway.

3) Project Cost

JMTPL (I) Corporation Project is a company who engaged NHAI road construction in PPP model, BOT toll basis. The Concession Agreement was signed in September 2005. The Company was entitled for a grant from NHAI of Rs 594,000,000 during operations period. Provisional Completion Certificate issued in September 2009. The Company is entitled for a grant from NHAI of Rs 396,000,000 during the construction period which has been shown as Capital Reserve. In terms of the Concession agreement the same is to be treated as Equity Support to be retained as such till the end of the concession period.

Table 12.6.31 Engagement profile

(Rs. In million)

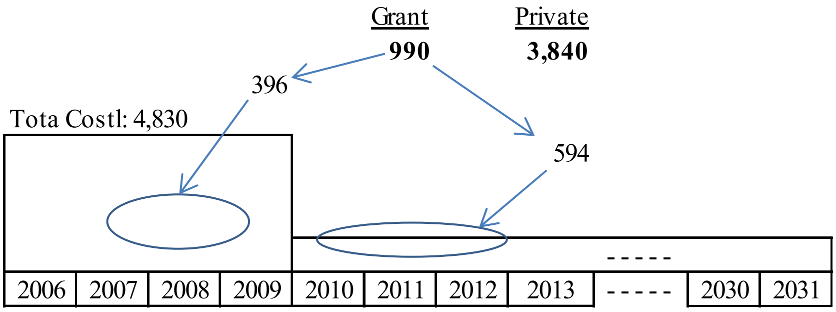
PARTICULARS	PROJECT COST	CONCESSION PERIOD	GRANT BY NHAI (VGF)	Share of Private Sector
MAHWA - JAIPUR (108 KM)	4,830	300 MONTHS	990	3840

Source: Union Government (Commercial) Ministry of Road Transport & Highways No. 36 of 2014

Table 12.6.32 Basic Time schedule of this Concession

Concession Agreement Signing Date Actual date on which the concession agreement is signed	25-Sep-05
Financial Closure Date Actual date on which financial closure is achieved	20-Mar-06
Apointed Date Actual date on which the project has started	20-Mar-06
Construction Completion Date (as per Concession Agreement) Construction completion date as per concession agreement	20-Mar-09
Construction Completion Date (Actual) Actual Construction completion date	26-Sep-09
Date to Start of Commercial Operation (Actual) Actual start date for commercial operation	26-Sep-09
Concession End Date (as per Concession Agreement) Date of end of concession as per the concession agreement	20-Mar-31

The Grant from NHAI is Rs. 990 million which is about 20% of the Total project cost. The company will pay Rs. 3,840 million or about 80% of the total cost.



Source: Drawing by JICA Study Team

Figure 12.6.4 The Total cost, cost portion and Grants.

4) Financial Performance

Most revenue from 2012 to 2014 comes from Toll operation while the Grant from NHAI is just 3%. In Expense of the same years, about 41% is Maintenance Expense but finance cost or interest expense is rather high, as much as 34%

Table 12.6.33 Engagement profile

Rs. Million

Performance Financial Results			2013-14	2012-13
Revenue				
	Revenue from Operation			
		Revenue from Toll Operation	961.2	870.2
		Operating Grant from NHAI	22.2	33.9
		Sub total	**983.4**	**904.1**
		Other Income	31.0	18.3
		Total Income	**1,014.3**	**922.4**
Expense			0.0	0.0
		Maintenance Expense	686.6	365.4
		Employee Benefit Expese	19.5	25.7
		Other Expenese	156.8	159.4
		Depreciation and Amortization	154.1	140.3
		Interst	432.5	448.3
		Total Expenses	**1,449.5**	**1,139.1**
Provision for Taxation			-435.2	-216.7
Balance Brought Forward			-979.8	-763.1
Balance carried to Balance Sheet			-1,415.0	-979.8

Source: Annual report of JMTPL (I) Corporation 2013-14

12.7 SPV Financial Modeling

12.7.1 Introduction

Government of India Cabinet leased 6th January 2016 that the Union Cabinet has approved the proposal for taking up Hybrid Annuity based PPP (Private Public Partnership) model under Namami Ganga Program which aims to reform the wastewater sector in India. This model will have two types of SPV (Special Purpose Vehicle), National-level SPV and ULB (Urban Local Body) -level SPV or the Project level SPV. In this chapter, the latter or ULB-level SPV is examined and analyzed.

HAM-PPP (Hybrid Annuity model) is different from current EPC model in the legal matters and various conditions in the agreement or the contracts. Similarly, HAM-PPP will show a different cash flow model or financial model. This section will provide the information of the financial model under HAM and also offer financial simulation based of DPR which is supposed to take HAM, 1) Mirzapur case, 2) Chunar case. Since these simulations cannot be conducted with the real information such as proposed cost from exact potential concessionaires nor the amount of equity or debts form stakeholders, the new simulation/calculation will be required in the future once the information will be obtained.

12.7.2 Base Conditions of Financial Modeling

1) Financial viewpoints in HAM

Although the key business function of Sewage system basically can be the same between the different structures, SPV model will show a different financial model from other non-SPV model.

In this section where HAM is to be simulated, it is defined at the beginning here about SPV scheme in the financial point of views. In the following simulation here in this section, the basic structure of this business model that affect financial model is considered as "To-be next model" in the Figure 50.1.1 below.

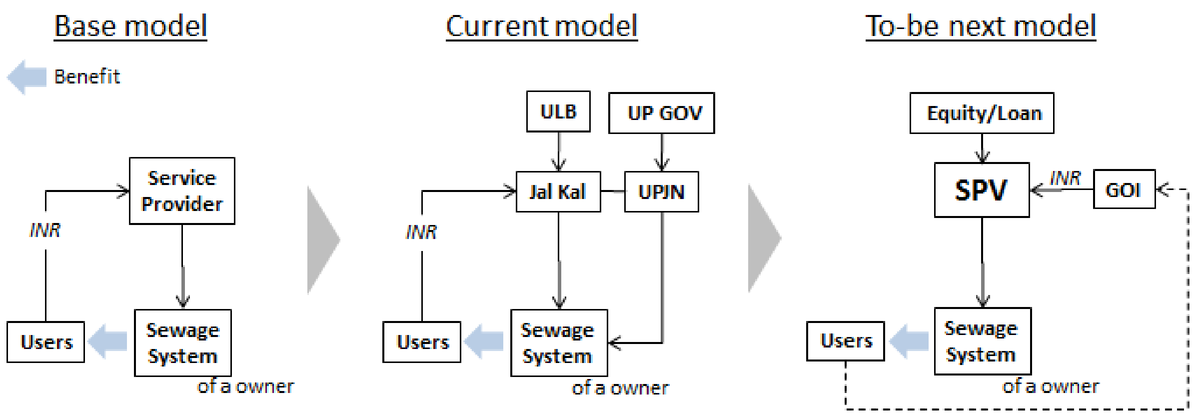


Figure 12.7.1 The basic structure of SPV of financial viewpoint

More in detail, the financial/accounting relationships/flow can be described in the following chart. Figure 50.1.2 based on "To-be next model" in the above. There are some important conditions in the financial point of view to consider HAM. The simulation in the section depends upon those;

- The size of balance sheet, amount of debt and equity is not predetermined as a rule so the debt/equity ratio is not predetermined while the majority of the equity holder should be Central Government or Government of India. (See Ref.2 in the below as another case).
- It can be probable that private company (Concessioner) or others puts equity in SPV.
- SPV can contract business agreements (design/build/O&M, etc.) with outside vendors however SPV in itself can do so.
- Debt or loan will be paid back with its interest to lenders (note: The below Figure does not show this flow, SPV to lenders)
- It is not always necessary that Government itself collect tariff from users but it should belong to GOI in accounting/financial perspective, as one of sources of Annuity from GOI.
- Escrow account would be prepared by SPV, whose bank account would be for incoming tariff, Annuity, bonus and any other payments.

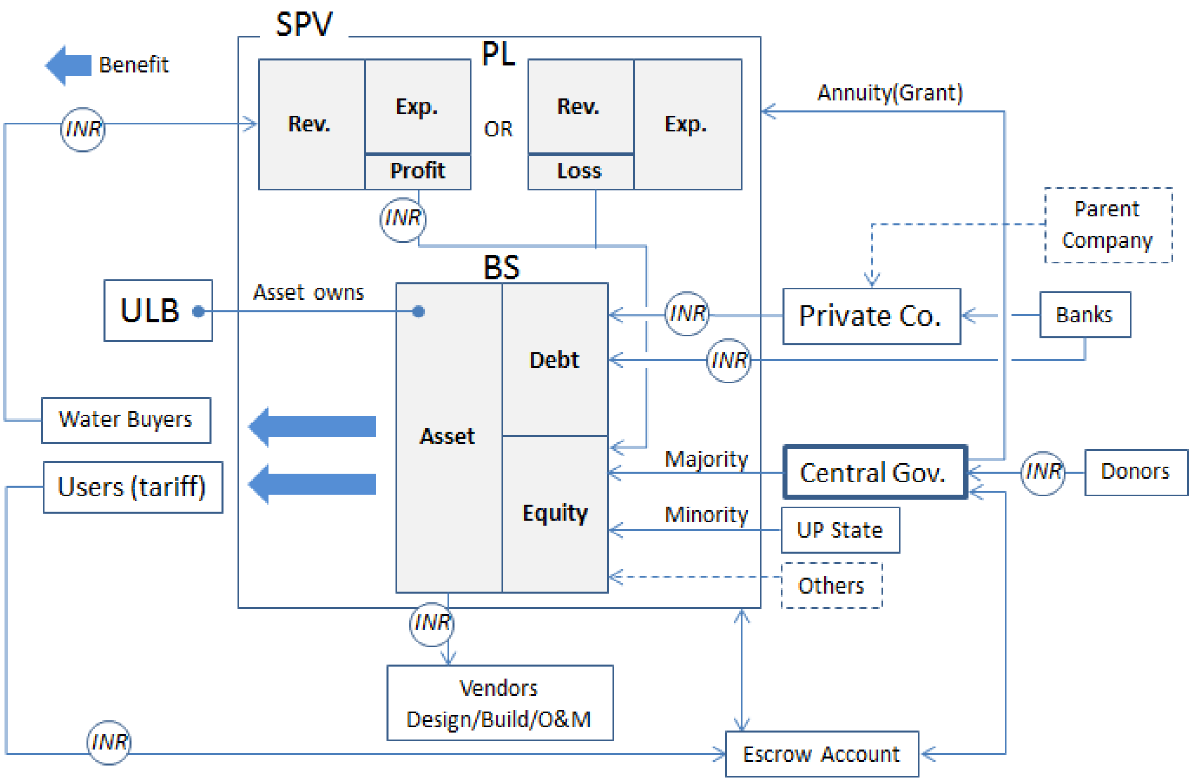


Figure 12.7.2 Financial viewpoints under HAM

Ref.1: Smart City Guideline in India, for example, has this definition; "*The Smart City Mission will be operated as a Centrally Sponsored Scheme (CSS) and the Central Government proposes to give financial support to the Mission to the extent of Rs.48,000 crores over five years i.e. on an average*

Rs.100 crore per city per year. An equal amount, on a matching basis, will have to be contributed by the State/ULB; therefore, nearly Rupees one lakh crore of Government/ULB funds will be available for Smart Cities development."

2) The main basic rules in the financial viewpoints

Under the HAM structure depicted before, it is necessary to have the basis conditions in more details for having the financial simulation of HAM. These will determine the cash-flow or if bring anther cash-flow model once these will be changed. (Note: legal matters, organization structures or business contract matters are not referred here)

Table 12.7.1 The basic conditions of HAM related Finance/Accounting

Overall	
1	SPV is established by Government of India and State government under Companies Act 2013
2	Majority stake (at lesat 51%) comes from Government of India and the minority stake comes from State government
3	Equity from other parties is not particularly defined otherwise GOI has majority
Government	
1	Part of the capital investment (up to 40%) will be paid by government through construction linked milestones and the balance
2	Government pays to Annuity over the contract duration up to 20 years to SPV
3	Government receive sewage tariff from users, which can be a part of source of annuity.
4	This Annuity contains remaining capital investment (SPV's construction payment and its paid interest) and O&M cost in the contract
SPV	
1	SPV pays the capital investment (up to 60%) or construction cost along with necessary interest expense incurred
2	SPV pays O&M cost during the concession periods. O&M cost is the contracted amount in the agreement
3	SPV can sell the treated water for its revenue source, along with other salable materials such as sludge
4	SPV will receive Annuity from Government of India during the O&M concession period
5	SPV will transfer the assets (STP, sewer network, PS, etc.) to ULB at the end of the concession period
Others	
1	Annuity could be less amount if the service level of SPC will not meet the requirement in the agreement
2	Financial conditions including annuity could be modified if there is Force Majeure event

3) The basic structure under HAM-model

It is important to understand the pre-condition business framework under the new HAM when to have the cash flow model or financial model. As of today, there are two business models, one is related with focusing on STP and the other is focused on Sewer Network. Several models can be thought under HAM for the same way of either STP or Sewer Network in the illustrated in the table below. Other words, based on the model of business scheme, the financial model will vary so the financial simulation will show different results. So if the SPV will only work of STP and some MS, the business coverage is just for those facilities. If SPV will work on Comprehensive, composing of Sewer Network, STP and PS, etc., the financial will cover all of those. In this chapter, it is assumed that all key operational functions will belong to one single SPV (Model-Y for both STP/Sewer Networks) for doing the simple simulation.

As of today

STP	GOI	UP-S	ULB	UPJN	J/K	P/C
Asset Own						
Design						
Finance						
Build				PM		
O&M						
Tariff						

Primary
Secondary
GOI: Government of India
UP-S: UP State Government
J/K : Jal Kal
P/C: Private Company
P/C*: SPV or Concessioner
PM: Project Management
Mo: Monitoring
BOT*: Asset will be transferred after concession

Model - X

	GOI	UP-S	ULB	UPJN	J/K	P/C*
Asset Own			BOT*			
Design				PM		
Finance						
Build				PM		
O&M			Mo	PM		
Tariff						

Model - Y

STP	GOI	UP-S	ULB	UPJN	J/K	P/C*
Asset Own			BOT*			
Design						
Finance						
Build						
O&M			Mo			
Tariff						

As of today

S-N/W	GOI	UP-S	ULB	UPJN	J/K	P/C
Asset Own						
Design						
Finance						
Build				PM		
O&M						
Tariff						

Model - X

S-N/W	GOI	UP-S	ULB	UPJN	J/K	P/C*
Asset Own			BOT*			
Design				PM		
Finance						
Build						
O&M			Mo		PM	
Tariff						

Model - Y

S-N/W	GOI	UP-S	ULB	UPJN	J/K	P/C*
Asset Own			BOT*			
Design						
Finance						
Build						
O&M			Mo			
Tariff						

Figure 12.7.3 Theoretical Function map that earns Cash Flow at SPV

4) HAM types

In HAM for Sewage HAM, there can be thought two types of financial model, one: Annuity from GOI to SPV is fixed amount for every year, the other: Annuity is not always fixed but varies depend upon the year. The first typical case is NHAI who pays fixed amount Annuity including construction cost and O&M cost incurred by SPV. In the NHAI Agreement, “Model Concession Agreement for annuity based project”, there is the saying,

> *“8.1 Annuity: Subject to the provisions of this agreement and in consideration of the concessionaire accepting the concession and undertaking to perform and discharge its obligation in accordance with the term, conditions and covenants set forth in this agreement, NHAI agrees and undertakes to pay the concessionaire, on each annuity payment date, the sum of Rs. (The Annuity)”*

In here, “*Rs. ______(The Annuity)*” is the fixed amount that will be equally paid in the concession period. However, for Sewage, it can be thought that population will vary (basically increase trend for the DPR in this report) which will affect the O&M expenses. So JICA study team have financial simulation for both ways, flat Annuity model and variable Annuity model, in the later section.

5) Base Logic in HAM

Based on the assuming structure and key assumptions under HAM noted in before, the cash flow model or financial model can be illustrated. This explanatory model is flat type Annuity model and example here bases;

<Common conditions>

- The concession period is 20 years, and the construction takes two years for the 1st and 2nd year and O&M is from 3rd year until 20th year or 18 years.
- Construction cost (capital cost) is Rs.100 million and GOI will pay up-to 40% at commercial operating date (COB).
- So SPV pays 60% of this construction cost by itself by borrowing from lenders or banks will lend the loan to SPV or is appropriated by all equity.
- Lender interest rate is 10% and the payment is as Principal and interest equal repayment.
- O&M cost is Rs.5 million for all years. (for simplification, no inflation here)
- The sales of treated water is Rs.0.4 million/year, which is one of revenue sources to SPV
- Balance Sheet is omitted here (Only illustration of P/L);

Rs. million			0.00																				
O&M Period			*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	
Revenue side																							
Annuity			12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	Rs. 241.0
Sales			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Rs. 0.0
			12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	Rs. 241.0
Construction Period																							
Cost side																							
	10	10																					
	10	10																					
	10	10																					
	10	10	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	Rs. 141.0
	10	10	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	Rs. 100.0
	50	50	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	Rs. 241.0
SPV C/F per year																							
	-30	-30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Depreciation			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	Rs. 60.0
	-30.0	-30.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
SPV C/F accumulation																							
	-30.0	-60.0	-57.0	-54.0	-51.0	-48.0	-45.0	-42.0	-39.0	-36.0	-33.0	-30.0	-27.0	-24.0	-21.0	-18.0	-15.0	-12.0	-9.0	-6.0	-3.0	0.0	
NPV																							
		¥-31.3																					
		-60.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
		10%																					

Total construction cost		Rs. 100.00
GOI	40%	Rs. 40.00
SPV	60%	**Rs. 60.00**

Principal	**Rs. 60.00**	million	
Rate	10.0%		
Term	20.0	years	
Payment	Rs. 7.0	per year	
Year	Principal	Interest	Total
1	1.0	6.0	7.0
2	1.2	5.9	7.0
3	1.3	5.8	7.0
4	1.4	5.7	7.0
5	1.5	5.5	7.0
6	1.7	5.4	7.0
7	1.9	5.2	7.0
8	2.0	5.0	7.0
9	2.2	4.8	7.0
10	2.5	4.6	7.0
11	2.7	4.3	7.0
12	3.0	4.1	7.0
13	3.3	3.8	7.0
14	3.6	3.4	7.0
15	4.0	3.1	7.0
16	4.4	2.7	7.0
17	4.8	2.2	7.0
18	5.3	1.8	7.0
19	5.8	1.2	7.0
20	6.4	0.6	7.0
	60.0	81.0	141.0

Figure 12.7.4 Basic Cash-flow model under HAM (1)

<GOI>

- In this model, 40% of Construction cost, Rs.40 million is paid at COB by the Government of India.

- After construction, Annuity of about Rs.7 million/year from 3rd to 20 year (for 20 years) are paid by GOI, Rs.241 million in totals.

- This composes the construction cost and interest paid by SPV for its first two year, Rs.141 million. And this also composes O&M cost Rs.5 million/year, the total of Rs.100 million.

- No profit margin addition in this table.

<SPV>

- Pays 60% of Construction cost or Rs.60 million during this two year construction periods.
- Payment to lenders by SPV is about Rs.7 million/year (including principal and interest) times 20 (10%, 20years) or Rs.141 million in total.
- O&M Cost is incurred actual basis, but the planning here shows Rs.5 million/year from 3rd to 20th year in the concession period, Rs.100 million in total (no inflation rate reflected here)
- Sale of Treated water by SPV is zero in here.
- Total amount revenues belong to SPV is Rs.241 million (no other revenue)

This explanatory example in the above shows negative NPV (net present value) when the hurdle rate of 10%, simply because Annuity from GOI to SPV only covers construction cost, interest paid by GOI and O&M, no margin profit added. NPV can be zero and above if the Annuity will increase from Rs.12 million/month to Rs.15.1 million /month adding the sales of treated water of Rs.1 million/month by SPV while this is just an example

Rs. million 3.05

Total construction cost		Rs. 100.00	Principal	**Rs. 60.00**	million
GOI	40%	Rs. 40.00	Rate	10.0%	
SPV	60%	**Rs. 60.00**	Term	20.0	years
			Payment	Rs. 7.0	per year

O&M Period			*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	
Revenue side																							
Annuity			15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	Rs. 302.0
Sales			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Rs. 20.0
			16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	Rs. 322.0
Construction Period																							
Cost side																							
	10	10																					
	10	10																					
	10	10																					
	10	10	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	Rs. 141.0
	10	10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Rs. 100.0
	50	50	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	Rs. 241.0
SPV C/F per year																							
	-30	-30	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	
Depreciation			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	Rs. 60.0
	-30.0	-30.0	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	
SPV C/F accumulation																							
	-30.0	-60.0	-53.0	-45.9	-38.9	-31.8	-24.8	-17.7	-10.7	-3.6	3.5	10.5	17.6	24.6	31.7	38.7	45.8	52.8	59.9	66.9	74.0	81.0	
NPV																							
		¥0.0																					
		-60.0	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	
		10%																					

Year	Principal	Interest	Total
1	1.0	6.0	7.0
2	1.2	5.9	7.0
3	1.3	5.8	7.0
4	1.4	5.7	7.0
5	1.5	5.5	7.0
6	1.7	5.4	7.0
7	1.9	5.2	7.0
8	2.0	5.0	7.0
9	2.2	4.8	7.0
10	2.5	4.6	7.0
11	2.7	4.3	7.0
12	3.0	4.1	7.0
13	3.3	3.8	7.0
14	3.6	3.4	7.0
15	4.0	3.1	7.0
16	4.4	2.7	7.0
17	4.8	2.2	7.0
18	5.3	1.8	7.0
19	5.8	1.2	7.0
20	6.4	0.6	7.0
	60.0	81.0	141.0

Figure 12.7.5 Basic Cash-flow model under HAM (2)

This illustration is too simplified (not showing inflation rate that will increase O&M cost, etc.); however the important things to remember are;

1) Debt portion could be up-to 60% in SPV. Finance source varies but it probably is loan from lenders.

2) Annuity from GOI includes the capital cost paid by SPV (its interest and planned O&M cost) SPV O&M cost (in the agreement) and the profit margin.

3) SPV will earn profit through its operation as well and sales opportunities such as treated-water.

4) Sewage Tariff is the revenue of GOI (not belong to SPV) which will be a composition of Annuity

(not shown in the illustration in the above)

6) Debt / Equity - financial cost

SPV is to have the balance sheet to kick-off the project, which of course has debt/equity at the start of the project. Up-to 40% of capital cost is to be provided by the Government (GOI as majority and State as minority). This would be routed through the SPV at ULB level by the initial capital or Grant given thereafter. Hence the capital is or is not be equal to the Contribution of capital cost made by the Government. They will have a fixed capital and can show the receipts afterwards as capital grants/revenue grants depending on the purpose of grant for O&M construction. (Note: in Smart City Case in India, the shareholding is the minimum as prescribed and it will change according to the size of project, commercial/financing requirements. It is only minimum capital for ensuring capital base. But the capital ratio will always be 50:50 (State: ULB) to be maintained)

There can be various financing patterns regarding debt/equity and there is no golden rule to reach to the “best balance sheet model” since the project depends upon various factor, project size, concession periods, operational risks, borrowing rate, etc. (Ref: Total Cost of all Project in Pune Smart City Mission, Rs.3480 crore of which Contribution by GOI/State/ULB up-to Rs.1000 crore Deficits financed through Loans, Municipal Bonds and other options.)

However there are three major decisions that affect the balance sheet;

- The total of Public side is 51% at least. (The maximum of concessionaire is 49%). Public side composes of Central government, State Government, ULB. (In the explanatory figure, GOI (government of India is a majority stakeholder (over 51%) and ULB is omitted for simplification.
- State government is a minority stakeholder
- Capital investment up-to 40% is paid by central government.

Figure 20.2.6 explains some models.

Theoretically E1) and E2) does not need debt since it is financed by all Equity with no debt interest payment for the construction cost. But from A) to G) shows the model that needs debt.

A) Three shareholders, the equity portion is the highest at the beginning balance sheet by keeping GOI as majority, so the equity portion is 78.5% while debt portion is 21.5%. So the borrowing cost including interest will be the least (Rs.50.5 million in this model) Since GOI pays its all capital investment (as up-to 40%) as equity, no capital-grant will come later. B) Similar model of A) but shareholders are only GOI and State. Still the debt portion is the least so the payment total is the same of A). C) The equity from State is less so the debt portion will increase as well as its borrowing cost will increase. D) Similar model of C) but central government pays half of capital cost supported by government at the beginning as equity but the other half will come as capital-grant later. So the debt portion will increase as well as its borrowing cost will increase.

E) Similar model of D) but less equity from government and more capital-grant later based of up-to 40% rule. F) Up-to 40% of capital cost is assured by government but most of it comes from capital grant later. During the construction period, SPV should actually borrow money more than Rs.59.1 million so the payment is close to the one of G). G) This shows an extreme, GOI pays very little equity, Rs.500,000 that is only the initial capital requirement with which a limited company in India is to be incorporated. It can be increased at any time. The reason they might have kept it to the basic minimum is to comply with minimum incorporation requirements. This will be increased appropriately whenever the grant/funds are released by the Government, and the same would be used to increase the share capital of the Company accordingly but this case intentionally shows that total capital investment is much less than up-to 40% of capital cost and that's all. The most of the finance cost should be covered by SPV. The finance cost is extremely high.

As noted before, the model omits ULB as a shareholder for the simplification

Beginning BS — Capital cost (construction cost) = Rs.100 million — Interest rate: 10% — Payment: 20 years

		Rs. million				DE	Ratio %				
		PC*	GOI	UPS	Total	Ratio	PC*	GOI	UPS		
E1)	**Debt**	0.0			0.0	0.0%				*Equity: GOI+UPS*	
	Equity	49.0	50.0	1.0	100.0	100.0%	49.0%	50.0%	1.0%	51.0%	
	later Grant		0.0								
	Capital cost	49.0	50.0	1.0	100.0		49.0%	50.0%	1.0%		
E2)	**Debt**	0.0			0.0	0.0%				*Equity: GOI+UPS*	
	Equity	49.0	26.0	25.0	100.0	100.0%	49.0%	26.0%	25.0%	51.0%	
	later Grant		0.0								
	Capital cost	49.0	26.0	25.0	100.0		49.0%	26.0%	25.0%		
A)	**Debt**	21.5			21.5	21.5%				SPV Debt	21.5
	Equity	19.0	40.0	19.5	78.5	78.5%	24.2%	51.0%	24.8%	Payment total	50.5
	later Grant		0.0								
	Capital cost	40.5	40.0	19.5	100.0		40.5%	40.0%	19.5%		
B)	**Debt**	21.5			21.5	21.5%					
	Equity	0.0	40.0	38.5	78.5	78.5%	0.0%	51.0%	49.0%		
	later Grant		0.0								
	Capital cost	21.5	40.0	38.5	100.0		21.5%	40.0%	38.5%		
C)	**Debt**	59.0			59.0	59.0%				SPV Debt	59.0
	Equity	0.0	40.0	1.0	41.0	41.0%	0.0%	97.6%	2.4%	Payment total	138.6
	later Grant		0.0								
	Capital cost	59.0	40.0	1.0	100.0		59.0%	40.0%	1.0%		
D)	**Debt**	59.1			59.1	73.9%				SPV Debt	59.1
	Equity	0.0	20.0	0.9	20.9	26.1%	0.0%	95.7%	4.3%	Payment total	138.8
	later Grant		20.0								
	Capital cost	59.1	40.0	0.9	100.0		59.1%	40.0%	0.9%		
E)	**Debt**	50.5			50.5	72.1%				SPV Debt	50.5
	Equity	0.0	10.0	9.5	19.5	27.9%	0.0%	51.3%	48.7%	Payment total	118.6
	later Grant		30.0								
	Capital cost	50.5	40.0	9.5	100.0		50.5%	40.0%	9.5%		
F)	**Debt**	59.1			59.1	96.9%				SPV Debt	59.1
	Equity	0.0	1.0	0.9	1.9	3.1%	0.0%	52.6%	47.4%	Payment total	138.8
	later Grant		39.0								
	Capital cost	59.1	40.0	0.9	100.0		59.1%	40.0%	0.9%		
G)	**Debt**	99.5			99.5	99.5%				SPV Debt	99.5
	Equity	0.0	0.26	0.25	0.5	0.5%	0.0%	51.0%	49.0%	Payment total	233.7
	later Grant		0.0								
	Capital cost	99.5	0.3	0.2	100.0		99.5%	0.3%	0.2%		

Principal	Rs. 21.5	million
Rate	10.0%	
Term	20.0	years
Payment	Rs. 2.53	per year

Year	Principal	Interest	Total
1	0.4	2.2	2.5
2	0.4	2.1	2.5
3	0.5	2.1	2.5
4	0.5	2.0	2.5
5	0.5	2.0	2.5
6	0.6	1.9	2.5
7	0.7	1.9	2.5
8	0.7	1.8	2.5
9	0.8	1.7	2.5
10	0.9	1.6	2.5
11	1.0	1.6	2.5
12	1.1	1.5	2.5
13	1.2	1.3	2.5
14	1.3	1.2	2.5
15	1.4	1.1	2.5
16	1.6	1.0	2.5
17	1.7	0.8	2.5
18	1.9	0.6	2.5
19	2.1	0.4	2.5
20	2.3	0.2	2.5
	21.5	29.0	50.5

Figure 12.7.6 Several patterns for Debt/Equity Portion

Source: Created by JICA Study team

7) Revenue

Revenue is to be recognized to the extent that is probable that the economic benefit will flow to the SPV and the revenue can be reliably measured. The specific recognition criteria must be defined in a concession agreement for each project.

Sources of revenue in Sewage HAM are Annuity, the payment from GOI to SPV, and other possible sales such as treated water, sludge, etc. and others such as interest income; however the most of the portion of the revenue for SPV is Annuity from GOI.

Annuity composes of mainly three; (1) Construction cost and its interest paid by SPV (up to 60 % of construction), (2) O&M Cost (estimate submitted by SPV in the agreement) and (3) profit margin for SPV. Annuity, the highest portions of revenue sources, is assumed from two ways of calculations, flat annuity (fixed amount annuity) and variable amount annuity (Escalable Annuity) as described before.

- Flat (fixed) Annuity

  Equal payment method (principal and interest) to lender which is as Capital-grant by GOI plus equal amount payment of O&M cost (this O&M cost submitted from SPV is converted into NPV basis and then divided by concession period to obtain equal amount of O&M cost per year). So the Annuity is calculated as equal (fixed) amount for every year.

- Variable Annuity (Escalable Annuity)

  The finance cost is the same logic as in flat annuity, so the fixed amount. But O&M cost varies depend upon O&M cost estimation proposed by SPV in the agreement, which is mostly related with population increase in Sewage HAM model. So the sum of them is variable (escalable), not fixed one, in the end.

- Common subject matters

  It is assumed that either fixed annuity or variable annuity will depend upon SPV monitoring items or KPI such as BOD, but not Volume processed by SPV since SPV doesn't control input or the Volume (**1)

  (Reference note; there could be another way in general that SPV is to be monitored its performance by the volume amount, especially the SPV handles STP. In this case, at the beginning of project formation, Annuity is directly calculated based upon O&M cost proposed but in the actual operation phase, the processed volume will be monitored for SPV performance. For example, if actual treated water processed by SPV will not achieve target volume (MLD), the annuity may be reduced since projected O&M cost will be excessive than planned (proposed) O&M cost. Vice versa, if SPV would process more MLD than planned MLD, Annuity of that period can be modified for having an additional fee to SPV.

  In the illustration below, new SPT can have 20 MLD as its capacity and will incur O&M expense of Rs.88 million at some years later while at the first year of this concession only require 15MLD capacity that will incur O&M expense of Rs.80. If the actual MLD will be under the planned MLD, the annuity would be less than defined since the service does not reach to the target volume. This type of method is adopted Desalination projects)

**1*: Source – An officer comment at NMCG (30th June 2016)*

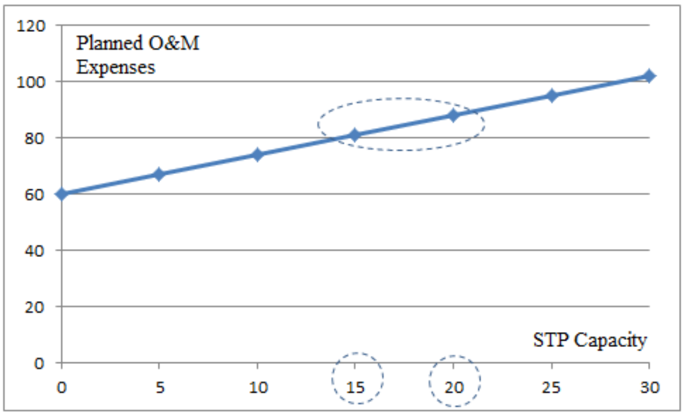


Figure 12.7.7 The base of revenue recognition (Illustrative)

Source: Created by JICA Study team

Under fixed Annuity model, Annuity amount is fixed one even if there is a gap between plan and actual MLD

(Reference note: In volume metric model, when there is a gap between plan and actual MLD, the O&M cost (gap or excessive or less), Annuity may be fixed by addition/deduction to the fixed Annuity.)

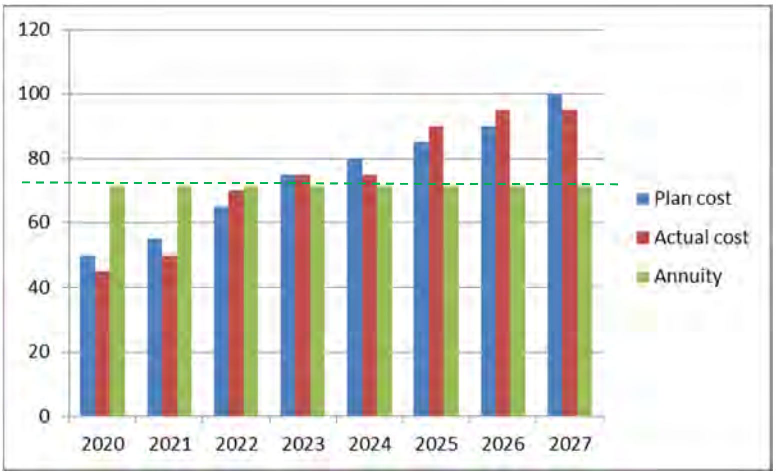


Figure 12.7.8 Fixed Annuity model (Illustrative)

Source: Created by JICA Study team

Similarly, under variable Annuity model, Annuity amount is not changed as noted in the agreement even if there is a gap between plan and actual MLD

(Reference note: In volume metric model, when there is a gap between plan and actual MLD, under variable Annuity model, when there is a gap between plan and actual MLD, the O&M cost gap (excessive or less), Annuity may be fixed by addition/deduction to each variable Annuity which is predetermined in the agreement. In volume metric model, for both fixed annuity or variable annuity,

Annuity will be paid depend upon volume that SPV processes, adding to other key monitoring KPIs)

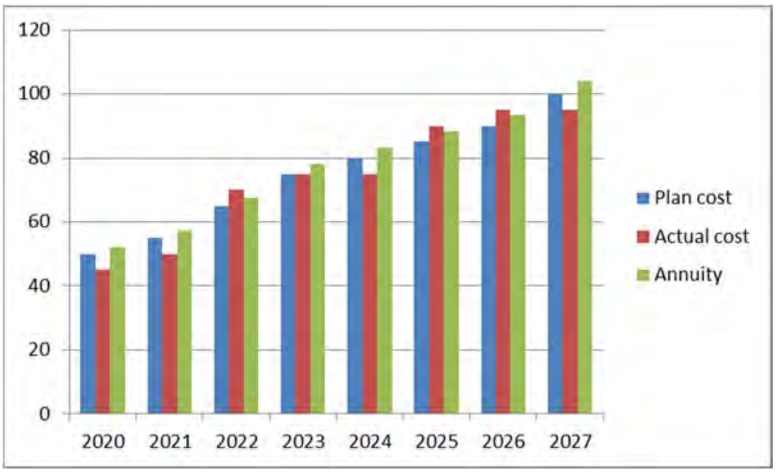


Figure 12.7.9 Variable (Escalable) Annuity model (Illustrative)

Source: Created by JICA Study team

8) O&M Cost

O&M costs are five items, Manpower Cost, Annual Repair Cost, Power Consumption Cost, DG Set Maintenance Cost and Chemical Cost for STP. In the simulation here, Manpower cost and power cost is examined by actual cost incurring at UP JP. It is concluded that Monthly Salary/Wages is adopted from DPR since required manpower is to be hired as an addition. (The actual cost incurring at UP JN is a bit higher than those in DPR. At UPJN, the workloads are; Design work: 15-20%, Build (Construction) Work: 50-55% and O&M: 30%)

Table 12.7.2 Actual labor Cost at UP JN in 2016 (budget)

		Unit 1 (Sewerage)				Unit 2 (STP)				Unit 3 (Electricity and Dinapur)			
		Head count	Total per annum (Rs. million)	Avg. per person	Per person per month	Head count	Total per annum (Rs. million)	Avg. per person	Per person per month	Head count	Total per annum (Rs. million)	Avg. per person	Per person per month
Class 1		2	Rs. 2.42	Rs. 1,210,200	Rs. 100,850	1	Rs. 0.78	Rs. 782,400	Rs. 65,200	0			
Class 2		5	Rs. 4.78	Rs. 955,680	Rs. 79,640	4	Rs. 2.88	Rs. 719,700	Rs. 59,975	3	Rs. 2.42	Rs. 806,400	Rs. 67,200
Class 3		25	Rs. 10.75	Rs. 429,936	Rs. 35,828	20	Rs. 7.86	Rs. 393,000	Rs. 32,750	20	Rs. 9.34	Rs. 466,800	Rs. 38,900
Class 4	Office	4	Rs. 1.41	Rs. 353,700	Rs. 29,475	3	Rs. 1.01	Rs. 336,800	Rs. 28,067	3	Rs. 1.05	Rs. 348,800	Rs. 29,067
	Field	30	Rs. 9.93	Rs. 330,920	Rs. 27,577	28	Rs. 8.74	Rs. 312,300	Rs. 26,025	57	Rs. 18.93	Rs. 332,105	Rs. 27,675
Total		66	Rs. 29.29	Rs. 443,782	Rs. 36,982	56	Rs. 21.28	Rs. 379,929	Rs. 31,661	83	Rs. 31.73	Rs. 382,308	Rs. 31,859
		Unit 4 Mirzapur				Unit 5 CU: Construction Unit				**Total**			
Class 1		0				1	Rs. 0.83	Rs. 826,800	Rs. 68,900	**4**	**Rs. 4.03**	**Rs. 1,007,400**	Rs. 83,950
Class 2		1	Rs. 0.96	Rs. 964,800	Rs. 80,400	2	Rs. 1.64	Rs. 822,000	Rs. 68,500	**15**	**Rs. 12.69**	**Rs. 845,680**	Rs. 70,473
Class 3		4	Rs. 1.49	Rs. 371,400	Rs. 30,950	10	Rs. 4.76	Rs. 476,400	Rs. 39,700	**79**	**Rs. 34.19**	**Rs. 432,835**	Rs. 36,070
Class 4	Office	0				3	Rs. 1.00	Rs. 333,600	Rs. 27,800	**13**	**Rs. 4.47**	**Rs. 344,031**	Rs. 28,669
	Field	28	Rs. 9.07	Rs. 324,000	Rs. 27,000	2	Rs. 0.61	Rs. 306,000	Rs. 25,500	**145**	**Rs. 47.29**	**Rs. 326,110**	Rs. 27,176
Total		33	Rs. 11.52	Rs. 349,164	Rs. 29,097	18	Rs. 8.85	Rs. 491,533	Rs. 40,961	**256**	**Rs. 102.67**	**Rs. 401,044**	Rs. 33,420

Source: JICA study team by data from UP JN of 2016

Table 12.7.3 Each labours for each work area at UP JN

Class	UPJN GPPU Post	Equivalent Category	Work Coverage
1	General Manager	Superintending Engineer	U1: Sewer line 142.5km, SPS x 2 (120 MLD and 18 MLD) and STP (120 MLD) for Comprehensive Sewerage Works in Trans-Varuna Area under JNNURM U2: Sewer line, SPS and STP (140MLD) for GAP1-2 funded by JICA and O&M of STP at Bhagwanpur U3: O&M for STP at Dinapur, Ghat SPS x5, Konia MOS U4: O&M for Mirzapur U5 (CU): Rehabilitation of Old Trunk Sewer and Existing STP and O&M such as Storm water drainage construction
2	Civil Project Manager	Executive Engineer	
2	Civil Project Manager	Executive Engineer	
2	E/M Project Manager	Executive Engineer	
2	Project Engineer	Assistant Engineer	
2	Project Engineer	Assistant Engineer	
3	Asst Project Engineer	Junior Engineer	
3	Support / Finance	Support / Finance	
4	Peon / 4th Class	Peon / 4th Class	
4	Supervisory	Supervisory	

9) Power consumption cost

The assumption is that electricity charge is paid by SPV under HAM while currently UPJN and Jal Kal do not but State government pays. Power consumption cost in DRP is calculated by Rs.5.5 /Unit Times total-KWH/ day for the year. JICA study team examined the actual billing from Electric Company to UP JP in 2016 (half year portion) which shows Rs.7.1/unit. So in the simulation of financial model, Rs.7.1 /Unit are adopted. The electricity charge is included in the simulation, which mean the SPV will pay as one of O&M cost although currently these bills are paid by the UP State of Government. The inflation rate is not used in the financial model later.

10) Interest Rate

In the following simulation, 13.2% is used for the bank borrowing rate. In the real simulation based on the proposals submitted from concessionaires, the rates will vary upon each project. And also, the rate may be from project finance rate calculated by the banks, not as the rate from corporate finance. Besides it could be possible that concessionaire will borrow much lower rate from its parents company or its group financing company.

Table 12.7.4 Bank Borrowing Interest rate

Reserve Bank of India Policy Rate (Bank Rate)	6.50%
Base Premium for commercial bank	3.45%
Spread for Larger business	2.75%
Long term Loan Premium +10 years	0.50%
Interest rate applied to simulation	**13.20%**

Source: Website of Reserve Bank of India and Central

11) Tax

Any Company registered under Indian Companies Act has to pay tax. He can be exempted from payment of income tax only if such a company performs a specified business as per the Income Tax Act 1961. There is no specific exemption for any government company from payment of Income

Tax as such. It can have exemption for certain years if it is into specified businesses but that is applicable for companies. Hence SPV as a government company has to pay tax at normal rates like for any company. Following SPV financial model has to include income tax in simulation. The basic tax rate for an Indian company is 30 percent which, with applicable surcharge and education cess, results in a rate of either 30.9% or 33.06 or 34.61%. (Education cess: Applicable at 3 percent on income tax (inclusive of surcharge, if any))

According to Tax regulations in India, there is no clear definition regarding tax exemption or tax refund during the course of procurement by the executing agency under the project supported by international corporation agency. It is recommended that tax treatment including exemption or refund should be clearly stated in E/N and L/A in detail as much as possible to ensure desirable tax treatment regarding domestic and foreign procurement. In addition, Base MOU, Project MOU and Bidding Condition Document should have clause to state tax treatment during the project work such as import tax on foreign procurement, VAT on domestic procurement, corporate income tax levied to SPV and individual income tax relating to technical advisor from abroad. Practically, when SPV procure goods or service from suppliers, SPV should agree with NMCG in writing to arrange with tax authority so that SPV can ensure tax exemption or refund during the project period.

12) Other conditions under HAM

There are now two funding sources, AMUR (Atal Mission for Rejuvenation and Urban Transformation) or NMCG, which will covers different scopes of DPR. The execution agency, UPJN can submit each DPR to AMRUT as well so that their project should be treated as in-scope of SAAP - State Annual Action Plan to get financed by State Government, not only to NCMG. So it is obvious that some of the projects submitted to UP state will be duplicated to NMCG project, while UPJN is not sure which project or mission will be accepted earlier.

The simulation in this chapter will be for the DPRs that we think belong to NMCG grant.

Table 12.7.5 Fund source and the adaptability

No.	Asset / Fund from	House Connection	N/W	PS (IPS)	STP (with MPS)	ID&T	Comprehensive Flag
1	AMRUT	(x)	X	X	X		X
2		(x)	X		X		X
3		(x)	X	X	*E*		X
4		(x)	X		*E*		X
5		X					
6	NMCG				X		
7				X	X		
8					X	X	
9				X	X	X	
10						X	
11				X		X	
12				X			

X: New Build (or work) *E: Existed* (x): Yes or No (whichever)

Source: Created by JICA Study team

Footnote: From UPJN officer's comments, UPJN Varanasi has already applied its DPRs to PDMC, Project Development Management Committee, of AMRUT as well and submitted to Service Level Improvement Plan to get approved for the DPRs relating following projects which most of their scope are duplicated to the project for NMCG-JICA. (updated cost Rs.19.5 million will be necessary to meet the new guidelines for water quality management)

Table 12.7.6 Application from UPJN to AMRUT

Varanasi (Rs. million)	Rs. 10.5
House Comm Chambers	Rs. 18.0
Secondary Sewerage Varanasi District 3	Rs. 38.4
Secondary Sewerage Varanasi District 2	Rs. 27.8
Secondary Sewerage Varanasi District 1	Rs. 15.5
50MLD DTP in Ramana	Rs. 110.2
Additional posible cost increase	Rs. 19.5

Source: Interviews at UP JN 2016

12.7.3 Trial Financial Modeling

Based on assuming structure, frameworks and preconditions mentioned so far, the following two cases are simulated as a trial for Mirzapur DPR.

1) Fixed Annuity model pattern

This explanatory example shows that Annuity model as fixed amount base is about Rs.258.7 million per year for the concession 20 years for Mirzapur project (ID&T and rehabilitation).

Principal	**Rs. 1,030.5**	million
Rate	**13.0%**	%
O&M	**20.0**	years
Payment	Rs. 146.69	per year

	O&M Cost		
(g)	Inflation		
	5.00%	10%	Cost of capital

Year	(a) Principal	(b) Interest	(c) Total	(d) OM	(e) Profit	(f) Annuity			
1	12.7	134.0	146.7	**110.0**	2.0	**258.7**	**72.8**		
2	14.4	132.3	146.7	110.0	2.0	258.7	76.5		NPV-O&M
3	16.3	130.4	146.7	110.0	2.0	258.7	80.3	(m)	882.2
4	18.4	128.3	146.7	110.0	2.0	258.7	84.3		
5	20.8	125.9	146.7	110.0	2.0	258.7	88.5		Installment
6	23.5	123.2	146.7	110.0	2.0	258.7	93.0	(n)	110.0
7	26.5	120.2	146.7	110.0	2.0	258.7	97.6		
8	29.9	116.7	146.7	110.0	2.0	258.7	102.5		NPV-OM
9	33.8	112.9	146.7	110.0	2.0	258.7	107.6	(o)	882.2
10	38.2	108.5	146.7	110.0	2.0	258.7	113.0		
11	43.2	103.5	146.7	110.0	2.0	258.7	118.6		
12	48.8	97.9	146.7	110.0	2.0	258.7	124.6		
13	55.2	91.5	146.7	110.0	2.0	258.7	130.8		
14	62.4	84.3	146.7	110.0	2.0	258.7	137.3		
15	70.5	76.2	146.7	110.0	2.0	258.7	144.2		
16	79.6	67.1	146.7	110.0	2.0	258.7	151.4		
17	90.0	56.7	146.7	110.0	2.0	258.7	159.0		
18	101.7	45.0	146.7	110.0	3.0	259.7	166.9		
19	114.9	31.8	146.7	110.0	4.0	260.7	175.3		
20	129.8	16.9	146.7	110.0	5.0	261.7	184.1		
	1,030.5	**1,903.4**	**2,933.9**	**2,199.6**	**46.0**	**5,179.5**	**2,408.4**		103.04873
			57%	42%	1%				

Mirzapur	Capital	O&M	Total		Capital	O&M	Total			OM 1st
IDT	884.6	870.4	1,755.0			870.4	1,755.0			60.1
Alternative	182.8	184.8	367.6	Add		184.8	367.6	SPV	**60%**	12.8
	1,067.5	**1,055.2**	**2,122.6**	650	**1,717.5**	**1,055.2**	**2,122.6**		**1030.49**	**72.8**
	(h)			(i)	(j)				(k)	(l)

Figure 12.7.10 Cash flow chart under Fixed Annuity model (1)

Source: Created by JICA Study team

The basic conditions in this model are; (a) Principal of loan borrowed by SPV (b) Interest incurring from the debt and paid by SPV also (c) Total finance cost per year composing of Principal and its interest (d) O&M cost annualized for 20 years

(e) Profit embedded to SPV by GOI (f) Calculated Annuity paid by GOI to SPV (g) Inflation rate during this project (h) Capital cost of Mirzapur project from DPR

(i) Estimated additional to DPR cost of Mirzapur DPR (j) Capital cost that both GOI and SPV have to pay (k) The construction cost paid by GOI (up-to 60% in this case)

(l) The O&M cost of the 1st year of the operation from DPR (m) NPV of O&M cost proposed by SPV (n) The O&M cost portion among Annuity per year (o) NPV of 20 times even O&M cost from (d)

So the money flows can be drawn in the following tables.

				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
		103																							
		103																							
	103	103																							
	103	103	103	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	Finance	2,934
	103	103	103	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	OM	2,200
																									5,133

Flat (Fided)

Annuity(F)				257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257
SPV	124	207	83	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257
TTL cost	310	517	207	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257	257

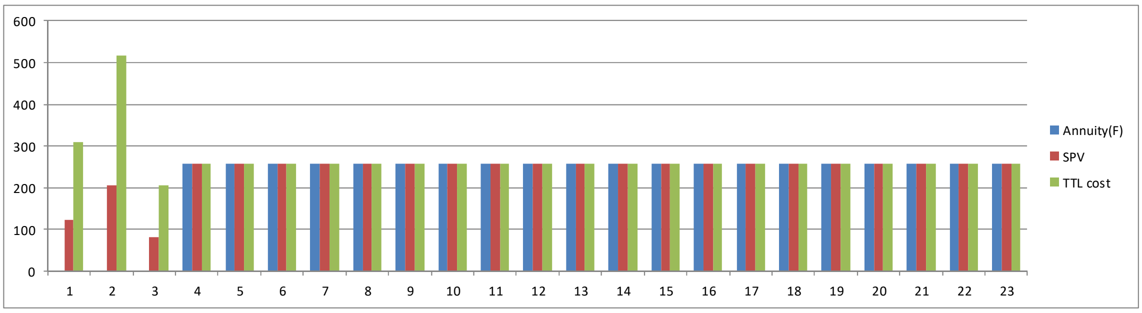


Figure 12.7.11 Cash flow chart under Fixed Annuity model (2)

Source: Created by JICA Study team

2) Variable Annuity pattern

This explanatory example shows that Annuity model as variable amount base in Mirzapur DPR. Since the population in Mirzapur will be increasing year by year, the O&M cost will be increasing aside from inflation increase. Compared with the previous model, fixed Annuity payment model, the total of Annuity, Rs.5388 million for 20 years are larger than Rs.5179 million of fixed Annuity model.

Principal	**Rs. 1,030.5**	million
Rate	**13.0%**	%
O&M	**20.0**	years
Payment	Rs. 146.69	per year

	O&M Cost		
(g)	Inflation		
	5.00%	10%	Cost of capital

Year	(a) Principal	(b) Interest	(c) Total	(d) OM	(e) Profit	(f) Annuity	
1	12.7	134.0	146.7	72.8	2.0	**221.5**	**72.8**
2	14.4	132.3	146.7	76.5	2.0	225.2	76.5
3	16.3	130.4	146.7	80.3	2.0	229.0	80.3
4	18.4	128.3	146.7	84.3	2.0	233.0	84.3
5	20.8	125.9	146.7	88.5	2.0	237.2	88.5
6	23.5	123.2	146.7	93.0	2.0	241.7	93.0
7	26.5	120.2	146.7	97.6	2.0	246.3	97.6
8	29.9	116.7	146.7	102.5	2.0	251.2	102.5
9	33.8	112.9	146.7	107.6	2.0	256.3	107.6
10	38.2	108.5	146.7	113.0	2.0	261.7	113.0
11	43.2	103.5	146.7	118.6	2.0	267.3	118.6
12	48.8	97.9	146.7	124.6	2.0	273.3	124.6
13	55.2	91.5	146.7	130.8	2.0	279.5	130.8
14	62.4	84.3	146.7	137.3	2.0	286.0	137.3
15	70.5	76.2	146.7	144.2	2.0	292.9	144.2
16	79.6	67.1	146.7	151.4	2.0	300.1	151.4
17	90.0	56.7	146.7	159.0	2.0	307.7	159.0
18	101.7	45.0	146.7	166.9	3.0	316.6	166.9
19	114.9	31.8	146.7	175.3	4.0	326.0	175.3
20	129.8	16.9	146.7	184.1	5.0	335.7	184.1
	1,030.5	**1,903.4**	**2,933.9**	**2,408.4**	**46.0**	**5,388.3**	**2,408.4**
			54%	45%	1%		

103.04873

Mirzapur	Capital	O&M	Total		Capital	O&M	Total			OM 1st
IDT	884.6	870.4	1,755.0			870.4	1,755.0			60.1
Alternative	182.8	184.8	367.6	Add		184.8	367.6	SPV	**60%**	12.8
	1,067.5	**1,055.2**	**2,122.6**	650	**1,717.5**	**1,055.2**	**2,122.6**		**1030.49**	**72.8**
	(h)			(i)	(j)				(k)	(l)

Figure 12.7.12 Cash flow chart under Variable Annuity model (1)

Source: Created by JICA Study team

The explanation or key parameters are almost same mentioned in fixed Annuity model in the above. The O&M cost varies by each year and these different cost will be covered by each year Annuity which is not same one for this concession period.

And the money flows can be drawn in the following tables.

				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
		103																							
		103																							
	103	103																							
	103	103	103	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	Finace	2,934
	103	103	103	73	76	80	84	89	93	98	102	108	113	119	125	131	137	144	151	159	167	175	184	OM	2,408
																									5,342
Variable																									
Annuity(V)				220	223	227	231	235	240	244	249	254	260	265	271	277	284	291	298	306	314	322	331		
SPV	124	207	83	220	223	227	231	235	240	244	249	254	260	265	271	277	284	291	298	306	314	322	331		
TTL cost	310	517	207	220	223	227	231	235	240	244	249	254	260	265	271	277	284	291	298	306	314	322	331		

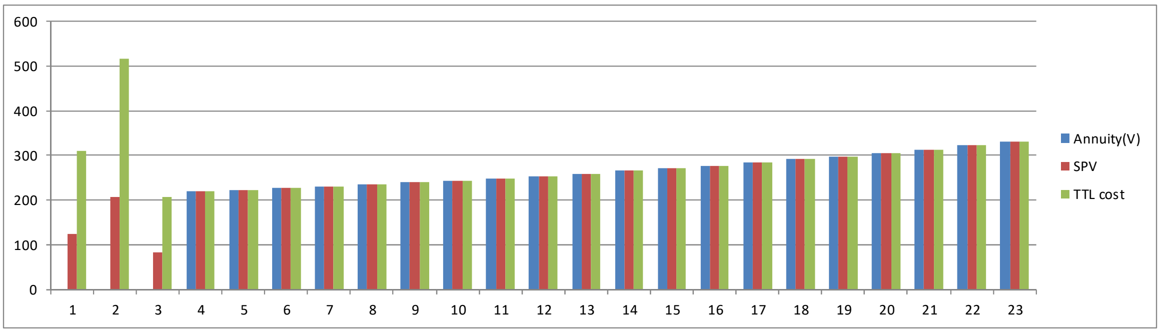


Figure 12.7.13 Cash flow chart under Variable Annuity model (2)

Source: Created by JICA Study team

12.7.4 HAM Financial Model (1) - Mirzapur

1) Precondition for financial modeling in Mirzapur

There are four DPR proposed from Mirzapur, A) Comprehensive, Rs.34.9 million, B) ID&T (Rs.17.55 million), C) Rehabilitation and process up-gradation of existing STP, either one of Rs.3.7 million or the other Rs.1.98 million. Based on the Fund adaptability noted before regarding AM-RUT and NMCG, the finance model of Mirzapur is simulated based on B) with the larger one of C), or not A) since it is considered the funding from NMCG.

However Nagar Palika Parishad Mirzapur or UPJN Mirzapur is eager to obtain any funding when it comes to regardless the fund source, which might lead to Comprehensive scheme instead of IT&D and rehabilitation if AMRUT grant will be approved earlier that NMCG. For now, it is said that Mirzapur will be granted Rs.5 million out of Rs.21.476 million on SAAP as part of Comprehensive DPR by AMRUT.

2) The Cost of Mirzapur

The cost of DPR for financial simulation is from ID&T and the rehabilitation of the larger one.

Table 12.7.7 The cost of ID&T of Mirzapur

A	**Basic cost**	
i	Basic Cost of work	725.88
ii	Contingency @2% of Basic cost	14.52
	Sub Total (A)	**740.40**
B	**Cost of Work on which no Centage is admissible**	**0.00**
i	Communication & Public Outreach	4.00
ii	Environmental and Management Plan (EMP)	8.00
iii	Governance and Accountability Action Plan (GAAP)	1.00
iv	Power Connection & Allied Works	26.08
v	Hiring of Godown and Site Office	1.85
vi	Cost of sewer cleaning equipments, Flushing Van	2.63
vii	TPI Charges @0.1% of Basic Cost ie Sub Total (A)	0.73
	Sub Total (B)	**44.29**
C	**Operation & Maintenance**	
i	Operation & Maintenance for first 10 years of commissioning of project	870.37
	Sub Total (C)	**870.37**
D	**Centage Charges**	
i	Centage charges @ 12.5 % of Basic Cost ie Sub Total A	92.55
	Sub Total (D)	**92.55**
E	**Labour Cess Charges**	**0.00**
i	Cess Charges @ 1% of Basic Cost ie Sub Total A	7.40
	Sub Total (E)	**7.40**
	Grand Total (A+B+C+D+E)	**1,755.00**

Source: Mirzapur DPR

Table 12.7.8 The cost of rehabilitation of Mirzapur

A	**Basic cost**	
i	Cost of work	**277.02**
ii	Contingency	5.54
	Sub Total (A)	**282.56**
B	**Cost of works on which no Centage is admissiable**	
i	Communication & Public Outreach	2.00
ii	Environmental and Management Plan (EMP)	2.00
iii	Governance and Accountability Action Plan (GAAP)	1.00
iv	Hiring of Godown and Site Office	1.33
v	Power Connection & Allied Works	2.51
vi	TPI Charges @0.1% of Basic Cost i.e. Sub Total (A)	0.28
	Sub Total (B)	**9.12**
C	**Operation & Maintenance**	
i	Operation & Maintenance for first 10 years of commissioning of project	206.74
	Sub Total (C)	**206.74**
D	Centage Charges	
i	Centage charges @ 12.5%of Basic Cost ie Sub Total(A)	35.32
	Sub Total (D)	**35.32**
E	Labour Cess Charges	
i	"@ 1%of Basic Cost ie Sub Total (A)	2.83
	Sub Total (E)	**2.83**
	Grand Total (A+B+C+D+E)	**536.57**

Source: DPR from Mirzapur

Footnote (remarks from UPJN): Some of the items in this ID&T are different from estimated costs in Comprehensive. Comprehensive DPR only covers the area inside the municipal border (internal Mirzapur city area) but some of the drain pipes are connected sub drain which collects sewer generated outside of municipal border. ID&T covers rather outside of internal Mirzapur city; the targeted are different although the mission is the same, stopping dirty water to come into Ganges River. AMRUT covers Comprehensive DPR but NMCG doesn't finance to Comprehensive DPR whose population is under 1 Lac, there is still be a way to deal with this conflict according to Chief Engineer of UPJN. That is, to align both kinds of DPR in terms of scope of work which is to be implemented separately and more harmonized manner to maximize the sewage treatment effectiveness and efficiency.

3) The detailed conditions for financial simulation for Mirzapur HAM

In the simulation, there are some conditions to be set. Those parameters can be modified based on assumption and actual offering data coming from potential concessionaries, which can give us different results. Those in the below are major parameters in the simulation sheet.

Table 12.7.9 Calculation Basis (1)

1	Fixed Asset Classification in the Construction Cost
	Construction cost should be allocated based on the Civil works and E&M works cost on each DPR.
	Civil works in DPR are allocated to Building
	E&M works in DPR are allocated to Plant and Machinery.
	Mirzapur : Building 58.6% Plant Machinery 41.4%
2	Useful life (depreciation years) of fixed asset
	Depreciation years is applied, shorter of O&M period or which is determined in the GAAP.
	Therefore, at latest on the end of 20th year of O&M period, all the fixed assets are fully depreciated and net book value should be zero.
	The fixed assets are assumed that there will be no residual value after the 20 years of O&M period ends.
3	VAT
	It is assumed that all of O&M cost incurred during the O&M period are procured domestically, and thus there is no imported goods and material and import duty is not included to this model as a cost.
	Only 12.5% of Central VAT is included to the model. VAT amount is excluded from P/L and the difference between input VAT and output VAT are deducted from cash flow as it is paid in the same year.
	Therefore, VAT Payable is not shown on the B/S in each year end.
4	TSA (Technical Service Advisor) Fee
	TSA Fee is estimated as 15% of Construction cost along with Engineering cost.
5	Share Capital / Equity registration fee
	1% of equity capital is required for Share Capital / Equity registration fee.
7	Equity of Capital set to 40% of total project cost
8	Working Capital Requirement
	It is assumed that approximately 2 months of O&M cost will incur through the O&M period.
9	Upfront fee of debt
	0.5% of debt is added as financial cost. Financing Cost is consisted of Upfront fee and Interest on construction period
10	Interests in Construction period
	Interests in Construction period are assumed to incur as if the loan proceeds will be withdrawn by 30%, 50% and 20% of total loan amount from 1st year to 3rd year of construction period.
	Interests in construction period is paid in each year when it incurs.
	Distribution of loan drawdown are assumed to be same as construction cost incurs, year 1 30%, year 50% and year 3 20%, as the construction cost are spread during 1st, 2nd and 3rd years in the ratio of 30%:50%:20% respectively.
	Therefore, there is no interest on interest as interest in each year is paid to creditor, under this assumption model.

Source: Assumption set by JICA Study Team

Table 2.7.10 Calculation Basis (2)

11	Interest rate
	13.2% (tentatively set as assumption)
12	Annuity payment
	Base model of this spreadsheet is based on 40% payment of the total Capital cost of the project upfront
	(over the construction period - three years) followed by annuity payments over the O&M period.
13	Insurance during the construction period
	Fee for Insurance during the construction period is borne by constructor not by SPV and thus, fee for insurance during construction period is not included.
14	Insurance during operation period (Operating Phase Insurance)
	It is assumed that 3.5% of net book value of fixed asset.
15	Land use rights fees
	It is assumed that there is no annual fee for land use right incurs, the land for STP can be used for free of charge, once it is acquired from landlord.
16	Transportation expense
	It is assumed that there is no transportation expense for treated water resale, because reuse of treated water is estimated as limited to irrigation and fertilizer manufacturer located close to STP.
17	Sales revenue of sludge and treated water.
	Assumed as zero.
18	O&M Cost Foreign
	No foreign purchase is assumed. Cost of O&M works are fully covered by domestic procurement.
19	Corporate income tax rate
	Corporate income tax rate is set as 30.09% - Standard rate of 30% plus 3% of education cess is multiplied to standard rate that comprises 30.09%.
20	Inflation rate
	Inflation rate which is used to indexation and O&M expense estimation is 5.05%, based on analysis of relevant item category in CPI and DPI in India.
21	Deferred tax
	It is assumed that there is only one source of temporary tax difference between financial accounting and tax accounting - difference of depreciation years.
22	Debt service
	For debt service in the annuity, total of principal and interest paid are equal in each year. Level payment or principal & interest equal payment is assumed.
	Debt service are paid semi-annually.
23	O&M Expense Manpower
	Manpower cost estimation is updated as follows:
	Indexed annual manpower cost is deducted by coverage of STP capacity by estimated sewerage water to be treated.
24	Operation Margin for SPV is set to be 2%

Source: Assumption set by JICA Study team

4) The simulation of Mirzapur ID&T and rehabilitation

Assumption and the simulation result show the followings:

- Construction will be from 2017 to 2019, three years. 30% of the construction will be done in the 1st year, 50% in the 2nd year and remaining 30% in 3rd year
- COD is in the year 2020, April 1st and this concession will be complete until 31st March 2040, 20 years.
- Annuity model is two type; Flat (Fixed) amount and Variable amount by Mirzapur DPR.

Table 12.7.11 The base data for simulation in Mirzapur

Operating year	1	2	3	4	5	6	7	8	9	10
Population	252,955	254,659	256,374	258,101	259,840	261,590	263,352	265,126	266,912	268,710
Household size	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82
Sewerage Connection Rate	20%	21%	23%	25%	27%	29%	31%	34%	36%	39%
Connected population	49,604	53,934	58,641	63,759	69,323	75,373	81,951	89,104	96,880	105,336
Gross Sewage Generation per capita (lpcd)	135	135	135	135	135	135	135	135	135	135
Water to Sewerage conversion ratio	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Additional Sewerage water collected	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
Net Sewerage Water to be collected and treated (Litter/Day)	5,893,001	6,407,314	6,966,513	7,574,517	8,235,584	8,954,345	9,735,837	10,585,533	11,509,387	12,513,871
Net Sewerage Water to be collected and treated (MLD)	6	6	7	8	8	9	10	11	12	13
Net Sewerage Water to be collected and treated	5,893	6,407	6,967	7,575	8,236	8,954	9,736	10,586	11,509	12,514

m3:Cubic Meter lpcd: Litter per Capita Day

Operating year	11	12	13	14	15	16	17	18	19	20
Population	272,436	276,213	280,043	283,926	287,863	291,524	295,231	298,985	302,787	306,637
Household size	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82
Sewerage Connection Rate	42%	46%	49%	53%	58%	62%	67%	73%	78%	85%
Connected population	115,340	126,294	138,289	151,423	165,804	181,346	198,344	216,935	237,270	259,510
Gross Sewage Generation per capita (lpcd)	135	135	135	135	135	135	135	135	135	135
Water to Sewerage conversion ratio	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Additional Sewerage water collected	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
Net Sewerage Water to be collected and treated (Litter/Day)	13,702,374	15,003,756	16,428,736	17,989,053	19,697,561	21,543,881	23,563,263	25,771,929	28,187,621	30,829,743
Net Sewerage Water to be collected and treated (MLD)	14	15	16	18	20	22	24	26	28	31
Net Sewerage Water to be collected and treated	13,702	15,004	16,429	17,989	19,698	21,544	23,563	25,772	28,188	30,830

Table 12.7.12 The simulation result Mirzapur Hybrid Annuity Model

	Annuity type	
	Flat (Fixed)	Variable
Annuity Total from GoI	242,514	241,978
Annuity Debt Service	124,458	124,458
Annuity O&M	118,056	117,520
Annuity O&M -User Tariff Coverage	11.43%	11.49%

At the last concession year or 2040 for Flat Annuity model, Equity will be 579,817, Legal Reserves/Thin Capitalization Requirement will be zero, Free Reserves will be -249,662, so Total Equity will be 330,154, and then Total Liabilities and Equity will be 127,905, while Total Liabilities and Equity for Variable Annuity model will be 451,451. (Thousand Rs.)

If HAM-PPP for Mirzapur should obtain its IRR as 5%, the Annuity from the GOI will be much larger than the simulation result in the above.

Table 12.7.13 The simulation result Mirzapur Hybrid Annuity Model (IRR 5%)

	Annuity type	
	Flat (Fixed)	Variable
Annuity Total from GoI	305,521	290,281
Annuity Debt Service	124,458	124,458
Annuity O&M	181,062	165,823
Annuity O&M -User Tariff Coverage	7.45%	8.14%

12.7.5 HAM Financial Model (2) – Chunar

1) Precondition for financial modeling in Chunar

There are two DPR proposed from Chunar, A) Comprehensive, Rs.1255.3 million, B) ID&T Rs.53.7 million. Based on the Fund adaptability noted before regarding AMRUT and NMCG, and the population of Chunar is under 1 Lack, the finance model of Chunar is simulated based on B), IDT. (If Chunar would have an approval from AMRUT earlier than from NMCG, it would adopt Comprehensive, but the simulation of it will not to be considered here since it's belong to AMRUT)

2) The Cost of Mirzapur

The cost of DPR for financial simulation is from ID&T and the rehabilitation of the larger one.

Table 12.7.14 The cost of ID&T of Chunar

i	Cost of work	**277.02**
ii	Contingency	5.54
	Sub Total (A)	**282.56**
B	**Cost of works on which no Centage is admissiable**	**0.000**
i	Communication & Public Outreach	2.00
ii	Environmental and Management Plan (EMP)	2.00
iii	Governance and Accountability Action Plan (GAAP)	1.00
iv	Hiring of Godown and Site Office	1.33
v	Power Connection & Allied Works	2.51
vi	TPI Charges @0.1% of Basic Cost i.e. Sub Total (A)	0.28
	Sub Total (B)	**9.12**
C	**Operation & Maintenance**	**0.00**
i	Operation & Maintenance for first 10 years of commissioning of project	206.74
	Sub Total (C)	**206.74**
D	Centage Charges	**0.00**
i	Centage charges @ 12.5%of Basic Cost ie Sub Total(A)	35.32
	Sub Total (D)	**35.32**
E	Labour Cess Charges	**0.00**
i	"@ 1%of Basic Cost ie Sub Total (A)	2.83
	Sub Total (E)	**2.83**
	Grand Total (A+B+C+D+E)	**536.57**

3) The simulation of Mirzapur ID&T and rehabilitation

Assumption and the simulation result show the followings:

- Chunar Building cost is 72.3% and Plant Machinery is 27.7% for DPR analysis.
- Construction will be from 2017 to 2019, three years. 30% of the construction will be done in the 1st year, 50% in the 2nd year and remaining 30% in 3rd year
- COD is in the year 2020, April 1st and this concession will be complete until 31st March 2040, 20 years.
- Annuity model is two type; Flat (Fixed) amount and Variable amount by Chunar DPR.

Table 12.7.15 The base data for simulation in Chunar

Operating year	1	2	3	4	5	6	7	8	9	10
Population	48,000	48,700	49,400	50,100	50,800	51,500	52,200	52,900	53,600	54,300
Household size	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Sewerage Connection Rate	20.0%	21.6%	23.3%	25.2%	27.2%	29.4%	31.7%	34.3%	37.0%	40.0%
Connected population	9,600	10,519	11,524	12,622	13,823	15,134	16,567	18,132	19,842	21,709
Gross Sewage Generation per capita (lpcd)	135	135	135	135	135	135	135	135	135	135
Water to Sewerage conversion ratio	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Additional Sewerage water collected	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
Net Sewerage Water to be collected and treated (Litter/Day)	1,140,480	1,249,681	1,369,055	1,499,531	1,642,121	1,797,929	1,968,156	2,154,113	2,357,226	2,579,052
Net Sewerage Water to be collected and treated (MLD)	1.14	1.25	1.37	1.50	1.64	1.80	1.97	2.15	2.36	2.58
Net Sewerage Water to be collected and treated	1,140	1,250	1,369	1,500	1,642	1,798	1,968	2,154	2,357	2,579

m3:Cubic Meter lpcd: Litter per Capita Day

Operating year	11	12	13	14	15	16	17	18	19	20
Population	55,000	55,615	56,231	56,846	57,462	63,000	64,133	65,267	66,400	67,533
Household size	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Sewerage Connection Rate	43.2%	46.6%	50.4%	54.4%	58.7%	63.4%	68.5%	74.0%	79.9%	86.3%
Connected population	23,748	25,935	28,320	30,920	33,755	39,969	43,943	48,298	53,067	58,291
Gross Sewage Generation per capita (lpcd)	135	135	135	135	135	135	135	135	135	135
Water to Sewerage conversion ratio	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Additional Sewerage water collected	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
Net Sewerage Water to be collected and treated (Litter/Day)	2,821,283	3,081,078	3,364,384	3,673,300	4,010,110	4,748,357	5,220,479	5,737,751	6,304,376	6,924,939
Net Sewerage Water to be collected and treated (MLD)	2.82	3.08	3.36	3.67	4.01	4.75	5.22	5.74	6.30	6.92
Net Sewerage Water to be collected and treated	2,821	3,081	3,364	3,673	4,010	4,748	5,220	5,738	6,304	6,925

Table 12.7.16 The simulation result Chunar Hybrid Annuity Model

	Annuity type	
	Flat (Fixed)	Variable
Annuity Total from GoI	65,644	65,464
Annuity Debt Service	39,342	39,342
Annuity O&M	26,302	26,121
Annuity O&M -User Tariff Coverage	11.73%	11.81%

At the last concession year or 2040 for Flat Annuity model, Equity will be 183,285, Legal Reserves/Thin Capitalization Requirement will be zero, Free Reserves will be -32,160, so Total Equity will be 151,125, and then Total Liabilities and Equity will be 101,966, while Total Liabilities and Equity for Variable Annuity model will be 135,622 (Thousand Rs)

If HAM-PPP for Chunar should obtain its IRR as 5%, the Annuity from the GOI will be much larger than the simulation result in the above.

Table 12.7.17 The simulation result Chunar Hybrid Annuity Model (IRR 5%)

	Annuity type	
	Flat (Fixed)	Variable
Annuity Total from GoI	85,466	80,401
Annuity Debt Service	39,342	39,342
Annuity O&M	46,124	41,059
Annuity O&M -User Tariff Coverage	6.69%	7.51%

12.7.6 Disbursement procedure

There are two ways of disbursement methods; On-budget method and Off-budget method. Under On-budget method, Donors disburse the loan to budgetary account of borrower country which is a part of its general budgetary account system. On the other hand, under Off-budget method, the fund is disbursed to borrower country without through its budgetary system and is paid to supplier or executing agency's bank account by following procedures. For Donor's standpoint, Off-budget method is preferable since flow of the fund is transparent with specific project and its relating procurement to ensure accountability of disbursement. There are four disbursement procedures relating to Off-budget disbursement method; Commitment procedure, Reimbursement procedure, Special Account procedure and Transfer procedure.

1) Commitment procedure

Commitment procedure is basically used for foreign procurement settled by L/C based on loan agreement between Donor and Borrower country and based on procurement contract between executing agency and supplier. Advantage of this procedure for Donor's perspective is that, workload for administration and documentation handling is limited, and that evidence document for disbursement can be collected before cash delivery. From Borrower and SPV's point of view, it is advantageous that there is no administrative workload since L/C is submitted by supplier directly to supplier's bank account for payment. In addition, SPV does not need to pay to supplier before loaned money funded by donor. However, fee for L/C settlement should be paid by Borrower. Supplier outside of borrower country would prefer this payment procedure because payment is rather quick and ensured comparing to other procedure.

2) Reimbursement procedure

Reimbursement procedure is simplified process to pay for procured goods, service or project cost that SPV needs to pay the cost to supplier first then claim back to Donor through borrower country. Simplified procedure enables all stakeholders to have least workload during the disbursement process and it provides convenience especially for domestic procurement. Also, evidence document can be collected in place before reimbursement. However, for SPV's stand point, payment must be made to supplier before get the fund from Donor. In contradiction to SPV, if the borrower country and SPV's financial condition are not good, payment to supplier before reimbursement would be delayed ant it may result in delay of the project. L/C is not involved and there is no need to pay the cost for L/C issuance and handling.

3) Special account procedure

Borrower country open bank account dedicated to use as Special Account in its domestic bank. And also Borrower country open Non-resident Yen account in the bank of Donor's country. After closing of L/A, Donor execute initial disbursement upon request from Borrower Country, to Borrower's Yen account. Then the fund initially disbursed is transferred to the Special Account. Supplier will receive payment after they submit the claim for payment with evidence. Once this procedure started, replenishment deposited to this Special Account is made by the similar procedure of Reimbursement. This procedure will provide flexibility to deal with financial demand from SPV or Supplier. However, the fund deposited in Special Account needs to be monitored with due care in terms of each step in the procedure because once money is transferred to the Special Account, further disbursement to supplier is handled by Borrower and SPV. Therefore, it can be the case where Donor fail to collect all of the evidence that prove the funded money are used for the project purpose only.

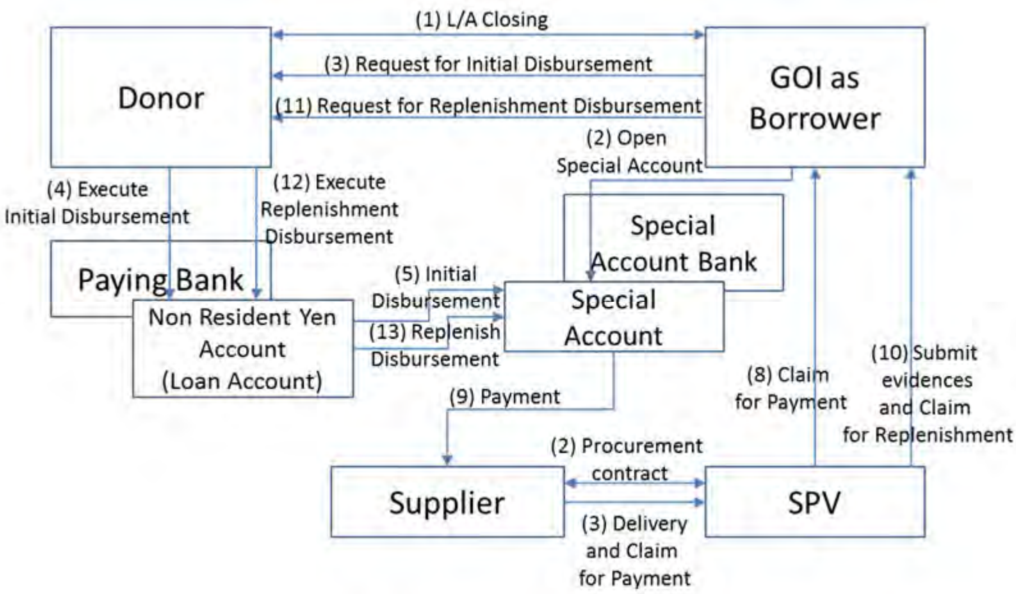


Figure 12.7.14 High level diagram of Special Account Procedure

4) Transfer procedure

Transfer procedure also disburse the money through Non-resident Yen Account of Paying Bank in

Donor's country. But the money is transferred to supplier directly and not through special account. The most important advantage of this procedure is, supplier can receive the cost for its goods or service according to the contract with SPV in a timely manner, no matter how SPV has financial difficulty. On the other hand, it is rather difficult to collect the evidence such as Receipt from supplier and SPV, owner of the Non-resident Yen account needs to bear relatively high cost for bank charge of the transfer.

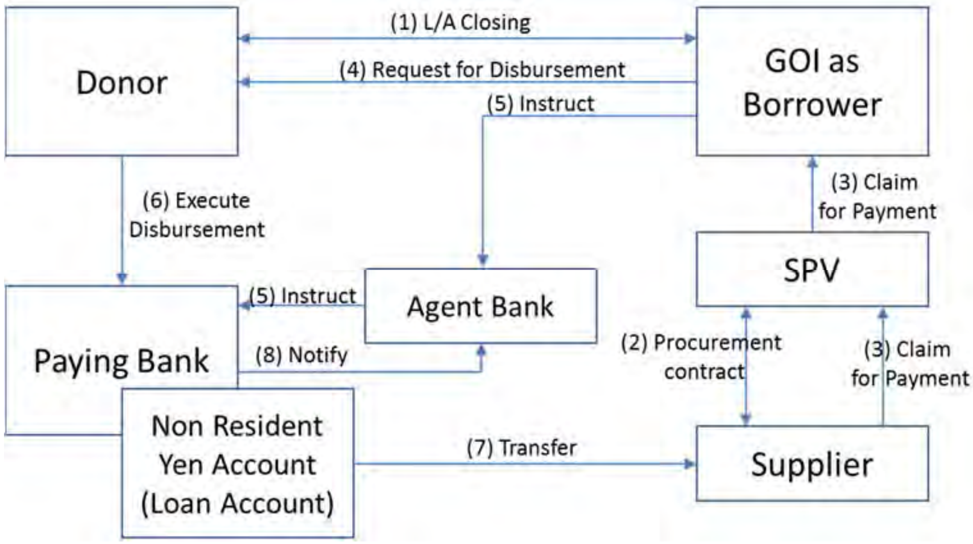


Figure 12.7.15 High level diagram of Transfer Procedure

5) Preferable disbursement procedure for this project

Each procedure has its own advantage and disadvantage; so if possible, it is proposed that Donor should consider using different procedure for different nature of payment. During the construction period, foreign procurement should follow Commitment procedure using L/C. Payment for domestic procurement can be handled by Transfer procedure. And once SPV enters to O&M period, Donor can choose Special Account procedure for Annuity payment by GOI to SPV, which comprises of capital cost and its interest portion. If such "combination" approach does not work for Donor, it is also recommended that we try to collect Hybrid Annuity Model which is not yet issued by GOI, since the template of Project MOU and Bidding document as basis of Hybrid Annuity Model are also the input for the choice of preferable disbursement procedure.

12.7.7 Risk and Control

Hybrid annuity model is different from traditional EPC project model, construction contract model and thus following risks would exist during the construction and O&M period.

Table 12.7.18 Risk and Control

Owners	Hybrid Annuity Model	Current EPC Model
Public - Sectors - GOI - State - ULB	- Transformation risk from current stake-holders to HAM - Possible financial burden (Interest amount paid to SPV later while Interest rate is supposed to be hedged) - Possibility that Annuity will be overpaying compared with actual O&M cost paid by SPV	- It had been observed that benefits accrued from substantial investments made under various past programs (Ganga Action Plan I & II, NGRBA, Yamuna Action Plan) were less than optimal. - According to Central Pollution Control Board (CPCB), almost 30% of the Sewage Treatment Plants (STPs) monitored in the 4 states of UP, Uttarakhand, Bihar & West Bengal was not operational and 94% were non-compliant with the prescribed effluent standards. - Hard to understand sewage performance in managerial accounting and finance point of view. - Cost increasing Risk in the current governance (UPJN, JALKAL, vendors)
Private Company (or SPV)	- Possibility that Annuity will be not enough to cover the actual O&M cost incurred by SPV in its operation (SPV's overpaying cost) - Risk not to find treated water sales	N/A
Lenders	- Bad debt risk since SPV is non-recourse finance structure. (GOI don't give sovereign guarantee to SPV)	N/A
Donors	- Possible project delay for GOI taking time to transform into HAM - Possible bad debt risk unless the loan repayment is guaranteed by GOI in loan the agreement (There is a risk of SPV bankrupt as a corporation)	N/A (need to confirm the current agreement with Government of India)

1) Sponsor risk

Risk Owner: Sponsors

Risk description:

Sponsor (e.g. GOI/State-Govt./ULB) will find the SPV does not achieve the business requirement or the people in that area won't need Sewage system or the existence of the SPV such as due to extreme decrease of population. GOI (Annuity provider) cannot earn adequate tariff from users which leads to very low rate of return on its capital investment. GOI will find the private company or concessionaire doesn't support SPV enough, or find the lenders will have difficulty offering loan/debt to SPV that will endanger SPV operation.

For lenders as a sponsor, they will have difficulty to collect the loan/debt from SPV.

Counter measure to control risk – contract level:

Conduct through examinations on the project applicants (candidate private companies). There may be no risk controls for lenders if SPV is non-recourse model.

Counter measure to control risk – process level:

Contingent equity/loan commitment: Sponsors are to invest/lend specific additional amount equity/loans to SPV under critical cash flow issues or financial problems. To offer necessary supports to SPV who cannot have by itself: Law enforcement for potential buyers buy the treated water. Integrate SPV, Restructuring the areas.

2) Construction risk

Risk Owner: SPV or outside Constructor

Risk description: Constructor fail to complete construction within due date and within the budget. Especially this risk is resulted by delay in site acquisition, inappropriate site condition (defected geological structure, soil contamination, and discovery of archaeological remains, etc.), delay in legal permits, insufficient competence to undertake the work in technical and financial terms, cost overrun and inadequate performance on project completion.

Counter measure to control risk – contract level:

Land acquisition is responsible to Government (GOI/State-Govt./ULB). Define right to claim damages and other securities under the construction contract. Incentives to SPV when the construction will be complete earlier (e.g. Bonus)

Counter measure to control risk – process level:

Perform risk assessment to qualify if the constructors have sufficient experiences to complete construction. Limit the bid participants only for qualified vendors. Engineer of Executing Agency (i.e. UPJN/ULB) and the SPV's own staff also mitigate this risk by supervising the activities of SPV or construction contractor.

3) Input-Supply risk (Electricity)

Risk Owner: SPV

Risk description:

SPV fails to obtain 24x7 unceasing electricity supply which is necessary for operation of STP and PS. Electricity charge increases beyond the estimate which is the basis of planned O&M annuity in the agreement; this may be affected by UP State's annual Electricity tariff order (unit cost and additional surcharges).

Counter measure to control risk – contract level:

Agreement with State electricity corporation to ensure unceasing electricity supply along with the clause to stipulate the advanced payment of electricity charge, a discount when the electricity disruption so that SPV can encourage State electricity corporation to supply electricity with 7x24 basis safely.

SPV is to have the long term fixed rate contract with Electricity Corporation. Add the clause to stipulate exoneration from annual electricity tariff increase order on project level MOU with UP State.

Counter measure to control risk – process level:

Exclude the disruption hours of STP operation due to Electricity Corporation's fault from the scope of Annuity reduction

4) Operation risk

Risk Owner: SPV

Risk description:

Sewerage treatment performed lower than the standard in the agreement due to inadequate STP operation management. Treated water quality fail to meet CPCB standard. Problems of PS and leakage from SNW or SNW get broken.

Counter measure to control risk – contract level:

SPV closes the O&M contract with sufficient experience in terns STP operation and encourage O&M contractor to have minority equity stake on SPV. Include the clause in the O&M contract to stipulate SPV has the right to terminate the contract with poorly performing O&M contractor.

Counter measure to control risk – process level:

Put penalty for poorly performing O&M contractor. Termination of the contract with poorly performing O&M contractor

5) Technology risk

Risk Owner: SPV

Risk description:

STP system fail to operate as planned due to obsolescence or gradual decline in operating efficiency between maintenance of the STP or cycle of major maintenance is turned out to be shorter than base projection of the project. Using new and untried technology whose performance cannot be checked against existing reference may fail to fulfill new water quality standard.

Counter measure to control risk – contract level:

Construction contractor provides long term performance guarantee.

Counter measure to control risk – process level:

Assess technology risk and its impact to project economics based on input from experts of the technology and past references to enhance accuracy of the future O&M cost estimate.

6) Revenue risk

Risk Owner: GOI

Risk description:

GOI would take the risk relating to shortfall of user tariff collected against the O&M cost incurred and thus, SPV does not have responsibility to collect the sewerage tariff or tax from users. On the other hand, SPV can earn additional revenue from sales of treated water and sludge as much as they sell it and SPV does not need to pay back the revenue to recover the shortfall of O&M cost and user tariff.

7) Interest rate risk and foreign exchange risk

Risk Owner: SPV (Interest risk), Contractor (Foreign currency exchange risk)

Risk description:

Increased interest may result insignificant difference between planned rate on base projection to calculate capital cost annuity and actual interest to be paid to lenders. Fluctuation of FX rate may result in increase of total project cost when SPV raises a loan from lender with currency other than Indian Rupee.

Counter measure to control risk – contract level

Interest rate hedging arrangement is put in place to mitigate interest rate risk when floating rate loan is used.

Arrange the finance in Rupee only and also set the payment currency to contractor is set to Rupee only.

Counter measure to control risk – process level

GOI may bear the Foreign exchange risk during the procurement from foreign supplier.

8) Cash flow risk

Risk Owner: SPV

Risk description:

Lack of sufficient fund balance in the separated account may result delay or reduce in annuity payment in a timely manner.

Annuity payment is reduced by GOI as a sanction due to poor operation of STP system and failure to meet performance standard.

Counter measure to control risk – contract level:

Stipulate to establish separate account which has a fund of two years' worth liability on MOU. Select the O&M contractor with sufficient experience in terns STP operation and encourage O&M contractor to have minority equity stake on SPV. Include the clause in the O&M contract to stipulate SPV has the right to terminate the contract with poorly performing O&M contractor. Terminate the O&M contractor with poor performance.

Counter measure to control risk – process level:

Monitor the separated account has a fund of two years liability balance periodically. Monitor to ensure O&M contractor to operate the STP system as planned and fulfill the performance standard periodically.

9) Environment risk

Risk Owner: SPV

Risk description:

SPV and operator fails to treat and emit treated water and sludge adequately and it may result in hazardous impact to surrounded environment and effluent to rivers.

Counter measure to control risk – contract level:

Closely monitor environment protection rules. Hold a long term contract with vendor to treat adequate by-product of sewerage treatment.

10) Severe disaster risk

Risk Owner: SPV

Risk description:

Natural disaster such as monsoon, flood, Cyclone or big earthquake, mayhem may result in disruption of STP/PS/SNW system operation.

Counter measure to control risk – contract level:

Enter into insurance arrangement to cover the damage of such disasters.

11) Regulatory and political risk

Risk Owner: SPV

Risk description:

Change in law：Difficulty to meet the current standard of treated water quality with current facility design if further stringent regulation will be enforced by government. Change in Regime：Change in GOI regime may result in disruption or delay of implementation of this new Hybrid Annuity model. And thus, each sewerage project may be disrupted, suspended or delayed. Miss-alignment or lack of coordination among governmental bodies in GOI: Lack of alignment and coordination by NMCG and PMO (Prime Minister Office) with related Ministries such as MoWR, RD, GR and MoUD and UP state Government which may result in miss-alignment of relating inter-dependent programs such as Smart city initiative, AMRUT, etc., especially in terms of scope of infrastructure development. Ministries fail to provide necessary support to implement this program.

Counter measure to control risk – contract level:

Hold Government support agreement to ensure legal framework of this program which is stipulated clearly on the base MOU among GOI and State. Contract political risk insurance and guarantee.

12.7.8 Other Considerations

1) SPV Candidates

It is not sure at this moment that who the SPV candidates are. The simulation in the following section is done by using not particular concessioners and vendors; however, there are some vendors in the past who applied to Design, Build and O&M for either new facilities or rehabilitation in Varanasi area: The **Table 12.7.17** shows Design and construction of 140 MLD sewage treatment plant (STP) at Dinapur including O&M for the years. Other vendors are listed in different tables

.

Table 12.7.19 For Design and Construction

1	M/S Passavant Orediger JV with HNB Engineer Pvt. Ltd.
2	M/S SPML JB with Waterleau.
3	M/S MIS Shivam-Consortiun.
4	M/S GSJ-SEPC Joint Venture.
5	M/S Shapporji Pallonji & Co.
6	M/S Tecpro Systems Ltd.
7	M/S Acciona Aqua S.A. L&T JV.
8	M/S VA Tech Wabag Ltd. JV with Bahadure & Co.
9	M/S Degremont and Degremont Ltd.
10	M/S GS Inima Environment SA
11	M/S Triveni Engineering & Industries Ltd.
12	M/S Cadagua JV with GEO Millaer
13	Corsan Corvian Construction SA.
14	Enviro Control Associated (I) Pvt. Ltd.
15	UEM India Pvt. Ltd.
16	Abeima Teyma

Table 12.7.5 For rehabilitation of old trunk sewer by trenchless technology

1	Insituform Technologies LLC.
2	Shriram EPC Ltd.
3	SPML India Ltd.
4	SPML Info Ltd.
5	GYPSYM

Table 12.7.6 For Sewage Pump Station and Rising Main Project

1	Gharpure Engineering and Construction, Pune
2	Larsen and Toubro Limited, Chennai
3	UEM India Private Limited, New Delhi
4	SPML India, Gurgaon
5	RK Engineers Sales Private Limited
6	Kirloskar Brothers, Pune

For projects which capital cost exceeds certain threshold defined by GOI guideline, ICB (International Competitive bidding) is required to decide constructor and vendors, not by NCB (National Competitive bidding).

2) Potential buyers of treated water

JICA study team tied pick up potential buyers of treated water through the Internet research. Once the SPV RFP (Request for proposal) will be ready, further research should be necessary for the concessionaires and ULB.

a) Mirzapur

Mirzapur district is one of the 34 districts in Uttar Pradesh currently receiving funds from the

Backward Regions Grant Fund programmer. It has Minor Minerals, Sandstone, Redstone and the total Forest Cover of 24% of geographical area.

- J P Associates Ltd Chunar, Mirzapur
- J P Chunar Cement Products Chunar, Mirzapur
- 2.5 Mn TPA Chunar Cement Factory (CCF), Mirzapur, UP
- R L J Concast Ltd Baragawn, Chunar, Mirzapur
- Santigopal Concast Ltd Baragawn, Vill DHauha Chunar, Mirzapur
- JHB Steel Ltd Vill. Dhauha, Chunar, Mirzapur
- Various Railway stations in the district or survey area

b) Chunar

- Purvanchal Co Operative Spinning Mill Ltd.
- Lord's Distillery Pvt Ltd.
- Sukhbir Agro Energy Pvt Ltd
- Various Railway stations in the district or survey area
- J P Associates Ltd
- J P Chunar Cement Products
- R L J Concast Ltd
- Santigopal Concast Ltd
- JHB Steel Ltd
- Various Railway stations in the district or survey area

CHAPTER 13 INSTITUTIONAL SET-UP FOR PROJECT IMPLEMENTATION

<Objective of the Study>

Successful setting up of organization for the project was studied in this chapter.

<Result of the Study>

Although the structure would be further considered depending on any decision in set-up by India side, but Survey team is suggesting that UPJN shall organize the Project Implementation Unit (PIU) in the UPJN Varanasi Zone office, set up as an independent office under the Office of the General Manager, UPJN Ganga Pollution Prevention Unit (UPJN-GPPU). The UPJN-GPPU implements centrally and state funded pollution prevention projects for the River Ganga. The proposed organization structure and staffing of PIU considers the application of organisational principles to ensure efficient and effective accomplishment of the Project objectives as delegated to it by the NMCG / SPMG and the particular SPV, together with organisational factors and practices existing in UPJN-GPPU. The engagement of the PIU staff will be governed by the Service Regulations of UPJN.

The successful implementation of the project depends on many factors, one of which is the readiness of the governmental organizations involved in project execution and implementation. It is important, therefore, to study the main stakeholders in Central and State government and in the Urban Local Bodies (ULB) which are involved in the Ganga Rejuvenation Project. Understanding these agencies' organisational mandates and functions provides the proper perspective when establishing the framework for project implementation as well as when assigning roles and responsibilities within the project implementation system.

This chapter is divided into six sections. The first section presents the Central, State and ULB level institutions with particular attention on their mandated functions and how these relate to the objectives of the Project. It also presents the administrative set-up, structure and staffing of these agencies. On the ULBs where sewerage facilities are to be constructed, focus is on the current structure and staffing of the Jal Kal, or the unit/ wing in charge of providing water supply and sewage / wastewater treatment services to the city and its immediate environs.

The second section addresses setting up the project implementation organisations for the smooth, project implementation within the time frame required. The current institutional framework in the water supply, sewerage and sanitation sectors in relation to this Project was established by properly situating the Central, State and ULBs actors operating within the sector. The organisations for project implementation were thus determined, and their roles and responsibilities in project implementation defined and delineated. The project implementation system takes into account the recent Government policy initiative of reforming the wastewater sector, which includes Ganga wastewater projects under the NMCG through setting up Special Purpose Vehicle (SPV).

The third section discusses the Project Implementation Unit (PIU) at the State and ULB level. It proposes the organization structure, the personnel/ staffing requirements including the educational and experience qualifications for each post. For managing project implementation tasks effectively, duties and responsibilities for each post are also proposed and enumerated.

The fourth section takes up the Special Purpose Vehicle as the institutional tool for the Namami Gange progamme for integrating reforms the wastewater sector by taking up the Hybrid Annuity based PPP model for the wastewater sector in India to ensure performance, efficiency, viability and sustainability. Discussed are the proposed structuring of the ULB-level SPVs and their project-related roles and responsibilities from project development to implementation and operation.

The fifth section touches on the tasks of the proposed Project Management Consultants that would be engaged by the SPMG during the project formation stage, for the primary purpose ensuring proper, efficient and effective implementation of the specific projects identified during the project formation phase.

The sixth section discusses the procurement processes in GoI, the State of U.P. and how these could be streamlined given project requirements. Considerations on the procurement process by the SPV for the PPP concessionaire were also enumerated.

13.1 Relevant Government Agencies, Organization Structure and Staffing

The lead national government agency mandated to formulate policies, to plan programmes, and execute projects aimed at purifying the river Ganga is the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR RD&GJ). Allocated under this Ministry are the National Ganga River Basin Authority (NGRBA) and the National Mission for Clean Ganga (NMCG), which is the operational wing of the NGRBA. The Ministry of Urban Development (MoUD) is a central government-level agency responsible for formulating policies, supporting and monitoring programmes, as well as coordinating the activities of various Central Ministries, State Governments and other nodal authorities as these relate to urban development, town and country planning and development, which include water supply, sanitation, and waste management, among others.

In Uttar Pradesh, the Urban Development Department (UDD) is state department in charge of the local bodies where the Project will be implemented. On the other hand, the U.P. Jal Nigam is the state organization in charge of implementing sanitation/ sewerage schemes/ projects as well as in operating and maintaining sewerage treatment plants. The state society that has direct linkage with NMCG is the State Ganga River Conservation Agency (SGRCA) / State Level Program Management Group (SPMG).

The distribution of sewerage/ pollution control projects is based on the level of the urban local body in the state of Uttar Pradesh, as shown in **Table 13.1.1.**

Table 13.1.1 Distribution of Sewerage Projects Based on ULB Level

Nagar Nigam		Nagar Palika Parishad	
1	Varanasi	1	Ramnagar
		2	Chunar
		3	Mirzapur
		4	Ghazipur

13.1.1 Central Government Level

1) Ministry of Water Resources River Development and Ganga Rejuvenation (MoWR RD&GR)

The Ministry of Water Resources River Development and Ganga Rejuvenation is responsible for laying down the overall policy guidelines and programmes for the development and regulation of country's water resource as well as provides coordination and guidance in the water resources sector. Among its allocated functions are the formulation of national water development perspective and the determination of the water balance of different basins /sub-basins; planning for the development of ground water resources, as well as overseeing and supporting State-level groundwater development; policy formulation, planning and guidance with respect to minor irrigation development, administration and monitoring of the Centrally Sponsored Schemes; and operating the central network for flood forecasting and warning on inter-state rivers, and preparing flood control master plans for the Ganga and the Brahmaputra.

a) National Council for River Ganga (NCRG)

The National Council for Rejuvenation, Protection and Management of River Ganga, referred as the National Council for River Ganga (NCRG) or the National Ganga Council was established vide notification no. S.O. 3187(E) dated 7th October 2016 under EPA 1986. The new body is to act as an authority replacing the existing National Ganga River Basin Authority (NGRBA) for overall responsibility for superintendence of pollution prevention and rejuvenation of river Ganga Basin.

The Act provides for the organisation of a five-tier structure at national, state and district levels to take measures for prevention, control and abatement of environmental pollution in river Ganga and to ensure continuous adequate flow of water so as to rejuvenate the river Ganga. The five-tier structure at national, state and district levels are the following: (i) The National Ganga Council under the chairmanship of Honourable Prime Minister of India; (ii) The Empowered Task Force (ETF) on river Ganga under the chairmanship of Honourable Union Minister of Water Resources River Development and Ganga Rejuvenation; (iii) The National Mission for Clean Ganga (NMCG); (iv) The State Ganga Committees; and (v) The District Ganga Committees in every specified district abutting river Ganga and its tributaries in the states.

The Empowered Task Force ensures that the Ministries, Departments and State Governments concerned have an action plan with specific activities, milestones, and timeliness for achievement of the objective of rejuvenation and protection of River Ganga, and a mechanism for monitoring implementation of its action plans. It will also ensure co-ordination amongst the Ministries and Departments and State Governments concerned for implementation of its action plans in a time bound manner.

At the State level, the State Ganga Committees have been created in each of the defined States as Authority, to function as Authorities in respect of each State and to perform the superintendence, direction and control over the District Ganga Protection Committees under their jurisdiction.

Similarly, the District Ganga Committees in each of the Ganga Bank Districts carry out the assigned tasks as an Authority at the district level, to take cognizance of local threats and needs of river Ganga and conceptualise such measures as necessary to ensure overall quality of water in river Ganga and monitor various projects being implemented.

b) National Mission for Clean Ganga

The National Mission for Clean Ganga (NMCG) was registered as a society on the 12th of August 2011 under the Societies Registration Act 1860. Since its establishment, it performed its mandate as the operational and implementation arm of National Ganga River Basin Authority (NGRBA) which was constituted under the provisions of the Environment Protection Act (EPA), 1986 until NGRBA's dissolution on the 7th October 2016.

The approval by the Union Government of the River Ganga (Rejuvenation, Protection and Management) Authorities Order, 2016 laid down NMCG's new institutional structure for policy and implementation in fast track manner, as well as empowered the NMCG to issue directions and discharge its functions in an independent and accountable manner. It has also been decided to grant a Mission status to the Authority with corresponding powers under the Environment (Protection) Act, 1986 and provide adequate delegation of financial and administrative powers which will distinctly establish NMCG as both responsibility and accountability centre and effectively accelerate the process of project implementation for Ganga Rejuvenation.

NMCG complies with the decisions and directions of the National Ganga Council and implement the Ganga Basin Management Plan approved by it; coordinate and carry out all activities necessary for rejuvenation and protection of River Ganga and its tributaries.

The establishment of the National Council for Rejuvenation, Protection and Management of River Ganga (referred as National Ganga Council) vide notification no. S.O. 3187(E) dated 7th October 2016 under EPA 1986 paved the way for the organisation of a five-tier structure at national, state and district levels to take measures for prevention, control and abatement of environmental pollution in river Ganga and to ensure continuous adequate flow of water so as to rejuvenate the river Ganga. The five-tier structure at national, state and district levels are the following: (i) The National Ganga Council under chairmanship of Honourable Prime Minister of India; (ii) The Empowered Task Force (ETF) on river Ganga under chairmanship of Honourable Union Minister of Water Resources River Development and Ganga Rejuvenation; (iii) The National Mission for Clean Ganga (NMCG); (iv) The State Ganga Committees; and (v) The District Ganga Committees in every specified district abutting river Ganga and its tributaries in the states.

- *Objectives:* The twin objectives of NMCG are: (i) To ensure the effective abatement of pollution and rejuvenation of the river Ganga by adopting a river basin approach to promote inter-sectoral coordination for comprehensive planning and management; and (ii) To maintain minimum ecological flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development.
- *Structure:* The NMCG has a two tier management structure and is comprised of the Governing Council and Executive Committee, both of which are headed by a Director General, NMCG. The Director General (DG) of NMCG is an Additional Secretary in Government of India. Note that the Executive Committee has been authorized approve all projects up to Rs.1000 crore.
- Authority with powers to issue directions and also to exercise the powers under the Environment (Protection) Act, 1986 to enable it to carry out efficiently its

mandate. The NMCG will have a two-tier management structure with a Governing Council (GC), to be chaired by DG, NMCG. Below the GC, there will be an Executive Committee (EC) constituted out of the GC, to be chaired by the DG, NMCG.

c) Integrated Ganga Conservation Mission (Namami Gange)

The Integrated Ganga Conservation Mission, or the Namami Ganga Yojana programme, better known as the "Namami Gange" was launched as a flagship initiative of the Government. It has a total program cost of Rs20,000 Crore, with Rs 2100 Crores programmed for the year 2015-2016. It is implemented by NMCG and its state counterparts, or the SPMGs, and stresses on improved coordination mechanisms between various ministries and agencies at both the central and state governments. The pillars of Namami Gange program are the following: (i) Sewage treatment infrastructure, (ii) River surface (iii) cleaning, (iv) Afforestation, (v) Industrial effluent monitoring, (vi) River front development, (vii) Bio-diversity, (viii) Public awareness, and (ix) Ganga gram.

- *Objective:* The objective of Namami Gange is to further integrate efforts to clean and protect river Ganga in a comprehensive manner by focusing on pollution abatement interventions, namely interception and diversion (I&D) and treatment of waste water flowing through open drains via bio-remediation and appropriate in-situ treatment using innovative technologies, sewage treatment and effluent treatment plants.
  Equally important objectives of this programme come from lessons learned, and these are to involve people living on the banks of the river to attain sustainable results, and to involve States and grassroot level institutions such as ULBs and Panchayati Raj institutions in implementation.
- *Organization*: The three-tier mechanism was established for monitoring, center-state coordination and effective implementation of projects. It is comprised of a high-level task force (HLTF) chaired by the Cabinet Secretary and assisted by NMCG at the national level, State-level committees chaired by the Chief Secretary and assisted by SPMG, and District-level committees chaired by the District Magistrate.

  Due to the multi-sectoral, multi-dimensional and multi-stakeholder nature of the challenge of clean Ganga Mission, other key ministries are involved aside from the MoWR RD&GR, such as the Ministry of Urban Development, the Ministry of Environment, Forests and Climate Change, the Ministry of Roads and Highways, and the Ministry of Rural Development and Sanitation. The program envisages creating 100% sanitation infrastructure for 118 priority towns and 1657 Gram Panchayats located along the Ganga.

- *Implementation Activities*: The activities under Namami Gange are the following: i) Scheme for rehabilitation and up-gradation of existing STPs along Ganga; ii) Ensuring 100% sewerage infrastructure in identified towns alongside Ganga; iii) In-situ sewage treatment in open drains; iv) Support for preparation of DPRs; v) River front management for Ghat's developments in selected cities and towns; vi) Industrial pollution abatement at Kanpur on priority; vii) Action Plan for Char Dham Yatra – public amenities, waste disposal and sanitation; viii) Capacity building of urban local bodies; ix) Afforestation – conservation of flora; x) Conservation of Aquatic life – special attention on dolphin, turtles and ghariyals etc.; xi) Disposal of flowers and other puja material; xii) Ganga Vahini; xiii) GIS data and spatial analysis for Ganga basin; xiv) Study of communities depending on Ganga for their traditional livelihood; xv) National Ganga Monitoring Centre; xvi) Special guidelines for sand mining in Ganga; xvii) Assessment of special properties of ganga water; and xviii) Communication and public outreach activities.

  To assist and support implementation, the following ministries and agencies have been roped in – the Ministry of Tourism, to takes steps to minimize pollution by promoting eco-friendly tourism activities; the Ministry of Shipping, to develop sustainable shipping and river transport; the Ministry of Drinking Water and Sanitation, to prioritise open defecation-free villages along the river and create wastewater management facilities in those villages; the Human Resources Ministry, to set up a national-level institution or a university that offers courses on applied river sciences; AYUSH, to develop conservation plan for medicinal plants in the Gangetic region and ensure medicinal biodiversity; and Youth Affairs and Sports, to encourage youth, volunteers and sportspersons to engage in activities related to Ganga cleaning.

- *Lessons Learnt:* In the GAP II Project, the communities were involved in what was called the "non-sewerage component" through social programmes and/or public consultations, an example of which was in the selection of sites for public toilets and dhobi ghats. There were also public information dissemination / education programmes targeting the general community. The activities, which were designed by the GAP II Consultants, were basically carried out by NGOs and supervised by the Project Management Consultants (PMC).

  For the Ganga Rejuvenation Project, the ways to put lessons learned into practice from past programs are:

- Firstly is **to institutionalize stakeholder involvement** into the project implementation system, from the Central, State and ULB level governments and organizations based on and within the bounds or confines of their own legal mandates, and then provide these stakeholder institutions with roles and responsibilities in the project implementation system in order that Project objectives are realized and sustained.
- Secondly is **to aim for strategic stakeholder engagement**, meaning, to divide the stakeholders into "target markets" and to design specific activities and/or communication plans for each set of stakeholders with inputs coming from the stake-holders themselves in a consultative and participative bottoms-up approach, rather than to use generalized top-down methodologies.

- *Special Purpose Vehicle (SPV)*: Early this year, the policies and procedures and guidelines for taking up the hybrid annuity model for public-private partnership (HAM-PPP) are being finalized. This will entail establishing a Special Purpose Vehicle (SPV) to plan, structure, implement, manage operate and maintain such PPP projects and also develop a market for treated wastewater. The proposed SPV will be established under the Companies Act, 2013 providing it with a governance framework and enabling its functional autonomy.

  The SPVs would enter into a tripartite memorandum of agreement (MoA) with participating State Governments and concerned Urban Local Bodies for taking up individual projects. These MoAs will aim at introducing reforms and regulatory measures for recovery of user charges on 'polluters pay' principle, restrictions on usage of ground and fresh water for non-potable purposes through stricter monitoring and guidelines that promote reuse of treated wastewater.[1]

2) The Ministry of Urban Development (MoUD)

One key mandate of the Ministry of Urban Development (MoUD) is taking up schemes / creating facilities to manage water supply, sewage, drainage and sanitation facilities subject to the overall

1 http://economictimes.indiatimes.com/news/economy/infrastructure/cabinet-okays-ppp-model-for-wastewater-sector-under-namami-gange-plan/articleshow/50467900.cms

national perspective of water planning and coordination assigned to the Ministry of Water Resources River Development and Ganga Rejuvenation (MoWR RD&GR). As such, the MoUD is involved in the conservation of rivers and lakes by improving and renewing the infrastructure of the towns. It has conceptualised the whole town approach, while the pollution abatement of rivers uses the river-centric approach.

The infrastructure created by NGRBA / NMCG may be fully utilized by MoUD, particularly in merging of the schemes and/or dovetailing with those of MoUD at the appropriate level of competence. The Ministry is very active in undertaking urban reforms in the sector, and implementing initiatives for urban infrastructure in water supply, sanitation and drainage.

MoUD has been a force in implementing the National Urban Sanitation Policy (NUSP), issued in November 2008. The NUSP that envisions "all Indian cities and towns become totally sanitized, healthy and livable and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women." The Ministry helps the states and cities in ensuring sanitation as a core responsibility of the Urban Local Bodies as envisaged in the 74th Constitutional Amendment Act of 1993 by encouraging State Governments to draft state sanitation strategies, and cities to formulate city sanitation plans in conformity with the national policy.

3) The Ministry of Environment, Forests and Climate Change (MoEF)

The Ministry of Environment, Forests and Climate Change is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. Its primary concerns and objectives are geared towards the implementation of policies and programmes relating to the protection and conservation of the country's natural resources, such as flora, fauna, forests, wildlife and lakes and rivers; ensuring the welfare of animals; and the prevention and abatement of pollution. It is guided by the principles of sustainable development and enhancement of human well-being.

The Ministry's environmental role is evident in several comprehensive approaches to river conservation works by additionally emphasizing on catchment area treatment, addressing the biota component and maintenance of ecological properties of the river waters. It coordinates with the Ministry of Urban Development, the Ministry of Water Resources, Ganga Rejuvenation and River Development and other sectoral ministries namely, Ministry of Rural Development and the Ministry of Agriculture.

The Ministry's work is supported by its regional and subordinate offices, by autonomous organizations, authorities, boards and public sector undertakings, such was the Central Pollution Control Board. Its mandates / objectives are well supported by a set of legislative and regulatory measures, aimed at the preservation, conservation and protection of the environment. Besides the legislative measures, the National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Forest Policy, 1988; Policy Statement on Abatement of Pollution, 1992; and the National Environment Policy, 2006 also guide the Ministry's work.

a) Central Pollution Control Board

The Central Pollution Control Board (CPCB) advises the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air. As such, it sets the environmental standards to be complied for air quality, water quality and noise; publishes technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement and prepares manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts. It plans and executes a nation-wide program for the prevention, control or abatement of water and air pollution while providing technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement.

There are State Pollution Control Boards under the ambit of the CPCB. The state boards advise the Sate Governments and Governments of Union Territories with respect to the suitability of any premises or location for carrying on any industry which is likely to pollute a stream or well or cause air pollutions. It also lays down standards for treatment of sewage and trade effluents, as well as for emissions from automobiles, industrial plants, and any other polluting source. It evolves efficient methods for disposal of sewage and trade effluents on land; develops reliable and economically viable methods of treatment of sewage, trade effluent and air pollution control equipment. Assess the quality of ambient water and air, and inspect wastewater treatment installations, air pollution control equipment, industrial plants or manufacturing process to evaluate their performance and to take steps for the prevention, control and abatement of air and water pollution.

13.1.2 State Level

In the past decades, Uttar Pradesh (UP) has undergone drastic urbanization that put tremendous pressure on the civic amenities available under both the state and local administration. As such, urban local bodies (ULBs) were formed to cater to the ever-increasing demand for better services.

1) Urban Development Department (UDD)

Currently, there are 634 local municipal bodies in UP – 14 Nagar Nigams, 195 Nagar Palika

Parishads, and 426 Nagar Panchayats. Around 22% of State's total population resides in cities and towns under these ULBs which are responsible for the provision of drinking water, drainage, waste disposal, roads, footpaths and pavements, maintenance of parks and route signage etc.

The Urban Development Department (UDD), also known as Nagar Vikash, not only provides administrative control over the ULBs, but also executes the different development schemes and plans for the ULBs, including provision of financial assistance. The UDD is also entrusted to look into sanitation works, environment and pollution prevention of water bodies in the State, such as rivers lakes and ponds.

One of the units under the UDD is the Local Self Department (also known as Swayat Shasan Vibhag), under which are following departments or organisations are functioning:

- Directorate of Local Bodies (*Sthaniy Nikay*): GoI formed Rural-Urban Relationship Committee in 1971, although formal operations started in 1973. It is headed by a director that manages / controls / administers its functions including finance and compliance to rules and regulation for local bodies. The directorate also acts as an coordinative body to get information on the performance of the local bodies; functions as Nodal Agency for implementation of JnNURM projects, the State Government's model town planning programs etc.
- U.P. JAL Nigam
  - Construction and Design Services (CNDS)
  - Nagar Area Environment Study Centre
  - Ganga Pollution Prevention Unit (GPPU)
- Jal Kal
- Municipal Bodies / Urban Local Bodies

2) Uttar Pradesh Jal Nigam (UPJN)

The Uttar Pradesh Jal Nigam (UPJN) is a corporation that came into existence on the 18th of June 1975. Its area of operation extends to whole of Uttar Pradesh excluding Cantonment areas under the Uttar Pradesh Water Supply and Sewerage Act, 1975. The U.P. Jal Nigam Board consists of a Chairman appointed by the State Government and 11 other regular members, plus one permanent invitee specified in sub-section (2) of the Water Supply and Sewerage Act 1975.

- *Objective:* The basic objective of UPJN is the "development and regulation of water supply and sewerage services and for matters connected therewith". It is, therefore, the apex body responsible for formulation, execution, promotion, financing, setting standards and fixing tariffs for implementation of water supply and sewerage services, sewage treatment and disposal, and river pollution abatement projects in the State.

- *Functions*: The important functions of UPJN are the following: (i) preparation, execution, promotion and financing the schemes for supply of water and for sewage disposal; (ii) providing all necessary services regarding water supply and sewerage to the State Government and local bodies; (iii) preparation of State plans for water supply, sewerage and drainage on the directions of the State Government; (iv) reviewing and advising on the tariff taxes and charges of water supply in the areas of Jal Sansthans and local bodies which have entered into on agreement with Jal Nigam under Section 46; (v) establishing State standards for water supply and sewerage services; (vi) establishing and maintaining a facility to review and appraise the technical, financial, economic and other pertinent aspects of every water supply and sewerage scheme in the State; (vii) managing, operating, and maintaining any water works and sewerage system if and when directed by the State Government on such terms and conditions and for such period as may be specified by the State Government; and (viii) assessing the requirements for manpower and training in relation to water supply and sewerage services in the State.
- *Tasks*: UPJN is also the principal implementing agency for river pollution control projects for the State. Its task is to prevent the direct flow of wastewater into important river bodies by diverting waste water/ domestic sewage flow to appropriate treatment sites before being allowed to drain out in river bodies. So far, 15 major towns located on the banks of the rivers Ganga, Yamuna and Gomti have been provided with wastewater treatment facilities for cleaning about 42 % of its domestic sewage flow.[2]
- *Organization and Staffing*: UPJN is divided into 14 zones, each headed by a Chief Engineer. The cities enumerated in the survey project fall under UPJN Varanasi Zone. There is also the Construction and Design Services (C&DS), the commercial wing of UPJN, which is headed by a Director. UPJN is a large organization, which has a total personnel complement of 16,145 officers and staff as shown in **Table 13.1.2**.

Table 13.1.2 Officers and Staff of Uttar Pradesh Jal Nigam (UPJN)

2 http://www.upjn.org/introduction.aspx

Serial No.	Designation	Available Posts	Elect / Mech Cadre against Col-2
1	Chairman	1	-
2	Managing Director	1	-
3	Finance Director	1	-
4	Chief Engineer – I	4	-
5	Chief Engineer – II	9	1
6	Superintending Engineer	51	8
7	Manager (E.D.P. Cell)	1	
8	Executive Engineer	199	32
9	System Analyst	2	
10	Chief Accounts Officer	1	-
11	Senior Accounts Officer	8	-
12	Chief Internal Audit Officer	1	-
13	Finance Analyst	1	-
14	Law Advisor	1	-
15	Law Officer	1	-
16	Manager (Ground Water)	1	-
17	Senior Hydro Geologist	1	-
18	Senior Geophysicist	1	-
19	Research Officer	2	-
20	Assistant Engineer	824	111
21	Accounts Officer	12	-
22	Assistant Accounts Officer	4	-
23	Divisional Accountant	253	-
24	Junior Engineer	2110	341
25	Junior Engineer (T) / Computer	154	19
26	Head Draughtsman	53	
27	Draughtsman	374	
28	P.A. (N.T.) / S. O.	34	-
29	Head Assistant	31	-
30	Library In charge	1	-
31	Senior Noter Drafter (Z)/ Circle/ H.Q. / H.C.	308	-
32	N.D. (Z / H.Q.)	561	-
33	Routine Grade Clerk (Z / H.Q.)	828	-
34	PA / PS (Zone / H.Q.)	33	-
35	Steno Grade - 3	89	-
36	Steno Grade - 4	142	-
37	Storekeeper	38	-
38	Telephone Operator / Lab Assistant	9	-
39	Driver	376	-
40	Group (Gha)	1452	-
	Sub Total	7973	-
	Regular Staff (Field)*	8172	
	Total	**16,145**	

Source: http://www.upjn.org/structure_directers_1.aspx. Retrieved 07 October 2015.

Abbreviations:

PA (NT)	: Personal Assistant (Non-Technical)	PS	: Personal Secretary
ND	: Noter Drafter	SO	: Section Officer
HQ	: Head Quarter		

- *Ganga Projects*: The Ganga Action Plan (GAP) was a program launched by GOI in 1985 for conservation of the water quality of holy River Ganga by preventing pollution due to direct discharge of domestic sewage and industrial waste as well as pollution from non-point sources. The main objectives of the Ganga Action Plan are: (i) abatement of the pollution of the river, (ii) improvement of river water quality by interception and diversion of the drains and sewers falling into the river, (iii) treatment of the domestic sewage before disposal in the environment, (iv) prevention of toxic and hazardous wastes from identified industrial units from entering in to the river, (iv) control of non point pollution of the river from a host of human activities, and (v) conservation of the bio-diversity of the river by adopting an integrated river basin management approach.

Phase I GAP project involved the construction of three new sewage treatment plants in Varanasi with a combined installed capacity of approximately 101,800m³ a day. Currently in the works is Phase II GAP project, which primarily involves the construction of a new 140,000m³/d sewage treatment plant, laying of 34kms of sewers, rehabilitation of existing sewerage systems, and construction of three new pumping stations, namely Phulwaria, Chaukaghat and Saria. Other ancillary project activities include the construction of community toilet complexes, renovation of 26 selected bathing ghats, development of nine dhobi ghats, conduct of public participation and awareness campaigns and an institutional development program.

The UPJN Ganga Pollution Prevention Unit (GPPU) is the implementer of GAP projects, with the executing agency being the NGRBA / the National Mission for Clean Ganga. The Unit is headed by a General Manager with the equivalent rank of Superintending Engineer (Class 1). **Table 13.1.3** shows the personnel strength of the UPJN GPPU.

Table 13.1.3 Personnel Strength of UPJN GPPU

	UPJN GPPU Post	Equivalent Category	Number	Class	Pay Band	Pay Scale Range
1	General Manager	Superintending Engineer	1	1	4	37400-67000+8700
2	Civil Project Manager	Executive Engineer	1	1	4	37400-67000+8700
3	Civil Project Manager	Executive Engineer	2	1	3	15600-39100+5400
4	E/M Project Manager	Executive Engineer	1	1	3	15600-39100+5400
5	Project Engineer	Assistant Engineer	4	2	4	15600-39100+5400
6	Project Engineer	Assistant Engineer	12	2	3	15600-39100+5400
7	Asst Project Engineer	Junior Engineer	48-64	3	3	9300-34800+4200
8	Support / Finance	Support / Finance	40-48		3 & 2	• 9300-34800+4200 • 5200-20200+1900
9	Peon / 4th Class	Peon / 4th Class	12		1	5200-20200+1900
10	Supervisory	Supervisory	120-160		1	5200-20200+1900

Source: UPJN GPPU, 06 November 2015.

3) Uttar Pradesh State Ganga River Conservation Agency (SGRCA / SMPG)

The Uttar Pradesh State Ganga River Conservation Agency (UPSGRCA)[3] was organized under Society Registration Act 1869 (Act No. 21 of 1860). It was registered on the 17th of February 2011.

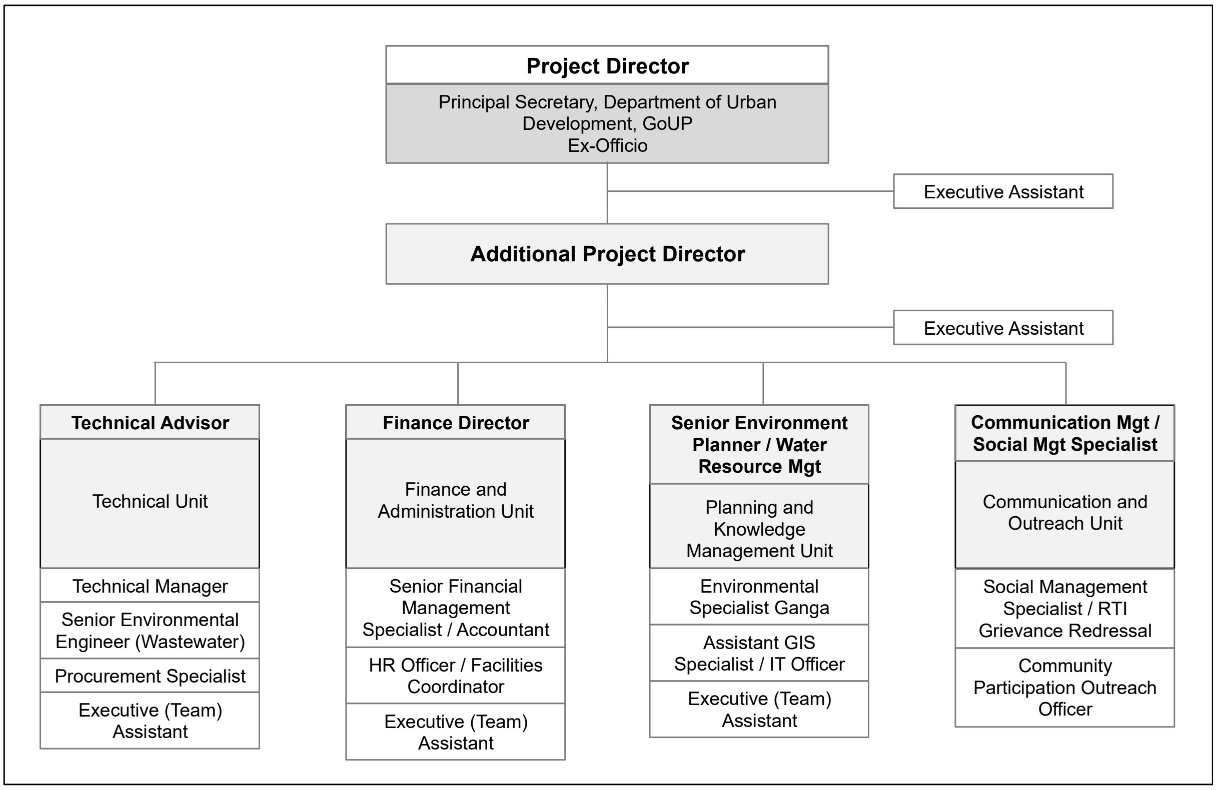
- *Objectives*: The main objective of SGRCA is to undertake measures for effective abatement of pollution of the river Ganga and the environmental and ecological improvement in the State of Uttar Pradesh. It coordinates and implements river conservation activities at the State level towards the comprehensive management of the river Ganga. The SGRCA also functions as the State Level Program Management Group (SPMG) for the implementation of projects sanctioned by NGRBA / NMCG in the State of Uttar Pradesh, although field works are to be carried out through State departments and organizations such as UPJN and the urban local bodies.

  Among its other objectives are: (i) To implement the River Basin Management Programme prepared and approved by the NGRBA and the UPSGRCA; (ii) To monitor the executed programme of NGRBA at State level; (iii) To supervise and coordinate the activities necessary for pollution control and treatment for maintaining the quality of water in river Ganga; (iv) To implement the recycling and reuse of water, rain water harvesting, decentralized sewage treatment system, water conservation and conservation procedures; (v) To facilitate State Government and/or local bodies in issues related to the land acquisition, removal of unauthorised encroachments, contracts for the purpose of implementation of instructions of NGRBA and UPSGRCA.

- *Organization Structure*: The organization structure of UPSGRCA is shown in **Figure 13.1.1**. Currently, there are 21 staff officers in the agency.[4]

3 In the exercise of the powers conferred by sub section 3 of section 3 of the Environment (Protection) Act 1986 (29 of 1986) the Central Government in continuation to Constitution of NGRBA on 20th February, 2009, vide notification No.1570 dated 30th September 2009 constituted the Uttar Pradesh State Ganga River Conservation Authority (SGRCA).

4 Interview with Mr. Jawed Ansari, 8 December 2015, Lucknow.



Source: http://www.sgrca.org/static/OrganizationStructure.aspx. Retrieved 05 October 2015.

Figure 13.1.1 Organization Structure of Uttar Pradesh State Ganga River Conservation Agency (UPSGRCA)

- *Functions*: To realize its objectives, UPSGRCA functions are focused on the following – ensuring that the State Government's consent on the programmes and structures of National Ganga River Basin Authority are obtained from the State Government's share in the programmes; generating public awareness by information, education and publicity drive regarding abatement of water pollution, control and treatment, environmental cleanliness in water of river Ganga; coordinating and implementing the activities of networking of sewerage and sewage treatment structures, remedial steps for treatment of wet land area, river conservation works including using other measures, development of river banks (river front) etc. at the State level.

  In addition, UPSGRCA also works on the appraisal of feasibility reports (FRs) and detailed project reports (DPRs) for programmes under NGRBA; manages funds related to land, acquisition for programmes/ projects and to get management of concerned contracts/ agreements; and prepares practicable suggestions, outlines and alternatives to make these projects financially self-supporting.

- *Project Implementation:* In the implementation of infrastructure projects, UPSGRCA selects the institutions that will undertake projects under the NGRBA programme, as well as selects private institutions for special purpose vehicles and/or the formation of SPVs.

  UPSGRCA has also responsibilities in guiding the concerned Nagar Nigams for capacity building for operation and maintenance (O&M) of their projects by suggesting practicable alternatives to make these projects financially self supporting in meeting the expenditure incurred O&M, including long term declaration of fixing of user charges for of such projects.

  In relation to river front development, UPSGRCA proposes works to improve the quality for river water after completion of River Pollution Controls Projects, so that local citizens and tourists visiting the city are attracted towards river banks. Towards this end, it suggests necessary methods for operation and maintenance of such projects to Nagar Nigams for utilization of Nagar Nigams' income generated from tourism and other commercial resources.

  It undertakes testing at the time of construction, commissioning, operation and maintenance to ensure the treatment of sewage is in accordance to standards prescribed by Government of India, the U.P. Government, the Central Pollution Control Board and U.P. Pollution Control Board; while getting River Pollution Control-related projects completed within stipulated time, cost and quality.

13.1.3 Urban Local Bodies

Three level local bodies have been constituted in accordance with the *74th Constitutional Amendment Act* (1992) in order to assure the participation of the public in (Government) power. These are the Mahanagar Nigam or Nagar Nigam (Municipal Corporation), the Nagar Palika Parishad (Municipal Board) and the Nagar Panchayat (Notified Area Council, City Council or Town Panchayat).

The 'Nagar Nigam' is formed in cities that have populations of more than one million. Its members are elected from the several wards of the specific city on the basis of adult franchise for a term of five years. The Mayor is the head of the municipal corporations; while the Municipal Commissioner is the chief executive officer and head of the executive arm of the municipal corporation. Therefore, all executive powers are vested in the municipal commissioner. Although the municipal corporation is the legislative body that lays down policies for the governance of the city, it is the commissioner who is responsible for the execution of the policies.

The 'Nagar Palika Parishad' is an urban local body that administers a city with population of 100,000 but less than 1,000,000.[5] Under the Panchayati Raj system, it interacts directly with the State Government, though it is administratively part of the district where it is located. Generally, smaller district cities and bigger towns have a Nagar Palika, a form of local self-government entrusted with duties and responsibilities enshrined in the *74th Constitutional Amendment Act* (1992).

The members of the Nagar Palika Parishad are elected representatives for a term of five years. The town is divided into wards according to its population, and representatives are elected from each ward. The members elect a president among themselves to preside over and conduct meetings. A chief officer, along with officers like an engineer, sanitary inspector, health officer and education officer who come from the state public service are appointed by the state government to control the administrative affairs of the Nagar Palika.

The 'Nagar Panchayat', a form of urban political unit, is comparable to a municipality but to a lesser degree, or with an urban centre with more than 11,000 and less than 25,000 residents. Each Nagar Panchayat has a committee consisting of a chairman with ward members. Membership consists of a minimum of ten elected ward members and three nominated members. The members of the Nagar Panchayat are directly elected by electoral from wards of the Nagar Panchayat for a term of five years.

These municipal bodies are vested with functions delegated to them by the State Governments under the municipal legislation, which relate to public health, which includes water supply, sewerage and sanitation, welfare, regulatory functions, public safety, public infrastructure works, and development activities, among others. It also points to sources of income, which are taxes on water, houses / property, markets, entertainment and vehicles paid by residents of the town and grants from the state government. The administrative set-up or structure of India is shown in **Figure 13.1.2.**

[5] However, there are exceptions, as previously Nagar Palikas were constituted in urban centers with population over 20,000 so all the urban bodies which were previously classified as Nagar Palika were reclassified as Nagar Palika even if their population was under 100,000.

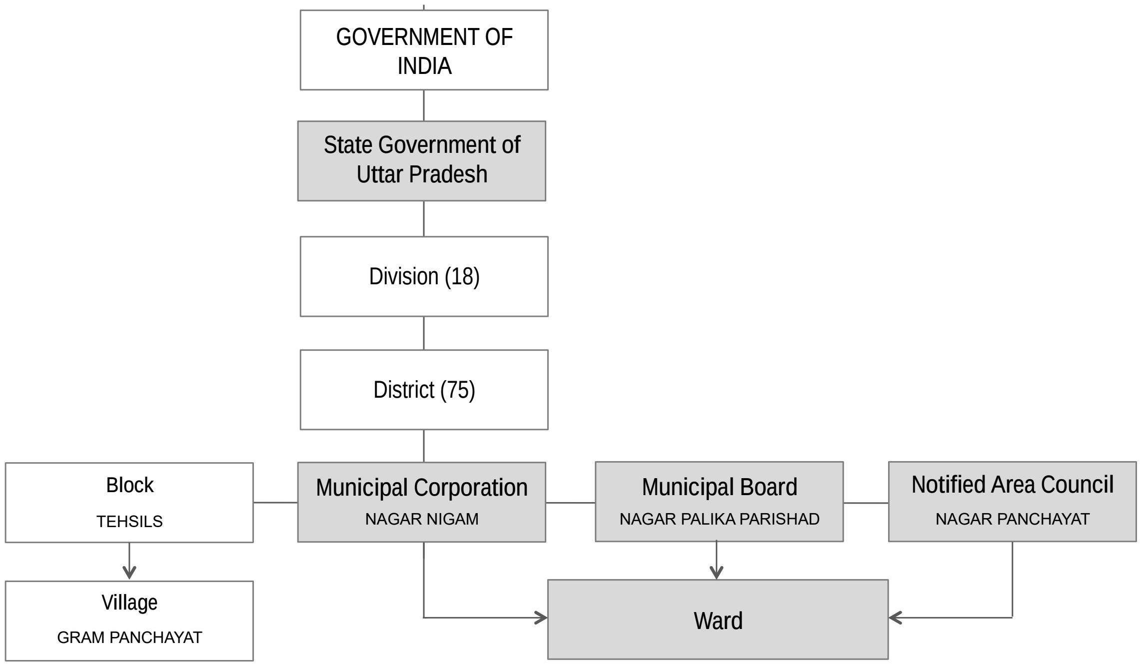


Figure 13.1.2 Administrative Structure (from National to State to ULB) in India

1) Varanasi Nagar Nigam (VNN)

Varanasi Nagar Nigam (also called Varanasi Municipal Corporation or VMC) was established on the 24th of January 1959 under the Act of the Uttar Pradesh Government or the Municipal Corporation Act of 1959 as a Nagar Mahapalika. In 1994, it was converted in to a Nagar Nigam under the Uttar Pradesh Government Act - 2. VNN has 90 wards under it and has within its jurisdiction some of the most densely populated areas in the world, providing basic services to rural and urban villages in its 79.79 sq. km. area.

The Twelfth Schedule of the Act gave urban local bodies like VNN five broad categories of mandates and functions – essential mandates which the ULBs must perform mandates; environmental management functions; planning functions, agency-type functions and functions relating to governance. Two essential municipal functions relating to water supply and sewerage are (i) Water supply for domestic, commercial and industrial purpose and (ii) Public health, sanitation, conservation and solid waste management. A related function, under "environmental management" is urban forestry, protection of environment and the promotion of ecological needs.

There are several activities performed by VNN as an urban local body. However, the major activities based on the above-mentioned mandates / functions directly related to water supply, sewerage and environmental protection are: (i) Managing service utilities like water supply, sewerage and sanitation, storm water drainage, city roads, street lighting and solid waste management; (ii) Maintenance of public gardens, parks, buildings, public area, parking spaces, street lightings, crematoria and other public utilities; (iii) The assessment and collection of municipal taxes like property tax, water tax and sewer tax, etc.; (iv) Planning and implementation of infrastructure development projects, their progress and monitoring and quality control; (v) Slum improvement works, community facilities, toilets, etc.; (vi) Accounting and credit management including payroll; and (vii) Public relations and grievance redressal.

a) Jal Kal Varanasi (JKV)

Jal Kal Varanasi (JKV), also known as Jal Kal Vibhag, is presently one of VNN's departments and was formed with the merger of Varanasi Jal Sansthan6 with VNN in 2010.

- *Powers and Duties of JKV*: The duties of JKV are the same as when it was still an autonomous Jal Sansthan. These are: (i) Ensuring uninterrupted supply of drinking water in the city; (ii) Provision of proper sewerage facility to the citizens; (iii) Creating awareness among the citizens for conservation of water; (iv) Controlling infections in water supply; (v) Bringing transparency in the works (duties) of Jal Sansthan and to provide better facilities to the citizens; (vi) Placing, proceeding and executing the plans of water availability; (vii) Supervision of maintenance of the water availability processes; (viii) Preparing plans for sewer arrangement disposals related to sewerages etc., their progress, execution and enforcement, wherever necessary; and (ix) Cleaning the manholes and looking after the maintenance of sewer lines.

  In addition to the above, there are also water supply services that JKV provides to its customers in the areas of operation and maintenance of the facilities for water supply production and distribution up to individual house connection; operation and maintenance of the sewer networks, including connecting households and institutions to the sewer network; billing and collection for the services it renders, and also public information, education and communication services as it relates to raising awareness on water conservation and sanitation measures.

  There are powers vested also in JKV such as the execution of all the works related to water availability, sewer arrangement and sewer related disposal; the collection of land

[6] Varanasi Jal Sansthan (VJS) was constituted under the *Water Supply and Sewerage Act 1975* (Section 18 (1) of UP Government in Lucknow) to provide its citizens with supply of pure drinking water and proper sewerage facilities.

and other property taxes, having an authorized right on them, and sustaining it; carrying out any construction works related to water supply or sewer arrangement; the improvement or amendment of tariffs for water availability and sewer arrangements; and recovering the taxes for these services whatever are decided.

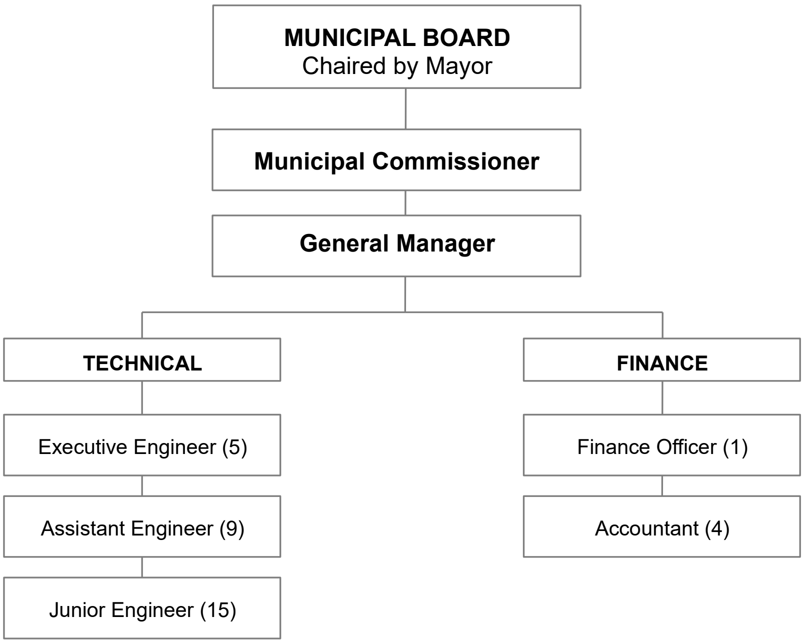
- *Functions of JKV*: The main functions of JKV are: (i) To plan, promote and execute schemes of and operate as efficient system of water supply; (ii) Where feasible, to plan, promote and execute schemes of, and operate, sewerage, sewage treatment and disposal and treatment of trade effluents; (iii) To manage all its affairs so as to provide the people of the area within its jurisdiction with wholesome water and where feasible, efficient sewerage service; and (iv) To take such other measures, as may be necessary, to ensure water supply in times of any emergency. In addition, JKV is also responsible for the collection of revenue in terms of water tax, water charges, sewer tax and sewer charges and bears all expenses related to the operation and maintenance of water supply and sewerage system.

  It should be noted that while the water supply system is fully operated and maintained by JKV, the sewerage system's operation and maintenance is shared by JKV and UPJN. Activities pertaining to O&M of the sewer network, connecting households to the system, and billing and collection of sewer charges are performed by JKV; while O&M of the sewage treatment plants and all major pumping stations are performed by UPJN.[7]

- *Organization and Staffing of JKV*: The organization structure and manpower requirement of JKV are still based on 1975 statistics when the population of Varanasi was five lakhs, which corresponded to the water supply and sewerage services' needs of the city at that time.[8] The current JKV organization is still established along the 40-year old structure; however, it takes into consideration the line of authority from VNN. As shown in **Figure 13.1.3**, the structure is delineated along two main areas/ divisions/ streams – technical and finance.

7 Uttar Pradesh Jal Nigam. *Detailed Project Report for Sewerage Treatment Plant Assi-BHU Sewerage District*, *Varanasi* (Volume I), p. 13.

8 Interview with JKV Executive Engineer/ Secretary, 04 November 2015.



Source: http://www.jalkalvaranasi.org/webpages.php?tag=Organisational_Structure. Retrieved 05 October 2015.

Figure 13.1.3 Organization Structure of Jal Kal Varanasi (JKV)

The technical area/ division is further subdivided into four water supply and sewerage zones, each headed by an executive engineer. Each water supply and sewerage zone has its own commercial, finance and accounting, and administrative staff. The finance area/ division/ stream consolidates the transactions of the water supply and sewerage zones.

For governing municipalities in the state of Uttar Pradesh, the Municipalities Act, 1916 was promulgated on 01 July 1916. The Act also contained provisions (Section 57 to 80 of the Act) regarding the recruitment of service staff of municipalities. In particular, centralized services in the municipalities are governed by provisions of Section 69-B of the Act (1916) and the Rules framed thereunder, as amended by UP Act No. 15 (1983) and UP Act No. 5 (1984). The provisions of 69-B Centralization of Services of Municipal Officers and Servants asserts that the State Government may at any time, by rules provide for creation of one or more services of such officers and servants as the State Government may deem fit, common to all or some Municipal Boards or to the Municipal Boards and prescribe the methods of recruitment. Service Rules for Centralized Services of Municipalities were framed applicable to municipalities covering the following services: (i) Administrative (Superior) and Administrative (Subordinate) services; (ii) Revenue (Superior) and Revenue (Subordinate) services; (iii) Engineering (Superior) and Engineering (Subordinate) services; (iv) Water works Electrical and Mechanical

Engineering (Superior); and Water works Electrical and Mechanical Engineering (Subordinate) services; (v) Accounts (Superior) and Accounts (Subordinate) services; (vi) Audit (Superior) and Audit (Subordinate) services; (vii) Public Relations service; and (vii) Palika Ministerial service.

The centralized cadre for all Urban Local Bodies of the state of UP is the source of the recruitment of officers. Accordingly, there are two types of personnel in terms of recruitment, selection and placement – Groups A and B cadre, recruited by the State Government (centralized) and Groups C and D cadre, hired by the Urban Local Bodies (decentralized). However, the senior and middle level employees (such as the engineers of JKV now merged with VNN) are regulated by the Rules and Regulations under the Director of Local Bodies UP under Urban Development Department, whereas the clerical and worker grades are regulated by VNN, which is also allowed to recruit personnel under contract basis, as and when necessary.

The categorization of employees from Group A to D as follows: Group A are those officers vested with executive power and decision making powers; Group B are officers with some supervisory/ managerial role; Group C are semi-skilled with no decision-making authority (eg. clerk, head clerk, assistant typist, telephone operator, etc.) and Group D are unskilled or semi-skilled (eg. peon, attendant, driver, gardener, etc.).

The current human resources configuration of JKV was carried over from the former Jal Sansthan, which was approved sometime in 1998. Since then, there has been no official change in the number of sanctioned posts for personnel Class 1 through 4 where Class 1 refers to gazetted top managerial officers; Class 2 refers to mid-level gazetted officers; Class 3 refers to non-gazetted technicians; and Class 4 refers to fourth class non-gazetted employees. Gazetted officers/employees are those whose transfer, appointment, promotion and superannuation are published on a yearly basis in the Official Gazette.

The total number of sanctioned posts per cadre is 30 under the centralized cadre, and 1,087 under the non-centralized cadre for a total 1,117 sanctioned posts. The distribution is shown in **Figure 13.1.3**.

Table 13.1.4 Distribution of Sanctioned Posts under JKV

Cadre	Post Includes	Sanctioned Post	Filled Post	Vacant Post
Centralized Recruited by State Government	General Manager	1	1	0
	Executive Engineer	5	3	2
	Assistant Engineer	9	2	7
	Junior Engineer	15	5	10

	Sub-total	30	11	19
Non-centralized Recruited locally by the GM's office	Administrative	2	0	2
	Class III (Clerks, Accounts Assistant, Supervisors)	149	86	63
	Class IV (Khalasi, Fitter, Plumber, Peon, Watchman)	936	412	524
	Sub-total	1087	498	589
	Total	**1117**	**509**	**608**

Source: Jal Kal Varanasi, 05 November 2015.

Table 13.1.5 shows that there are three categories of designations/ posts under Group A, two categories under Group B, 24 categories under Group C, and 37 categories under Group D.

Table 13.1.5 Sanctioned Posts' Categories Distributed according to Groups

Sr. No	Groups A, B, C: Engineering Cadre Designation / Post	Sanctioned Post	Filled Post	Vacant Post	Pay Band
1	General Manager (A)	1	1	0	15600-39100
2	Executive Engineer (A)	5	3	2	15600-39100
3	Assistant Engineer (B)	9	2	7	9300-34800
4	Junior Engineer (C)	15	5	10	5200-20200
	Sub-Total	*30*	*11*	*19*	
Sr. No	**Groups A & B: Accounts Cadre** Designation / Post	**Sanctioned Post**	**Filled Post**	**Vacant Post**	**Pay Band**
1	Finance Officer (A)	1	0	1	15600-39100
2	Accounts Officer (B)	1	0	1	9300-34800
	Sub-Total	*2*	*0*	*2*	
Sr. No	**Groups C** Designation / Post	**Sanctioned Post**	**Filled Post**	**Vacant Post**	**Pay Band**
1	Chemist	3	1	2	5200-20200
2	Pump House Superintendent	2	2	0	5200-20200
3	Stenographer	3	1	2	5200-20200
4	Lower Division Assistant (Clerk)	27	15	12	5200-20200
5	Junior Accounts Assistant (LDA)	8	4	4	5200-20200
6	Meter Inspector	1	0	1	5200-20200
7	Tax Inspector- II	35	28	7	5200-20200
8	Meter Reader	20	6	14	5200-20200
9	Metering Supervisor	6	0	6	5200-20200
10	Cashier	1	0	1	5200-20200
11	Draftsman	1	0	1	5200-20200
12	Personal Assistant	1	1	0	5200-20200
13	Office Superintendent	1	1	0	5200-20200
14	Chief Typist (Clerk)	2	2	0	5200-20200
15	Upper Division Assistant	12	10	2	5200-20200
16	Assistant Tax Superintendent	1	1	0	5200-20200
17	Tax Superintendent	1	0	1	5200-20200
18	Tax Inspector	11	7	4	5200-20200
19	Accountant	3	1	2	5200-20200
20	Assistant Accountant	2	2	0	5200-20200
21	Accounts Assistant (Clerk)	4	4	0	5200-20200
22	Accounts Auditor	2	0	2	5200-20200
23	Assistant Accounts Auditor	2	0	2	5200-20200
	Sub-Total	*149*	*86*	*63*	
Sr. No	**Group D** Designation / Post	**Sanctioned Post**	**Filled Post**	**Vacant Post**	**Pay Band**
1	Peon	42	40	2	4440-7440
2	Electrician	9	1	8	4440-7440
3	Car Driver	6	3	3	4440-7440
4	Carpenter	2	0	2	4440-7440
5	Pattern Maker	1	0	1	4440-7440

6	Meter Mechanic	2	0	2	4440-7440
7	Blacksmith	3	0	3	4440-7440
8	Sweeper/ Cleaner	4	2	2	4440-7440
9	Turner	6	3	3	4440-7440
10	Welder	1	1	0	4440-7440
11	Asst. Moulder	3	0	3	4440-7440
12	Junior Fitter	29	0	29	4440-7440
13	Fitter Helper	4	0	4	4440-7440
14	Valve Operator	262	104	158	4440-7440
15	Hammerman	3	0	3	4440-7440
16	Gardener	10	8	2	4440-7440
17	Storekeeper	3	0	3	4440-7440
18	Furnace Man	2	0	2	4440-7440
19	Watchman	29	26	3	4440-7440
20	Khalasi	176	178	(-) 2	4440-7440
21	Chlorine Doser	10	2	8	4440-7440
22	Painter	1	0	1	4440-7440
23	Office Attendant	2	2	0	4440-7440
24	Foreman	2	0	2	4440-7440
25	Chief Electrician	2	2	0	4440-7440
26	Shift In charge	5	0	5	4440-7440
27	Chief Fitter	2	2	0	4440-7440
28	Fitter	20	2	18	4440-7440
29	Moulder	1	0	1	4440-7440
30	Mechanical Filter Operator	4	0	4	4440-7440
31	Mason	3	0	3	4440-7440
32	Tandail	3	0	3	4440-7440
33	Chief Gardener	1	1	0	4440-7440
34	Chief Watchman	1	0	1	4440-7440
35	Chief Sweeper	2	0	2	4440-7440
36	Sweeper	10	3	7	4440-7440
37	Sewer Cleaner	270	32	238	4440-7440
	Sub-Total	*936*	*412*	*524*	
	TOTAL	**1117**	**509**	**608**	

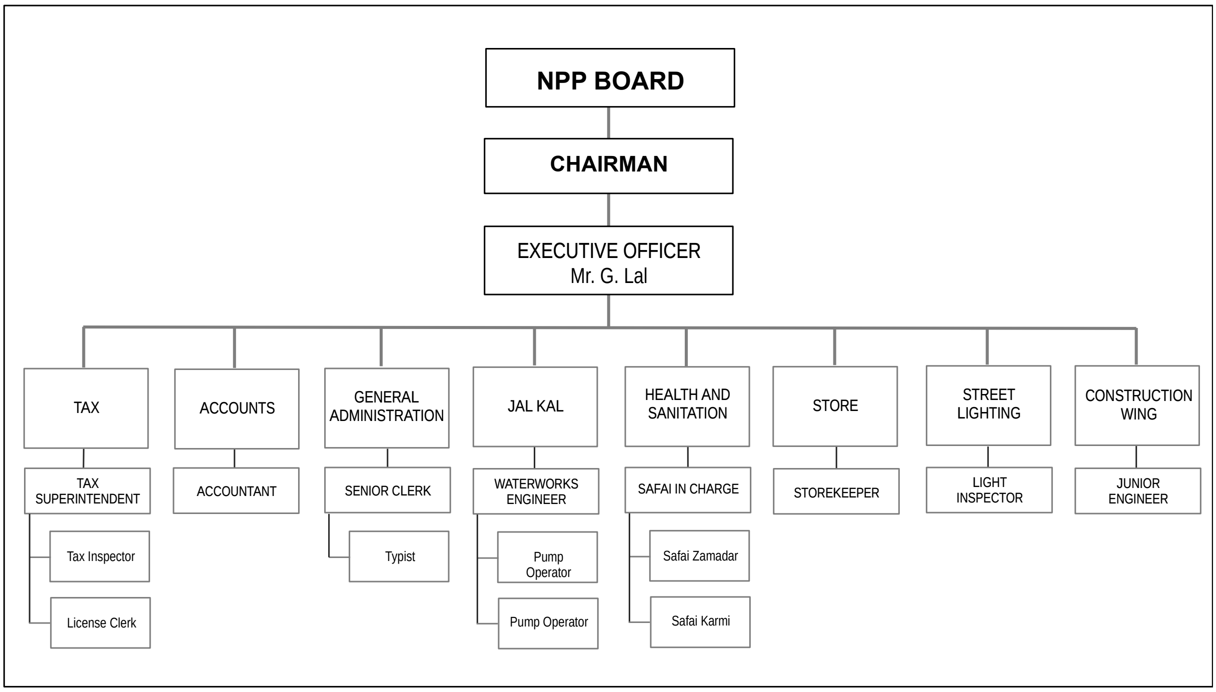
Source: Jal Kal Varanasi, 05 November 2015.

The personnel of JKV are treated as a "staff pool" in that they may have primary areas of assigned responsibility, but they can be rotated and/or assigned to other organisational areas depending on current needs and priorities. They can either be assigned to water supply operations or sewerage operations or both.

2) Ramnagar Nagar Palika Parishad (NPP)

Ramnagar is a Nagar Palika Parishad city in the district of Varanasi, Uttar Pradesh. Ramnagar city has a population of 49,132 (Census India 2011) and is divided into four wards for civic maintenance, which is further divided into 25 sections. It has total administration over 7,729 houses to which it supplies basic community services such as water supply and solid waste management services. Ramnagar is authorized to build roads within NPP limits and impose taxes on properties and collect water fees under its jurisdiction.

The administrative set-up of Ramnagar Nagar Palika Parishad is shown in **Figure 13.1.4**.



Data sourced from Ramnagar NPP on 04 November 2015

Figure 13.1.4 Organization Structure of Ramnagar Nagar Palika Parishad

The Jal Kal of Ramnagar currently provides only water supply services. It has the following facilities: 15 tube wells; one mini power tube well; 160 hand pumps; 80 public stand posts; six water tankers; 80 kms of distribution pipelines. The production capacity comes up to 158MLD

The Ramnagar Jal Kal is headed by a Junior Engineer, but the position has been left vacant. The Clerk now "heads" the Jal Kal as of this time. While there are 17 sanctioned posts, only 14 are filled. To augment staff, 10 assistant pump operators have been outsourced. See **Table 13.1.6** for the staffing of Jal Kal Ramnagar.

Table 13.1.6 Distribution of Posts under Jal Kal (Ramnagar)

S.L.	Category of Post	Number		Pay Band
		Sanctioned	Non-Sanctioned	
1	Junior Engineer	1 (vacant)	1	5200-20200
2	Clerk	1	2	5200-20200
3	Fitter	1	3	4440-7440
4	Pump Operator	1 (vacant)	4	4440-7440
5	Pump Attendant	1 (vacant)	5	4440-7440
6	Pump Driver	1 (vacant)	6	4440-7440
7	Cleaner	5	2	4440-7440
8	Gardener	2	7	4440-7440
9	Chowkidar	4		4440-7440
	Total	**17**	2	**8**

The main source of supply is groundwater. There are 6,987 piped water connections, with water supply coverage at 92% of the service area. Water tax is collected from the customers at 7.5% of property tax and the water fee is Rs.120 per annum per connection.[9]

The six water tankers at Jal Kal utilized to cater to customers during disruptions of water supply. These tankers also deliver water for construction requirements and social functions such as weddings. There charges are Rs.200 per tanker for domestic consumption and Rs.500 per tanker for commercial use.

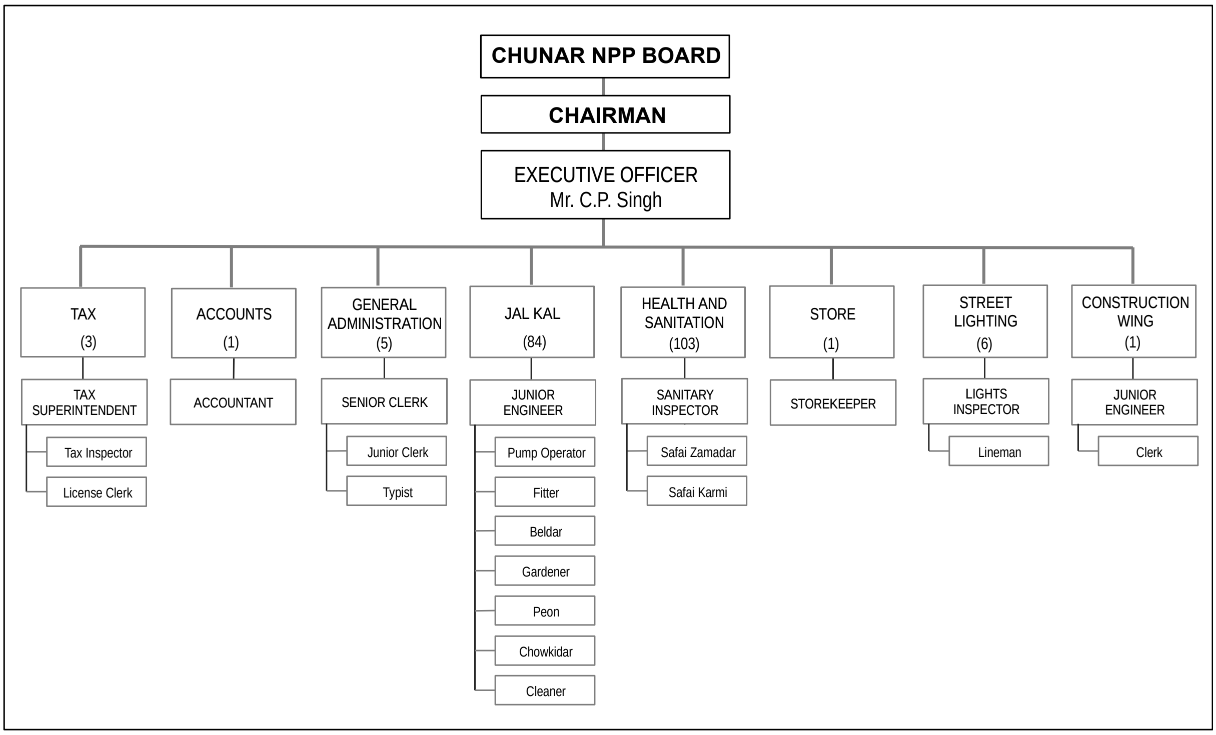
The clerk responsible for water supply receives customer complaints either in writing or through phone. These are all registered in a logbook. On the average 15-20 complaints are received during the monsoon season, while 3-5 complaints are received during other periods. Common complaints are “dirty” water and leakages.

3) Chunar Nagar Palika Parishad (NPP)

Chunar is a Nagar Palika Parishad city in the district of Mirzapur, Uttar Pradesh with a population of 37,185 (Census India 2011) that is spread over its 25 wards. Chunar NPP has total administration over 5,951 houses to which it provides basic community services under its jurisdiction, such as water supply and solid waste management, street lighting and roads and parks, and for which it also imposes and collects taxes on properties and services. It is also in charge of the construction repair and cleaning of street drains and storm water drains. There is no sewerage system in Chunar as of the present time.

Chunar is headed by an Executive Officer who is responsible for civic infrastructure in the city. The administrative set-up is presented in **Figure 13.1.5**.

[9] If the water tax for a household is Rs.180 and the water charge is Rs.120, the customer pays the higher amount of the two. In that case, the person pays Rs.180, which is going to be adjusted as Rs. 120 towards water tax, and Rs.60 towards water charge.



Data sourced from Chunar NPP on 20 November 2015.

Figure 13.1.5 Administrative Set-up of Chunar NPP

The total staff complement of 204 personnel in Chunar NPP is spread over eight functional divisions that are common to all NPPs. **Table 13.1.7** shows the summary of personnel per unit / division.

Table 13.1.7 Distribution of Personnel according to Wing, Chunar NPP

S.L	Name of Wing / Unit / Division	No. of Personnel
1	Tax	3
2	Accounts	1
3	General Administration	5
4	Jal Kal	84
5	Health and Sanitation	103
6	Store	1
7	Street Lighting	6
8	Construction	1
	Total	**204**

As on 30 October 2015

Chunar Jal Kal is comprised of 84 staff members and is headed by a waterworks engineer who holds the rank of a junior engineer. The distribution of staff according to post and number, including information on pay band, is shown in **Table 13.1.8**.

Table 13.1.8 Distribution of Posts for Chunar Jal Kal

S.L.	Category / Post	Number			Pay Band
		Sanctioned	Non-Sanctioned	Total	
1	Water Works Engineer	1		**1**	5200-20200
2	Pump Operator	4	42	**46**	4440-7440
3	Fitter	1		**1**	4440-7440
4	Beldar	2	26	**28**	4440-7440
5	Gardener	2		**2**	4440-7440
6	Peon	2		**2**	4440-7440
7	Chowkidar	3		**3**	4440-7440
8	Cleaner	1		**1**	4440-7440
	Total	**16**	**68**	**84**	

As on 30 October 2015

The source of water supply for Chunar Jal Kal is 29 tube wells. It has 8,375 domestic piped connections, which is equivalent to 95.4% coverage of its service area.[10] There are four tankers with a capacity of 4,000 liters used to supply water in times of disruptions, and also to cater to construction needs and social requirements during weddings and other functions. The cost of one full tanker delivery is Rs.450.

Chunar Jal Kal charges a water tax of 10% of the property tax, plus a water charge of Rs.180 per annum per connection.

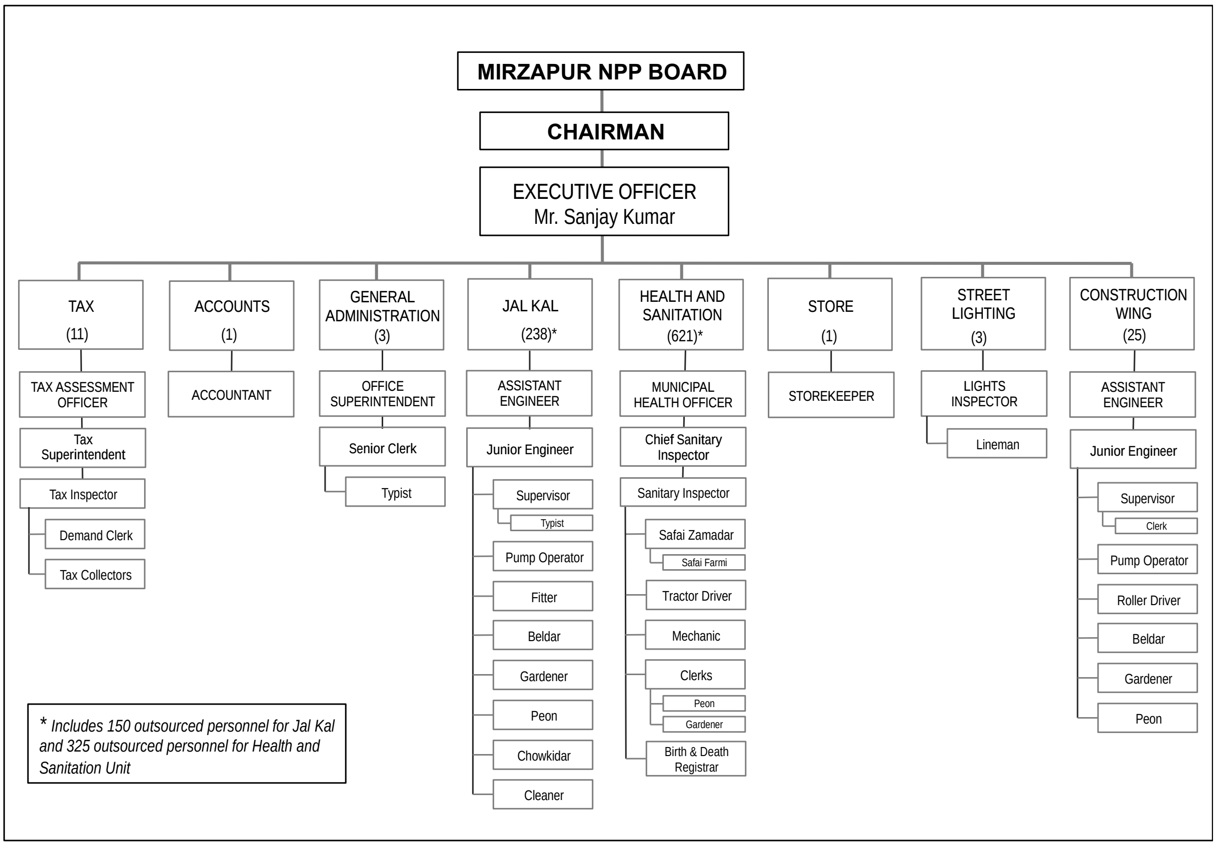
Customer complaints are received the by clerk responsible for water supply, and every complaint is logged in a complaint register. Customers either complain in writing, or via phone call. An average of 50 complaints are received every month, and the most common are “dirty” or turbid water during the monsoon season, leakage, and stand post breakdown.

4) Mirzapur Nagar Palika Parishad (NPP)

Mirzapur is a Nagar Palika Parishad city in the district of Mirzapur, Uttar Pradesh. It has a population of 234,871 (Census India 2011) and has 35 wards. Presently, Mirzapur NPP administers 38,185 houses to which it delivers basic community services like water supply and sewerage. It also provides street lighting, builds and maintains roads and parks under its jurisdiction. For civic maintenance, it constructs, repairs and cleans street and storm water drains. For all these services, the NPP imposes and collects taxes on properties and fees on its services.

[10] Interview with Shamsher Singh, Waterworks Engineer, Chunar Jal Kal 20 November 2015.

Mirzapur NPP is headed by an Executive Officer who has management and supervision over its personnel. The organisational / administrative set-up of Mirzapur NPP is presented in **Figure 13.1.6**.



Data sourced from Mirzapur NPP on 21 November 2015.

Figure 13.1.6 Organizational / Administrative Structure of Mirzapur NPP

There are 903 personnel in Mirzapur NPP, and they have been distributed in the eight wings / divisions as shown in

Table 13.1.9 Distribution of Personnel according to Wing, Mirzapur NPP

S.L	Name of Wing / Unit / Division	No. of Personnel
1	Tax	11
2	Accounts	1
3	General Administration	3
4	Jal Kal	238
5	Health and Sanitation	621
6	Store	1
7	Street Lighting	3
8	Construction	25
	Total	**903**

As on October 30, 2015

Mirzapur Jal Kal is headed by an Assistant Engineer. He takes charge of managing, operating and maintaining water supply facilities in the city composed of the surface and ground water sources (63 tube wells of production capacity of 20 MLD and 450 mini-tubewells with production capacity of 7 MLD), 11 overhead tanks, 355 kms of distribution pipelines and a 6 MLD water treatment plant.

The total number of staff of Mirzapur Jal Kal is 238 personnel, broken down into – 88 sanctioned and non-sanctioned personnel, plus 150 outsourced personnel. The distribution of personnel per category / post is shown in **Table 13.1.10** below.

Table 13.1.10 Distribution of Posts under Mirzapur Jal Kal

SL	Category / Post	Sanctioned		Non-Sanctioned	Total Staff	Pay Band
		Filled	Vacant	Number		
1	Waterworks Asst. Engineer	1	0	0	**1**	9300-34800
2	Junior Engineer	1	2	0	**1**	5200-20200
3	Supervisor	1	0	0	**1**	5200-20200
4	Clerk/Typist	3	0	0	**3**	5200-20200
5	Fitter	4	0	0	**4**	4440-7440
6	Beldar	21	0	0	**21**	4440-7440
7	Pump Operator	41	2	0	**41**	4440-7440
8	Foreman	1	0	1	**2**	4440-7440
9	Gardener	5	0	1	**6**	4440-7440
10	Chowkidar	2	0	0	**2**	4440-7440
11	Peon	6	0	0	**6**	4440-7440
12	Outsourced Personnel	0	0	0	**150**	
				Total	**238**	

As on 30 October 2015

There are 19,000 domestic / piped water connections, which is equivalent to a service coverage of 51% of the service area. In times of piped water disruptions, there are tanker services – 12 nos. of 5,000-litre water tankers for Rs.5000 per full tank and 10 nos. of 3,000 litres at Rs.3000 per full tank.

Water tax for Mirzapur is 10% of house tax plus a water charge of Rs600 per annun for domestic customers. Commercial customers are charged as follows:

- Tea shop / sweet shop Rs.100/ month
- Restaurants Rss150/ month
- Hotel/ Nursing Home Rs.200/ month
- Ice cream factory/ Wedding Hall / Carpet Factory Rs.300/ month

In terms of customer redressal, complaints are attended to within 24 hours. These are received by the clerk responsible and logged in the complaint register. Complaints are either given in writing, or are called in through phone. On the average, 250 complaints are received every month, the most common of which are "dirty" water or turbid water, non-functioning or breakdowns of mini-tube wells, leakages and motorized tube wells that are out of order.

There are two sewage treatment plants in Mirzapur – 4MLD and 14MLD sewage treatment plants. However, these plants are being operated and maintained by UPJN. According to the Mirzapur Executive Officer, around 1,889 households are connected to the sewerage system, and there are plans to charge a sewer tax in the future.

5) Ghazipur Nagar Palika Parishad (NPP)

Ghazipur came into existence in 1868, and in 1973 was upgraded into a Category II city. Presently, Ghazipur is an Urban Agglomeration coming under category of Class I UAs/Towns in the State of Uttar Pradesh. Although Ghazipur City has population of 110,587; its urban / metropolitan population is 121,020. (Census India 2011). The city, which has 28 wards, is governed by Nagar Palika Parishad. Ghazipur City is situated in Ghazipur Urban Region and is the headquarters of Ghazipur District.

The organisational / administrative set-up of Ghazipur NPP is presented in **Figure 13.1.7** Organizational / Administrative Structure of Ghazipur NPP.

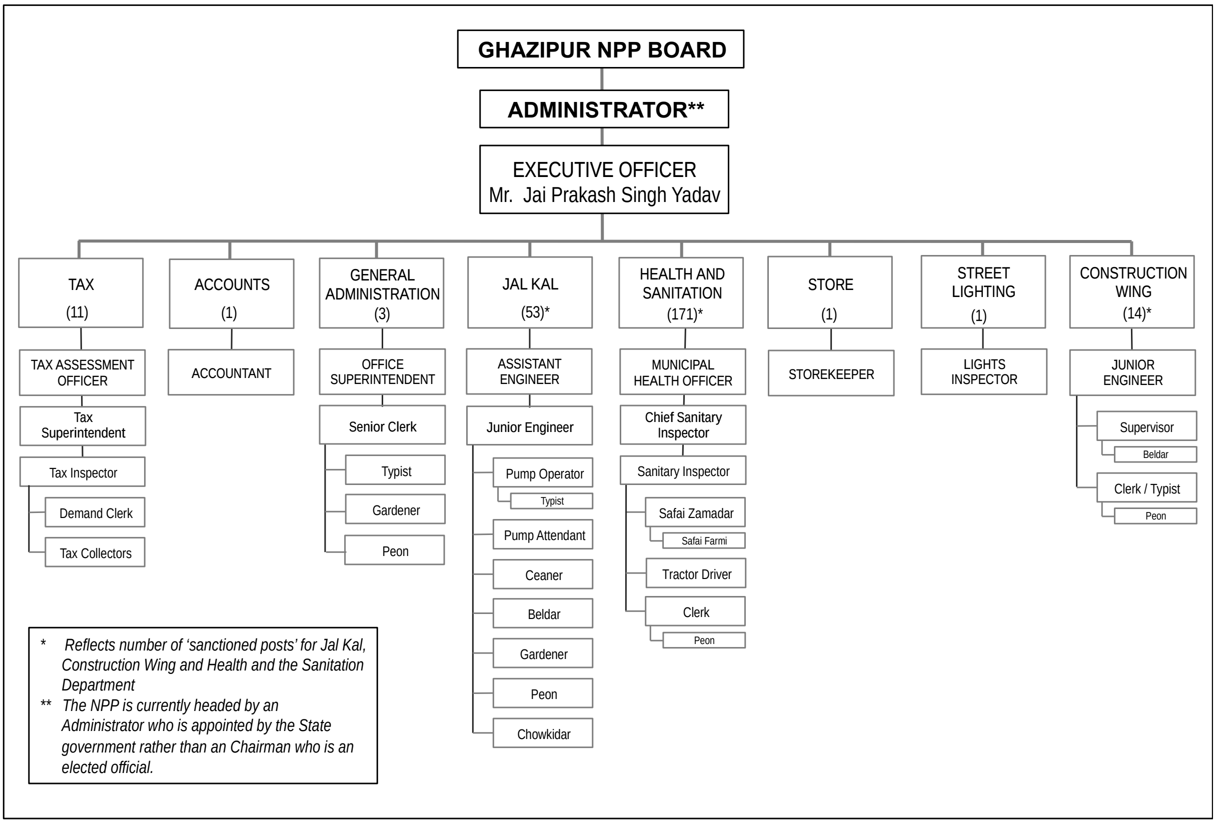


Figure 13.1.7 Organizational / Administrative Structure of Ghazipur NPP

The distribution of personnel in Ghazipur NPP is shown in **Table 13.1.11**.

Table 13.1.11 Distribution of Personnel according to Wing, Ghazipur NPP

S.L	Name of Wing / Unit / Division	No. of Personnel*
1	Tax	10
2	Accounts	2
3	General Administration	5
4	Jal Kal	53
5	Health and Sanitation	171
6	Store	1
7	Street Lighting	1
8	Construction (only eight out of 14 posts filled up)	14
	Total	**257**

* As per 'sanctioned posts' As on October 30, 2015

Ghazipur Ja Kal is divided into four water supply zones. Its existing facilities are: 36 nos. of tubewells with a production capacity of 1MLD per tubewell that each has a average depth of 150 meters; overhead reservoirs with a total storage capacity of 10.59 million litres; and 94.55 kms. of distribution pipelines. Treatment of groundwater is done through chlorination before being pumped into the overhead storage reservoirs. Water is then distributed by gravity to the service area. There is no sewerage system in Ghazipur.

Water revenue is charged as 10% of the property tax, plus a water charge of Rs.600 per annum to the 10,312 customers with piped water connections, which are all under "domestic" customer category. In times of water disruptions, there are two water tankers with a capacity of 3,000 litres (Rs.300 per tank) that supply water to the customers, as well as for construction purposes, and when requested, for social functions.

Customer complaints are received by the Jal Kal clerk and are recorded in a complaint register. These come either in written format, through phone call, or through personal visit by the complainant. On the average, 60 complaints are lodged and the most common complaints range from leakage, hand pump breakdown and the breakdown of the public stand posts.

There is a total of 43 staff in the Jal Kal, which is headed by a Junior Engineer. However, this post remains vacant. Instead, the JE of the Construction Wing is the concurrent head of the Jal Kal.11 The distribution of posts for Ghazipur Jal Kal is shown in **Table 13.1.12**.

Table 13.1.12 Distribution of Posts under Jal Kal Ghazipur)

SL	Category / Post	Sanctioned		Non-Sanctioned	Total Staff	Pay Band
		Filled	Vacant	Number		
1	Junior Engineer*	0	1	0	**0**	5200-20200
2	Clerk/Typist	1	0	0	**1**	5200-20200
3	Fitter	0	2	1	**1**	4440-7440
4	Beldar	9	0	0	**9**	4440-7440
5	Pump Operator	3	1	0	**3**	4440-7440
6	Pump Attendant	15	5	0	**15**	4440-7440
7	Cleaner	3	0	0	**3**	4440-7440
8	Gardener	1	1	0	**1**	4440-7440
9	Chowkidar	10	1	0	**9**	4440-7440
10	Peon	1	0	0	**1**	4440-7440
				Total	**43**	

As on 30 October 2015

* The post of Junior Engineer (JE) under Jal Kal Ghazipur is vacant, but the JE assigned under the Construction Wing is the concurrent head of Jal Kal.

[11] Interview with Mr. Vivekananda Singh, Junior Engineer, Construction Wing, Ghazipur. 24 November 2015.

13.2 Project Implementation System

The federal Constitution of India treats water supply and sanitation as a State matter. As such, States are vested with the constitutional right on planning, implementation, operation and maintenance and cost recovery of water supply and sanitation projects.

The role of the Central Government in water supply and sanitation is in the crafting of policy, the formulation of guidelines, and provision of implementation support for specific laws. It also acts as an intermediary in mobilizing external assistance in the sector and links assistance via State plans. To some extent, it sometimes provides direct grant assistance to water supply and sanitation programs in urban areas.

On the local level, the responsibility for the provision of water supply, sewerage services, and sanitation is entrusted by legislation to the urban local bodies like the municipal corporation, the municipal board, and the municipal council.

The successful implementation of the Ganga Rejuvenation Project entails setting up an effective project implementation system, with clearly defined responsibilities and provision for accountability that would take into consideration the following realities:

- The mutual agreements between both the lender, the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA), and the borrower, the Government of India (GOI) which will utilize the funds for the ULBs under consideration in the Project;
- The most recent policy decision of the Government that sewage treatment is to be mandatory and that all STPs along the river Ganga shall be taken up through the hybrid annuity-PPP mode. In addition, the institutionalization of the Special Purpose Vehicle (SPV) shall be also taken up for project execution through Transaction Advisors.

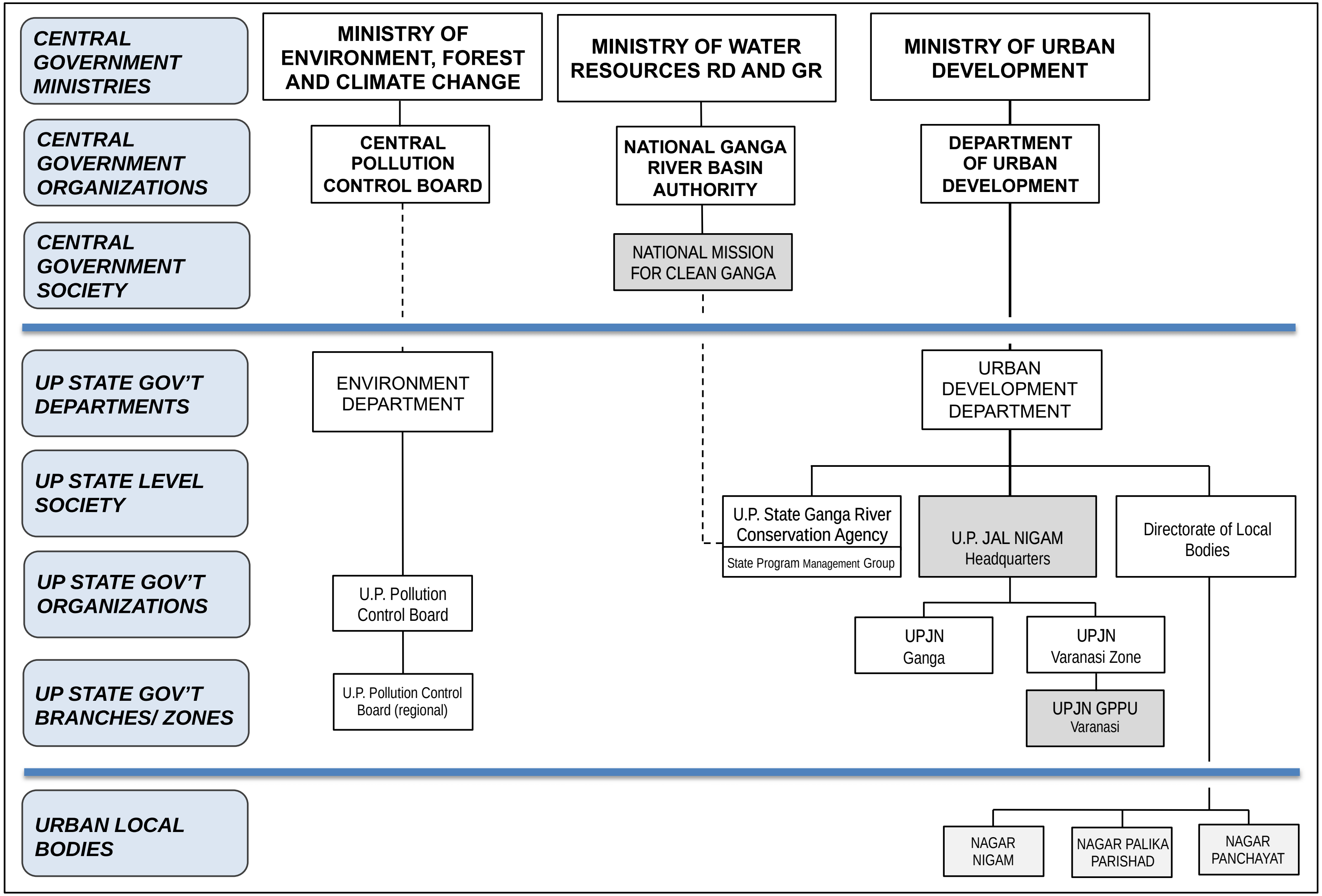
13.2.1 Current Institutional Framework for Water Supply and Sanitation

The objective of undertaking measures to prevent pollution in the river Ganga is not only to improve the water quality in India's holiest river, the Ganges, or the hygienic condition in the river basin; but also to improve the sanitation and living conditions of people who reside in the Project area. Among the approaches to address current sanitation situation is the construction of sanitation facilities to treat sewage before this is discharged into the Ganges. This means augmenting sewage collection systems and sewage treatment facilities leading to improved sewerage services, as well as implementing measures for efficient management both in the technical, institutional and financial aspects, including operation and maintenance of sewerage facilities.

There are central government, state and local government actors / stakeholders which make up the current institutional framework in the water supply and sanitation sector. These are:

- *For central government ministries* – the Ministry of Water Resources, River Development and Ganga Rejuvenation, under which the National Ganga River Basin Authority, and its implementation / operational arm, the National Mission for Clean Ganga are allocated; The Ministry of Environment, Forests and Climate Change, and the Ministry of Urban Development. These central government agencies formulate policies, plan and monitor program and project execution, and coordinate activities with other central ministries, state-level governments, nodal authorities and urban local bodies.
- *For state-level departments / organizations* – the State Ganga River Conservation Agency / State-Level Program Management Group (SGRCA-SPMG), UP Environment Department and the UP Urban Development Department (UDD), under which are the UP Jal Nigam (UPJN) and its subordinate office, UPJN Ganga Pollution Prevention Unit (GPPU).
- *For urban local body level* – the Varanasi Nagar Nigam, Ramnagar NPP, Chunar NPP, Mirzapur NPP, and Ghazipur NPP. These ULBs fall under purview of the Directorate of Local Bodies, UDD.

The current institutional framework is presented in **Figure 13.2.1.**



JICA Survey Team, 18 November 2015

Figure 13.2.1 Current Institutional Framework for Water Supply and Sanitation

13.2.2 Proposed Project Implementation System

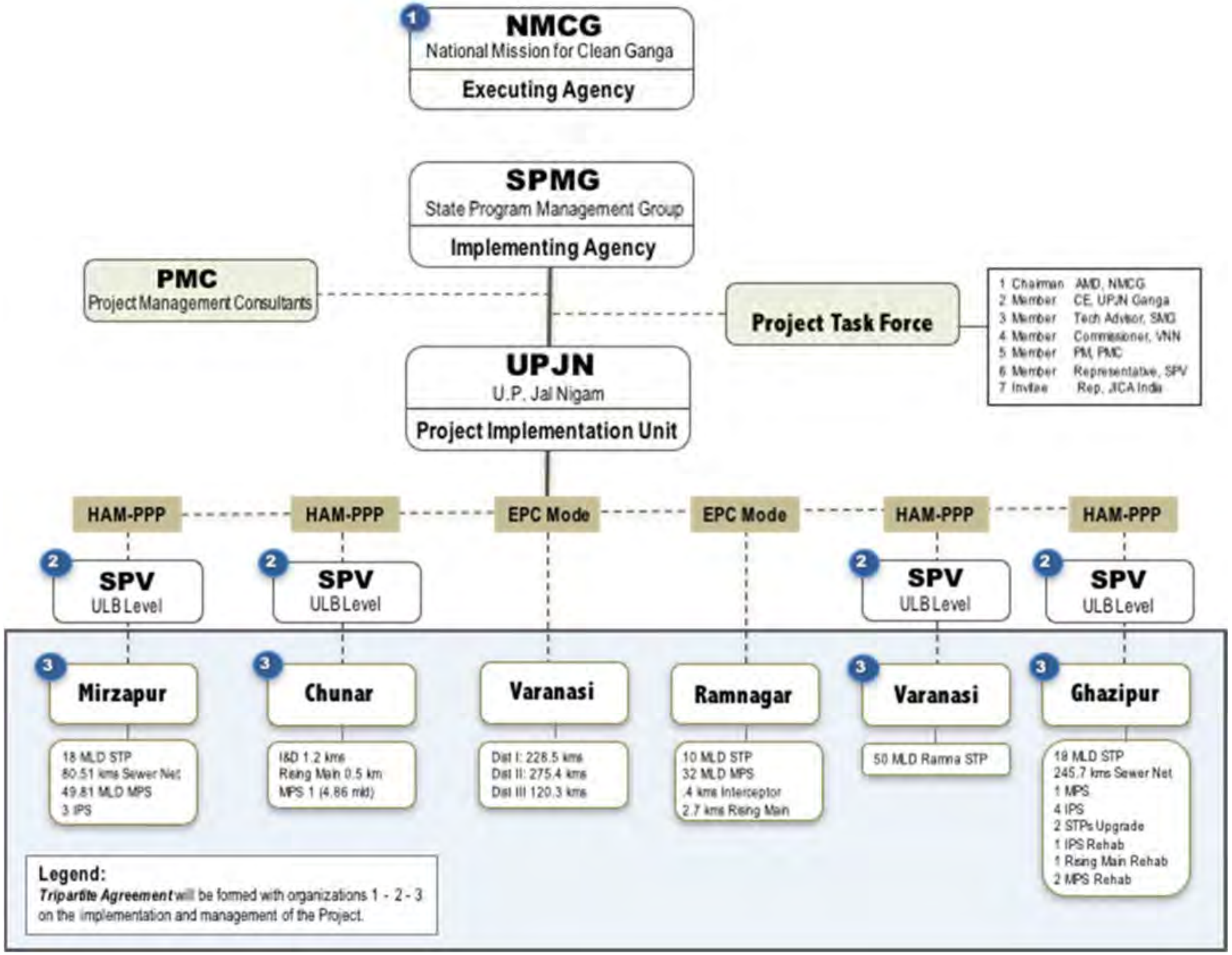
The proposed project implementation system necessitates the establishment of formal institutional linkages among the key stakeholder-institutions through a streamlined project organisation system. The system should provide avenues for coordination and policy guidance, on one hand, as well as guidelines in managing the activities of project implementation, on the other, with a sharing of roles and responsibilities to mitigate managerial, technical, financial, environmental and social problems that may arise in the course of the Project's implementation.

The implementation system also describes each major stakeholder's roles and responsibilities to help smoothen project implementation and ensure successful project completion. The project implementation system also includes the Special Purpose Vehicle (SPV) and the centrality of SPV's role in Ganga rejuvenation by scaling up future sustainability of completed projects.

The project implementation system / framework is proposed by JICA Survey Team, March 2017.

Figure 13.2.2: **Proposed Project Implementation System**. It shows the following sets of major stakeholders:

- *The regular agencies of government* directly involved in project implementation – the GoI through the MoWR RD&GR as the responsible Ministry, NMCG as the executing agency (E/A), SPMG as the implementing agency (I/A), and UPJN as the project implementation unit (PIU);
- *Specialized government corporations* or SPV(s) to be established at the ULB levels, which focus on planning, structuring, procuring concessionaires, monitoring implementation of sewerage system / sewage treatment projects and developing the market for treated wastewater through appropriate policy advocacy under the overall guidance of NMCG;
- *Ad hoc organizations* – Steering Committee and the Project Task Force – to support and to coordinate project implementation tasks; and
- *The Urban Local Bodies* where the Project(s) is / are to be implemented.



JICA Survey Team, March 2017.

Figure 13.2.2 Proposed Project Implementation System / Framework

1) Executing Agency (E/A)

The Executing Agency for the Ganga Rejuvenation Project is the National Mission for Clean Ganga, also the Central government's programme implementer of Namami Gange. The E/A shall:

- Spearhead setting up of the Special Purpose Vehicle, together with the SPMG, to steer Namami Gange towards the achievement of its general and specific programme objectives by taking up measures to ensure that each individual projects perform efficiently and effectively, and are viable and sustainable investments;
- Since the E/A implements projects through its State counterpart – the State Program Management Group, it shall ensure that the SPMG is given the required resources and is adequately capacitated to discharge its tasks;
- Representing the Central Government/ GoI, the E/A representative shall sit as a member of the Board of Directors of the SPV(s) to be organized;
- Appraise both the technical feasibility and commercial viability of individual projects through its Transaction Advisors, then offer these to the PPP market;
- Monitor projects' implementation considering that the 40 percent (maximum) exposure of GoI is in the form of loans from development partners like JICA;
- Comply with general stipulations in the Loan Agreement between GoI and development partner such as JICA in terms of expenditure / disbursements procedures, and overall work accomplishments; and
- Participate in project review missions and assess project implementation against targets and indicators.

2) Implementing Agency (I/A)

The Implementing Agency for the Ganga Rejuvenation Project shall be the State Program Management Group, being the State counterpart and operational wing of NMCG in the state of Uttar Pradesh. Its main role shall be the programme-level monitoring and coordinating for the Project. As such, it shall perform the following:

- Together with the NMCG, undertake formation of the ULB level Special Purpose Vehicle(s) that will take up individual projects on sewerage networks/ systems and sewage treatment;
- Assist the U.P. State government to mobilize financial resources from national or international institutions for said project(s);
- Representing the NMCG, the appointed I/A representative shall sit as a member of the Board of Directors of the SPV(s) to be organized in the State of U.P.;
- Appraise the technical feasibility and financial viability of projects to be undertaken

by the SPV through either feasibility reports and/or detailed projects reports;

- Be involved in formulating the "Tripartite Agreement" among the NMCG and/or SPMG, the ULB-level SPV, and the concerned/ participating ULB;
- Select and employ, negotiate with, award and sign the contract with the winning Project Consultant (to be named "Project Management Consultant") based on the *Guidelines for the Selection and Procurement of Consultants for JICA ODA Loans*.
- Plan and execute capacity building / training activities for participating ULBs in anticipation of the latter's role as enumerated in the MoA / Tripartite Agreement;
- Coordinate with SPV and/or execute its own programmes to generate public awareness, participation and support utilizing various forms of information, education and communications (IEC) media on the abatement of water pollution and on measures to enhance environmental cleanliness in rover Ganga;
- Considering that performance standards are linked with the payment of annuities, ensure that the treatment of sewage is in accordance with appropriate/ latest standards prescribed by GoI, U.P. State government, the Central Pollution Control Board, and the U.P Pollution Control Board;
- Prepare monitoring and reporting template for the Project(s), or utilize/ expand its current monitoring system to record implementation progress and results, which include the meeting of technical, financial and environmental targets;
- Report on implementation challenges and provide solutions; and
- Document lessons learned from project completion reports for possible replication in other NMCG projects in the area.

Monitoring: SPMG utilizes a 13-column project monitoring sheet[12] that provides information on all the projects that fall under the aegis of NGRBA/ NMCG programme in the state of U.P. For this Project, the same monitoring system can be utilized. The following are the information contained in the monitoring sheet:

- SL number
- State / Town
- Name of Project, including:
    - Reference of sanction

[12] Sourced from SPMG, 4 December 2015.

    - Project code
- Programme (under what Ministry / Office)
- Approved Cost
    - Total
    - Capital
    - 5-Year Main
- Major Component
    - Item
    - Quantity (mld for STP, kms for sewer net; number for SPS and MPS, numbers for dhobi ghats, urinals / toilets, water fountains, watch towers, change rooms, etc.)
- Physical Progress
    - In percentage for each major component / item
- Over-all Progress (in %)
    - Release of Fund for every major project component
    - Total for Share of Central / State
- Expenditure
    - Total for Central / State
- Present Status
    - A – Not started
    - B – On-going
    - C – Completed
- Remarks / Bottlenecks
    - The remarks portion identifies non-problematic status of the project(s) such as "work in progress" or "mobilization advance given survey work in progress";
    - The bottlenecks portion identifies the specific problems such as "court stay" or "district court" or "land dispute".

3) Project Implementation Unit (PIU)

The UPJN is the State parastatal organization with the mandate to formulate, execute, promote, finance, set standards and fix tariffs for water supply and sewerage services, sewage treatment and disposal of all schemes in the State including river pollution abatement projects. It also has the function to "render all necessary services in regard to water supply and sewerage to the State Government and local bodies, on request to private institutions or individuals".

In this connection, therefore, UPJN can and shall be appointed jointly by the SPV and SPMG as the implementing unit for the Project. This is borne out of the following circumstances:

- The SPV is still to be established and needs to develop the experience on the implementation of sewerage and sewage treatment projects;
- SPMG's powers and functions do not include project execution (plan, design and construct). Additionally, it also lacks the requisite experience on, and human resources for, project implementation; and
- UPJN possesses implementation capacity, having depth and breadth of experience in implementing projects similar to the scale and cost as the proposed Project(s).

UPJN has adequate institutional capacity in project implementation, project execution, project coordination, project monitoring, supervision, and project management. Specifically, it shall be UPJN-GPPU that shall be tasked to provide the day-to-day supervision over the project at the field level, or the tasks that relate to the application of project management concepts, tools and techniques. It shall address scope definition, scheduling, cost estimating, procurement management, financial management, human resource management, environmental and social considerations, public awareness and communications, capacity development and training, and risk management.

A more detailed discussion on the PIU is presented in **Section 13.3:** "PIU Structure, Personnel Composition, Roles and Responsibilities".

4) Special Purpose Vehicle (SPV)

According to the explanation by GoI, the Special Purpose Vehicle (SPV) for Hybrid Annuity-based Mode of Public Private Partnership (HAM-PPP) will be set up and institutionalized for project execution of sewage treatment infrastructure under Namami Gange. The SPV shall be established under the *Indian Companies Act 2013* to provide the required governance framework and enable functional autonomy. The Government has decided that all STP development and operation along the river Ganga will be taken up under HAM-PPP.

With this decision, Government can take up more projects with reduced financial liability in the initial years. There is also the opportunity of developing of the market for treated water that will lead to a reduced demand on riverine fresh-water and will result in enhanced flows in river Ganga. On the part of the private participant, risks over the project(s) are lowered as the stakes are spread over the entire period of the concession. To be equally benefited are the ULBs, which would be ensured of continued facility operations over a long term. Additionally, the ULBs would gradually build capacity by setting the ground for the recovery of user charges using the "polluter pays" principle. By linking performance standards with the annuities to be paid the private partner, the desired objective of treated water of appropriate standard will be achieved.

To start with, the SPV would enter into a Memorandum of Understanding (MoU) with the State Government and the ULB where the project is to be located. It is important to delineate the roles and responsibilities considering that provision of sewage services to the people / communities are a joint responsibility of the State and the ULB, with the latter in charge of the operation and maintenance of sewage networks and treatment facilities. The MoU will clarify the intent of the SPV in providing the needed reforms and regulatory measures which other previous projects on river Ganga were not able to address.

Thereafter, the SPV will enter into a Tripartite Agreement (T/A) with the concerned ULB and the Concessionaire that was awarded the particular project that would list the roles and responsibilities of each party in order that sewage treatment services can be provided as envisioned by Namami Gange and that project and programme objectives are realized.

More detailed discussion of the SPV is presented in **Section 13.4:** "SPV Organization Roles and Responsibilities".

5) Project Task Force (PTF)

While the Project Steering Committee was set up during the project formation stage, this will no longer be required during the project implementation stage. Instead a Project Task Force (PTF) will be organized to provide overall direction for the Project's implementation; facilitating coordination among concerned Government, State and ULB stakeholders, government corporations and state parastatal organizations; and seeking support from the concerned communities where the projects are implemented.

The project implementation phase can bring about problematic issues that would require immediate solutions to accomplish short-term tasks and realize specific objectives for the Project and the working group best suited for results-centred and problem-solving orientation is the task force.

A task force is typically comprised of a small group of people who are selected for their expertise in their recognized areas of knowledge, their history in the area of practice, and their interest in the Project. In this sense, the task force members bring different skills and ideas, become project advocates within the implementation system, foresee potential hurdles to implementation, and build solutions into their recommendations. Essentially, a task force, in itself, does not have on-going functions, as their purpose is to provide solid and collective recommendations within a given time frame. Thus, the Project as a whole will greatly benefit from the advantages of a task force and the rigorous analytical multi-disciplinary approach and comprehensive knowledge of the sanitation sector and the areas where the sub-components are to be implemented. The role of the PTF will be the following:

- Study, formulate and recommend solutions on issues referred to it because of legal, policy, technical and operational concerns or differences;
- Identify appropriate agencies to whom to refer and/or follow up solutions caused by project implementation bottlenecks, problems and issues;

- Facilitate timely release of construction and other licenses/ permits needed for the Project;
- Monitor and/or coordinate environmental and social requirements during project implementation,
- Monitor and/or coordinate public participation and enlightenment requirements related to project implementation;
- Should the project require it, monitor land acquisition procedures on their compliance to law;
- Hold regular quarterly meetings and call for special meetings, if required;

To provide technical and/or administrative support services to the Project Task Force, a 'secretariat' composed of staff from the SPMG shall be made available. The implementation arrangements summary for Ganga Rejuvenation project is shown in **Table 13.2.1**.

Table 13.2.1 Implementation Arrangements Summary

SL		Aspects	Arrangements
1	Estimated Implementation Period		
	1.1	Project Formation	To be determined during Loan Agreement stage
	1.2	Project Implementation	To be determined during Loan Agreement stage
2	Estimated Completion Date		To be determined
3	Estimated Loan Closing Date		To be determined
4	Management		
	4.1	Executing Agency (E/A)	National Mission for Clean Ganga thru the Mission Director
	4.2	Implementing Agency (I/A)	State Programme Management Group (SPMG) located in the State Ganga River Conservation Agency (SGRCA)
	4.3	Project Implementation Unit (PIU)	UPJN-GPPU with appointment from E/A, I/A and SPV
	4.4	Project Task Force (PTF)	Assistant Mission Director, NMCG – Chairman Chief Engineer, UPJN Varanasi – Member Advisor, Technical, SPMG – Member Municipal Commissioner, VNN – Member Project Manager, Project Management Consultants – Member Representative, JICA India – Invitee SPMG Staff – PSC Secretariat
	4.5	Special Purpose Vehicle (SPV)	To be established for each ULB-based project sewerage facility as a limited corporation under the *Corporation Act, 2013*
			SPV for Mirzapur
			SPV for Ghazipur
			SPV for Chunar
			SPV for Varanasi (for 50 MLD Ramna STP)

5	Procurement		
	5.1	PPP Concessionaire and/or O&M Contractor	National Competitive Bidding for ULBs under SPV Mode
	5,2	EPC Contractor and/or O&M Contractor	National Competitive Bidding for ULBs under EPC Mode
6	Procurement for Consulting Services		• By SPMG • International Competitive Bidding • Project Management Consultants (PMC) for project implementation support and capacity building (quality and cost-based)
7	Advance Contracting		NMCG/SPMG may require advance contracting of Project Management Consultants before actual implementation stage.
8	Disbursement		Loan disbursement will be in accordance with JICA's transfer and disbursement procedures and detailed arrangements between GoI and JICA

13.3 The Project Implementation Unit (PIU) Structure, Personnel Composition, Roles and Responsibilities

The establishment of the Project Implementation Unit (PIU) should take into consideration several factors – such as past experience from organizing PIUs for development projects in India for the water supply and sanitation sector together with executing and implementing agencies, and with SPVs. Also to be taken into consideration are the requirements of JICA as a development partner. Most, if not all, loan projects from the Government of Japan (GOJ) to the Government of India (GOI) that pass through JICA generally necessitate the establishment of PIUs. Considering the scope, the number of sub-project components and their locations for the Ganga Rejuvenation Project, the PIU is required.

As explained in the previous section, SPMG shall appoint UPJN to be the PIU. The main justifications are that UPJN possesses implementation capacity, having depth and breadth of experience in implementing projects similar to the scale and cost as the proposed project(s). It also has the mandate to render "all necessary services in regard to water supply and sewerage to the State Government and local bodies, on request to private institutions or individuals." The SPMG's powers and functions, on the other hand, do not include project execution (plan, design and construct). Additionally, it also lacks the requisite experience on, and human resources for, project implementation.

Given this situation, SPMG, as the Implementing Agency, will not only appoint UPJN as the PIU, but will also engage the project management consultants (PMC) to work alongside PIU in ensuring that the project(s) are implemented on schedule, within scope and on budget. The PIU and PMC shall provide regular implementation reports to SPMG for either information or action, if required.

In this connection, therefore, UPJN shall organize the Project Implementation Unit (PIU) in the UPJN Varanasi Zone office, set up as an independent office under the Office of the General Manager, UPJN

Ganga Pollution Prevention Unit (UPJN-GPPU). The UPJN-GPPU implements centrally and state funded pollution prevention projects for the River Ganga. It has adequate experience in implementing internationally-funded or overseas development assistance projects, such as but not limited to wastewater treatment projects, sewage collection and disposal projects, as well as pollution control-related projects in the areas of capacity development, health and hygiene, public awareness and IEC.

13.3.1 Organization Structure of PIU

The PIU for the Ganga Rejuvenation Project needs an effective structure for project implementation and control with clearly defined responsibilities and provision for accountability. It shall:

1) Serve as the technical arm in managing, supervising and controlling day-to-day project activities, which includes the work of the HAM-PPP Contractor-Concessionaire and the EPC Contractor in activities related to project planning and management, project construction supervision, disbursements, environmental management and monitoring, and preparation of reports;
2) Work alongside the Project Management Consultants (PMC) who will be engaged by the SPMG for the Project;
3) Institute a measurement system to assess results of work and schedule of progress, budget, compliance with technical specifications, and resource requirements in order to predict results of deviations, then implement actions(s) to correct deviations while continuing to review procedures; and
4) Monitor and evaluate the performance of each specific project.

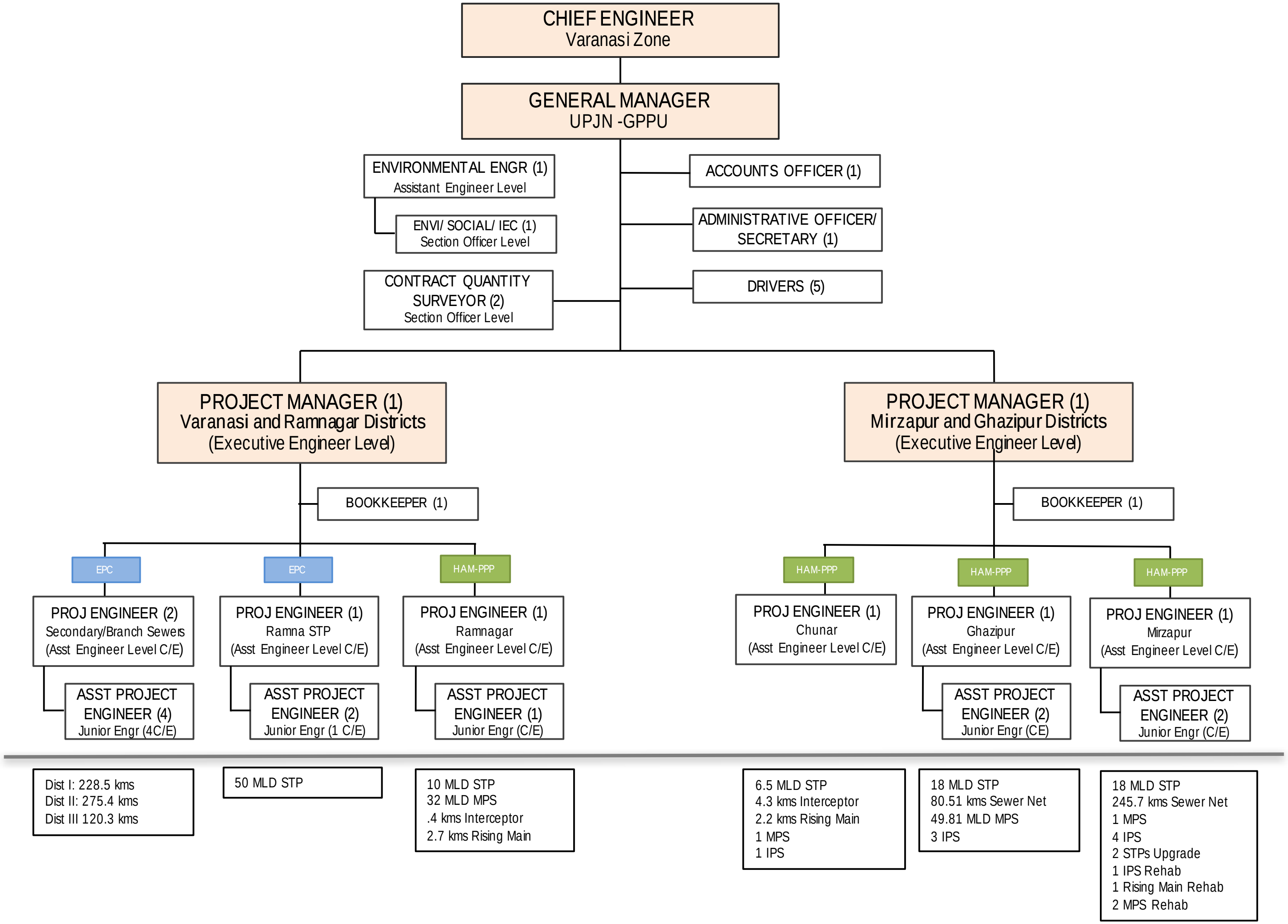
The proposed organization structure and staffing of PIU considers the application of organisational principles to ensure efficient and effective accomplishment of the Project objectives as delegated to it by the NMCG / SPMG and the particular SPV, together with organisational factors and practices existing in UPJN-GPPU, as follows:

1) The *organizational principles* that integrates work flows such as:
    - Vertical differentiation, or the levels of authority decision-making, responsibility, accountability and communication;
    - Horizontal differentiation, or the degree of separation and distribution of functions;
    - Spatial differentiation, or the geographic locations and equitable load distribution of the sub-projects;
2) The *reporting relationships* that provide:

- The order in the chain of command;
- The clarity in the span of control; and
- The logic in the pattern of inter-relationships.

3) The *line and staff positions* that provide management authority and responsibility in the division of work and achievement of Project objectives.
    - The number of staff required for the PIU shall be exclusively assigned for the Project, using the normal ratio for PE to assistant PE which is 1:2;
    - The proposed PIU posts have an equivalent post/ rank as contained in UPJN service rules regulations; and
    - The proposed PIU staffing shall be in addition to the existing staff complement in UPJN-GPPU.
4) The *coordinating activities* that ensure the process of linking support activities within and outside of the PIU for goal accomplishment.

Figure 13.3.1 shows for the organization structure of the PIU, the clustering of projects depending on the type of financing, that is EPC mode or HAM-PPP mode. The clustering also addresses the geographic areas on a per ULB basis.



JICA Survey Team, March 2017.

Figure 13.3.1 Organization Structure of PIU for Ganga Rejuvenation Project

13.3.2 Staff Requirement and Qualifications

Implementation should be managed by experienced project implementation staff with strong central control and supported by the active participation of staff in the project-specific areas. In this sense, the PIU should have dedicated staff to implement/ manage the project and its sub-components while allowing flexible use of staff from its own functional organization.

The General Manager, GPPU will serve as the *de facto* Project Director for the Ganga Rejuvenation Project. He will be supported by two full-time Project Managers (PM) – one to manage and supervise the EPC works in the Varanasi District, including Ramnagar; and another who will manage and supervise the HAM-PPP works in in the Varanasi District for Ramna STP, and the STPs in the Chunar, Mirzapur and Ghazipur Districts.

In addition, an environmental engineer, supported by an environmental / social specialist will be required to establish and monitor the environmental and social conditions during the implementation of the Project. The Project Accountant and the two Bookkeepers will be responsible for project finance and accounting. The Administrative Officer cum Secretary will be responsible for secretarial and administrative-related functions. See **Table 13.3.1** for the personnel requirement of the PIU. The number of personnel in **Table 13.3.1** shows the total of internally-deployed and externally-recruited staff for the project.

Table 13.3.1 Positions and Number of Personnel Required for PIU

SL	PIU Position	Equivalent Level /Position in UPJN	Number
1	Project Director	General Manager (Actual)	1
2	Project Manager	Executive Engineer	2
3	Project Engineer	Assistant Engineer	7
4	Assistant Project Engineer	Junior Engineer	11
5	Environmental Engineer	Assistant Engineer	1
6	Environmental/ Social/ IEC Specialist	Section Officer	1
7	Contract/ Quantity Surveyor	Section Officer	2
8	Accounts Officer	Accounts Officer	1
9	Administrative Officer/ Secretary	Administrative Officer	1
10	Bookkeeper	Bookkeeper	2
11	Driver	Driver	5
		Total	**34**

Note: The General Manager in **Figure 13.3.1** is supposed to be the Project Director

The engagement of the PIU staff will be governed by the Service Regulations of UPJN. The educational and experience qualifications of the proposed staff are as shown in **Table 13.3.2.**

Table 13.3.2 Proposed Educational and Experience Qualification of PIU Staff

Post	Proposed Qualifications	
Project Manager Executive Engr Level	Education	• A Bachelor's degree in Civil / Environmental Engineering; • Master's Degree in Civil / Structural Engineering; • Project Management Professional (PMP) Certification an added advantage.
	Experience	• At least 15 years' experience as project manager in sewerage and/or water supply planning, design and/or implementation projects; • At least 10 years' experience as senior project engineer or project manager of sewerage and/or water supply construction projects; • At least five years' experience as project manager of sewerage and/or water supply construction projects similar in scale to this Project.
Project Engineer Assistant Engr Level	Education	• A Bachelor's degree in Civil/ Environmental Engineering; • Master's Degree in Civil / Structural Engineering an advantage; • Project Management Professional (PMP) Certification also added advantage.
	Experience	• At least 10 years' experience as project engineer in water supply and/or sewerage projects; • At least five years' experience as project engineer or assistant project manager in sewerage and/or water supply construction projects; • At least two years' experience as project engineer or assistant project manager of sewerage and/or water supply construction projects similar in scale to this Project.
Assistant Project Engineer Junior Engr Level	Education	• Diploma in Civil/ Environmental Engineering from any reputable engineering university/ college; • A Bachelor's degree in Civil Engineering preferred.
	Experience	• At least eight years' experience as assistant project engineer / junior engineer in sewerage and/or water supply projects; • At least four years' experience as junior engineer in a water supply and/or sewerage construction project.
Environmental Engineer Asst Engr Level	Education	• A Bachelor's degree in Environmental Engineering.
	Experience	• At least, 10 years' experience as environmental specialist in sewerage and/or water supply projects; • At least five years' experience as environmental specialist in water supply and/or sewerage construction project.
Environmental / Social Specialist Section Officer Level	Education	• Diploma Course in Civil/ Environmental Engineering from a reputable government polytechnic institute.
	Experience	• At least five years' experience as project supervisor in water supply and/or sewerage project.
Contract / Quantity Surveyor Section Officer Level	Education	• Diploma in Civil/ Environmental Engineering from a reputable government polytechnic institute.
	Experience	• At least five years' experience as materials estimator/ contract/quantity surveyor for water supply and/or sewerage construction projects.
Accounts Officer	Education	• A Bachelor's degree in Business Accountancy from a

		reputable government university. • A Master's degree in Commerce with specialization in Accountancy.
	Experience	• At least five years' experience in accounts, financial planning and budgeting with exposure to financial computer software in a project office.
Administrative Officer / Secretary	Education	• A Bachelor's degree in Business Administration/ Commerce from a reputable government university.
	Experience	• At least five years' experience in administrative work in a reputable organization.
Bookkeeper	Education	• A Bachelor's degree in Business Commerce with accountancy specialization from a reputable government university.
	Experience	• At least five years' experience in accounts keeping in a reputable organization.
Driver	Education	• Passed 10th class/ standard.
	Experience	• At least five years' driving experience with a valid Driving License for type of vehicle to be driven.

13.3.3 Responsibilities of PIU Staff in Project Implementation

Duties and responsibilities have been specified for the posts proposed in the PIU that not only determine how critical each position or job is, but also show how the job or tasks relate to the others in the PIU.

1) Chief Engineer, UPJN Varanasi Zone

The Chief Engineer, UPJN Varanasi Zone shall exercise strategic-level management and leadership over PIU by ensuring that the objectives, targets and outcomes of the Project are achieved efficiently and effectively and according to plan. As such, the CE has general management and supervision over the PIU, and shall:

a) Approve technical/ engineering-related Project matters such as technical studies and detailed designs and over-all construction management requirements;

b) Undertake higher-level project coordination by bringing to the attention of UPJN Managing Director, SPV, SPMG, the Steering Committee, or the Project Task Force important implementation issues (legal, financial, and policy) that need immediate resolution;

c) Approve and/or endorse official documents and communications emanating from the PIU/ UPJN-GPPU addressed to inter-governmental and external offices;

d) Approve and/or endorse claims or requests for payments from the Contractor-Concessionaire of each ULB Level SPV through identified channels.

2) The General Manager (GM), UPJN-GPPU Varanasi

The General Manager, UPJN-GPPU shall be the *de facto* Project Director (PD) of PIU. He shall exercise administrative and operational control over the PIU and project implementation activities. As such, the GM/PD ensures that the Project is implemented in accordance with the schedules, plans and procedures agreed upon by GoI and JICA, and delegated authority from SPV and SPMG, and shall:

a) Initiate the hiring process or the engagement of technical, administrative/ finance personnel (PIU staff) required for the Project according to UPJN service rules;

b) Provide progress and/or performance evaluation reports to the Chief Engineer, Varanasi Zone, the UPJN Managing Director, SPMG, SPV, JICA, as well as to the concerned State and Central government authorities, when required;

c) Review and/or endorse for payment claims from the Contractor-Concessionaire of each ULB-Level SPV through identified / proper channels;

3) The Project Manager (PM)

The Project Manager is a position that requires *ad hoc* adjustments, based on moment-to-moment assessments of current conditions, within the context of a comprehensive plan created using sound, consistent and proven project management methods and practices from relevant past experience. This position also requires collaborative efforts among project stakeholders, such as GoI, JICA, NMCG, SPMG, SPV other state and local authorities, project beneficiaries, and other interested parties.

There shall be two project managers for the PIU – one for the Varanasi Zone, including Ramnagar, and another for the Ghazipur and Mirzapur Districts. Both PMs are expected to perform the following tasks/ responsibilities:

a) Provide management direction and leadership guidance to the personnel of the PIU by:

- Defining and delineating the roles, functions, responsibility and accountability of each PIU team member and securing their respective commitments;
- Defining the outputs, timelines and quality expectations in the performance and submission of work by each team member;
- Developing work systems, policies, rules and regulations for the proper functioning of the project office/ PIU; and
- Determining the resource and logistical requirements and constraints to complete the objectives of the Project.

b) Develop systems, standards, procedures and guidelines to effectively manage, monitor and evaluate the implementation of the Project components, which include:

- Monitoring scope, cost, quality, schedules, change, procurement and contract;
- Monitoring the progress of the Consultant and Contractors in terms of scope, time and budget;
- Monitoring preparation of regular Project Reports – financial, progress and procurement reports, among others; and
- Using appropriate software to create database and monitoring system that will enable quick and accurate online downloading of information on the progress of the Project.

c) Ensure the timeliness and quality of outputs of the Consultants and the work quality of the Contractors by:

- Reviewing and confirming the scope of work of the Consultant(s) and Contractor(s) for the approval of the General Manager/ Project Director (GM/PD), then of the Chief Engineer;
- Reviewing the Contractor-Concessionaires'' reports and recommending appropriate action(s), where required;
- Reviewing post-field reports from the PE/APE, identifying actual and potential issues and proposing recommendations; and
- Reviewing and/or approving invoices, certification of work completion and acceptance of the Contractor-Concessionaire(s) and Supplier(s).

d) Manage financial based on the Loan Agreement between by GOJ/ JICA and GOI such as preparation and submission of regular financial statements and financial reports in accordance with JICA requirements/ formats and with prescribed GoI standards;

e) Oversee the conduct of the following:

- Technical studies, detailed designs, and construction management,
- Monitoring plan for the natural and social environment; and
- Pre-operation and/or operation phases before turnover and acceptance of the newly constructed facilities;

f) Manage project office work and workflows, technical, financial and administrative coordination;

g) Provide regular progress and performance evaluation reports to the GM/PD and the Chief Engineer, Varanasi Zone.

4) Project Engineer (PE) and Assistant Project Engineer (APE)

There are nine Project Engineers and 11 Assistant Project Engineers responsible for specific components of the Project. The PEs will report directly to the PM, while the APEs will report directly to their particular PEs.

Working as a team, the PEs and the APEs will be responsible for supervising the assigned technical projects, construction packages and implementation-related activities of the PIU, developing various systems and procedures for the smooth implementation of the Project, installing and/or developing and utilizing project management processes for the PIU. The specific tasks of the PEs are to:

a) Assist the PM on his responsibility in the management and supervision of the Project, by:

- Developing and undertaking planning activities, such as but not limited to, the work (technical) and financial plans; and
- Undertaking the implementation of the approved work plan.

b) Directly oversee and supervise the implementation of field-level activities of the different components of the assigned project/ package, particularly in civil works construction through:

- Monitoring project activities and accomplishments, using in part, the monitoring system designed for ODA projects;
- Monitoring the performance of the Contractor-Concessionaires; and
- Reporting any deviations and problems, and recommending solutions.

c) Certify the completion of work and payments of the Contractor-Concessionaires and Suppliers by validating the progress of project implementation of each activity in the work plan.

d) Perform project finance and administration functions with the delegation of administrative and financial functions from the level of the PD/GM and PM to the PE/APE, such as:

- Developing and managing the Project's records system, project office documents and communications system, as well as physical facilities and supplies;
- Coordinating and processing procurement of goods and services for the PIU;
- Processing of vouchers and documents for the disbursements of project funds such as request for payments from suppliers and contractors based on the field-level disbursement procedures, and reviewing their compliance with GoI and JICA procedures; and
- Preparing report of disbursements and periodic accounting reports of the Project.

5) The Environmental Engineer and Environmental / Social Specialist

There are one Environmental Engineer and one Environmental/ Social Specialist for the Project. The Environmental Engineer will report directly to the GM/PD, while the Environmental/ Social Specialist will report to the Environmental Engineer.

Working as a team, the functions and responsibilities of the Environmental Engineer and Environmental / Social Specialist are the following:

a) Provide the activities needed for the environmental and social aspects in the Tender

Documents to UPJN and each SPV, which include the baseline monitoring, the management plan and the monitoring plan;

b) Supervise the contractor in the implementation of environmental mitigating measures during construction, and the operator during the operation of the Project;

c) Conduct of regular environmental management plan monitoring and submit monitoring reports, such as:

- Preparation and submission of quarterly monitoring report to the UP Pollution Control Board;
- Monitoring of social concerns particularly the impact of the project and if the mitigating measures have been implemented; and,
- Monitoring the lifestyle of the local residents on whether or not their lives have improved with the implementation of the Project.

d) Perform sustained information, education and communication (IEC) campaigns among stakeholders on their roles, and on the importance of the Project in order to attain the health and hygiene objectives of the Project.

6) The Contract / Quantity Surveyor (CQS)

There will be two Contract/ Quantity Surveyor for the Project, and both shall report directly to the GM/PD. The functions and responsibilities of the CQS are:

a) Prepare produce initial cost plans for use in the drafting procurement/ tender document(s) for the project;

b) Draw up the bill of quantities and their cost breakdown;

c) Review contract and sub-contract tenders;

d) Manage cost planning and control in terms of schedule and budget for the Project;

e) Generate valuations for work done, cost estimating, lifecycle costing, and if required, dispute resolution.

7) The Accounts Officer and Bookkeeper

There will be one Accounts Officer and two Bookkeepers for the Project. The Account Officer shall be under the direction of the GM/PD, while the Bookkeepers will be assigned to and support each Project Manager.

Working as a team, the Accounts Officer and Bookkeepers shall be responsible for ensuring appropriate financial/ accounts management for the Project. As such, they shall:

a) Perform project finance functions, such as planning, budgeting, accounting, financial reporting, internal control, auditing supplies management and disbursements relating to the Project.

- Process disbursements/ payment requests of Contractor-Concessionaires and Suppliers in compliance with GoI and JICA guidelines/ agreements and procedures;

b) Ensure timely preparation of financial reports based on GoI and JICA guidelines for submission to appropriate agencies, such as:

- Financial (audited) statements,
- Financial reports, particularly those involving JICA funds, and
- Procurement reports.

c) Create project accounting, recording, storage, production and disposal system in order to facilitate proper financial accounting and reporting and effective project management; and

d) Maintain and safeguard financial records by having adequate back-up procedures and protection from unauthorized access.

8) The Administrative Officer/ Secretary

The Administrative Officer/ Secretary shall work under the direction of the GM/PD and will be responsible for the following:

a) Office administration tasks or the set of day-to-day activities related to project records management, personnel/ human resources records management, and maintaining business premises and other facilities and equipment, and basic office logistics; and

b) Secretarial duties such as office coordination, planning and scheduling of meetings, preparing and maintaining office records, documentation of meetings, reports and correspondence.

9) Driver

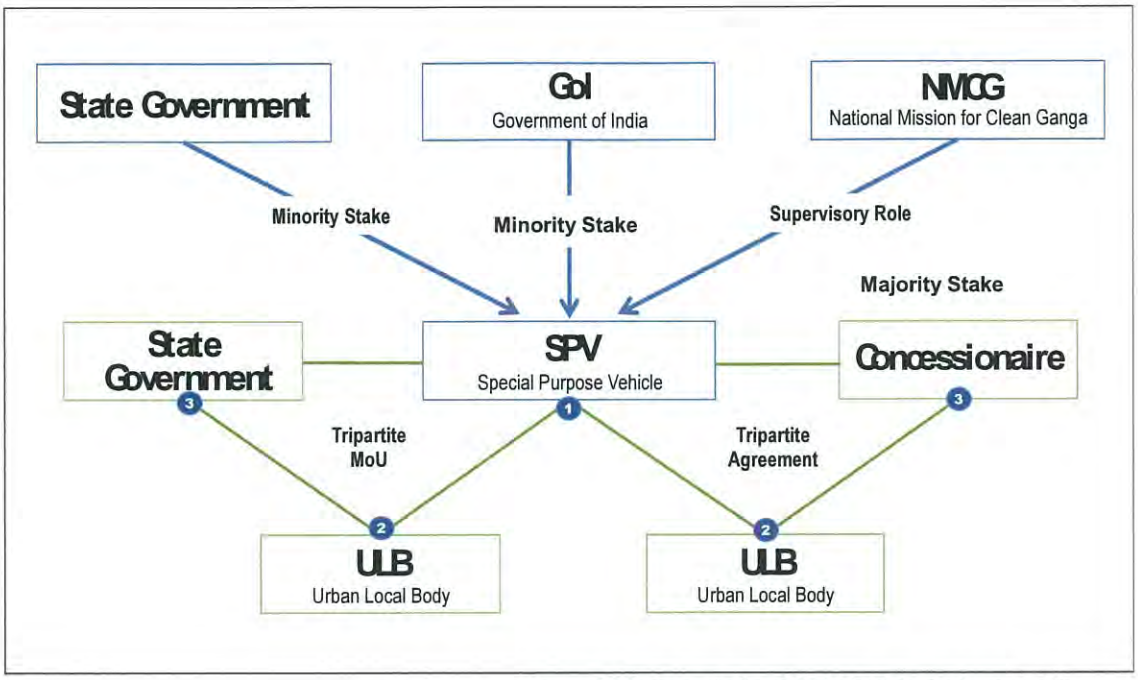
The Driver/s shall be under the GM/PD. Their main task is to ensure the safe transport of passengers and goods within and around the Project sites. The drivers will also perform daily checks and regular maintenance works on the vehicles assigned to them.

13.4 SPV Proposed Organization, Roles and Responsibilities

The Special Purpose Vehicle (SPV) for Hybrid Annuity-based Mode of Public Private Partnership (HAM-PPP) will be set up and institutionalized for project execution of sewage treatment infrastructure under Namami Gange for each ULB covered under this Project – Varanasi, including Ramnagar, Mirzapur, Ghazipur and Chunar. The Institutional Arrangement, recently released by NMCG for all projects under the Namami Gange, is shown in **Table 13.4.1.**

The arrangement shows the shareholding for the SPV, where the majority shares will come from GoI, and minority chares will come from the State Government concerned. In addition, there will be two sets of agreements that will be entered by the SPV – one will be a Memorandum of Understanding (MoU) among the State Government and ULB concerned, plus the SPV; and the other will be the

Tripartite Agreement among the ULB concerned, the Concessionaire and the SPV. The details of the agreements will center on the roles and responsibilities regarding financial structuring, financing (including tariff and revenue streams), technical (design, technologies, environmental safeguards, land arrangements, etc), procurement, project implementation arrangements, among others.



Source "Hybrid-Annuity-based PPP Model for the Creation of Sewage Infrastructure", Presentation by NMCG, February 2016

Figure 13.4.1 Institutional Arrangements for SPV

13.4.1 Proposed Structuring of the SPV

The proposed structuring of the SPV covers the following aspects / areas – purpose, structure, sponsor/ promoter, raising of funds, capitalization and shareholding, Board of Directors and CEO and implementation process as shown in **Table 12.4.1.**

Table 13.4.1 Proposed Structuring of the SPV

Area	Details
Purpose of SPV	• Plan the financial structuring of the Project(s) through the following: Hybrid Annuity Model (HAM)-PPP, O&M and engineering-procurement-construction (EPC) contracts, finance-operate-build-transfer (FBOT) contracts, joint ventures, subsidiaries, turnkey contracts suitably dovetailed with revenue streams; • Design and manage the bid process system or overall procurement planning, management, monitoring and quality assurance under the project, including contract management; • Perform the detailed procurement management functions such as preparing, issuing tenders, opening and evaluation of tenders, and placing the contracts; • Plan the implementation structure of the Project(s); • Enter into contracts, partnerships and service delivery arrangements as may be required;

	• Release funds; • Monitor and evaluate sewerage / wastewater project(s); • Determine and collect user charges as authorized by the ULB.
Structure of the SPV	The SPV to be established as a Limited Company under the *Indian Companies Act, 2013*
Sponsor / Promoter	National Mission for Clean Ganga (National Level SPV) and / or the State Programme Management Group
Raising and utilization of funds by the SPV	GOI grant: not more than 40%; PPP Proponent: 60% Share may also have equity from State of ULB. The SPV may access funds from other sources such as debt, loans from ODA, user charges, taxes, surcharges, etc.
Capitalization and Shareholding	TBD (To be determined) • To be commensurate with the size of the project, commercial financing required and the financing modalities; • GoI grants may be permitted / utilized as ULBs share of equity capital in SPV; • Should enable building up of the equity base of the SPV by allowing ULBs to contribute their share of the equity capital; • Paid up capital may be enhanced in the subsequent years as per project requirements, with the provision mentioned above ensuring that ULB is enabled to match its shareholding in the SPV with that of the State.
Board of Directors and CEO	TBD (To be determined) • Shall include additional, functional directors, additional director. Number of board of directors proposed shall be not more than nine. • Chief Secretaries of States through which the Ganga passes; • State representative (Department of Urban Development, U.P.); • The Municipal Commissioner of ULB where project will be implemented; • Will comply with the provision of the Companies Act 2013 with respect to induction of Independent Directors; • The SPV shareholders will voluntarily comply with the provision of the Companies Act 2013 with respect to induction of independent directors.
Implementation Process	• The SPV appoints a "Project Implementation Unit" or Execution Unit" managing and implementing area-based projects supported by Project Management Consultants depending on conditionalities between GoI and a Development Partner (like JICA). • The SPV appoints the Project Management Consultants (PMC) for assistance in design, project implementation and management; • In procurement of goods and services, transparent and fair procedures as prescribed under the GoI, the State / ULB financial rules as well as a Development Partner's rules based on loan conditionalities shall be followed.

13.4.2 Roles and Responsibilities of SPV according to Project-related Activities

In addition, the SPV will undertake activities in seven areas of project identification and development; implementation arrangement and pre-procurement; procurement; approval and contract awarding; contract management; project implementation and project operation, as shown below:

1) Project Identification and Development

- Identify the specific project(s) to be undertaken;
- Conduct technical and financial appraisal of the identified/ eligible project(s);
- Prepare conceptual project structure;

- Prepare preliminary and final financing plan;
- Perform risk analysis;
- Prepare business model for commercial viability;
- Involvement in drafting of the Tripartite Agreement with ULB and the Concessionaire and/or Contractor and the MoUs with the State Government and ULB.

2) Implementation Arrangement and Pre-Procurement
    - Assess existing legal and regulatory regime and current public policy;
    - Assess GoI public procurement, State procurement, as well as JICA procurement processes and requirements;
    - Prepare “Procurement Manual”;
    - Prepare bid documents, bid evaluation criteria, draft concession agreement, draft contract documents for the private proponent depending on the financial model selected, whether EPC, HAM-PPP, as well as O&M packages;
    - Set up committees – technical, financial, approval;
    - Formulate implementation arrangement strategy/ies for PIU;
    - Together with SPMG, appoint the Project Implementation Unit (UPJN-GPPU);
    - Get government approval.
3) Procurement
    - Undertake pre-qualification of PPP bidders – HAM-PPP-O&M, FBOT-O&M, EPC-O&M or any other PPP financial structure / combination as deemed fit by the SPV;
    - Prepare RFP for the bidders;
    - Finalize service and output specifications for the bidders;
    - Finalize tender, bid evaluation and selection for the bidders;
    - Get government approval.
4) Approval and Contract Awarding
    - Undertake FBOT and O&M contract awarding to the PPP Concessionaire, and/or EPC and O&M contract awarding to the Contractor, as the case may be;
    - Undertake financial closing and contract signing for all awarded contracts;
    - Get government approval.
5) Contract Management
    - Undertake service delivery management;
    - Monitor contract compliance;
    - Undertake relationship management;
    - Undertake renegotiation (when needed);
    - Get government approval for renegotiation terms.

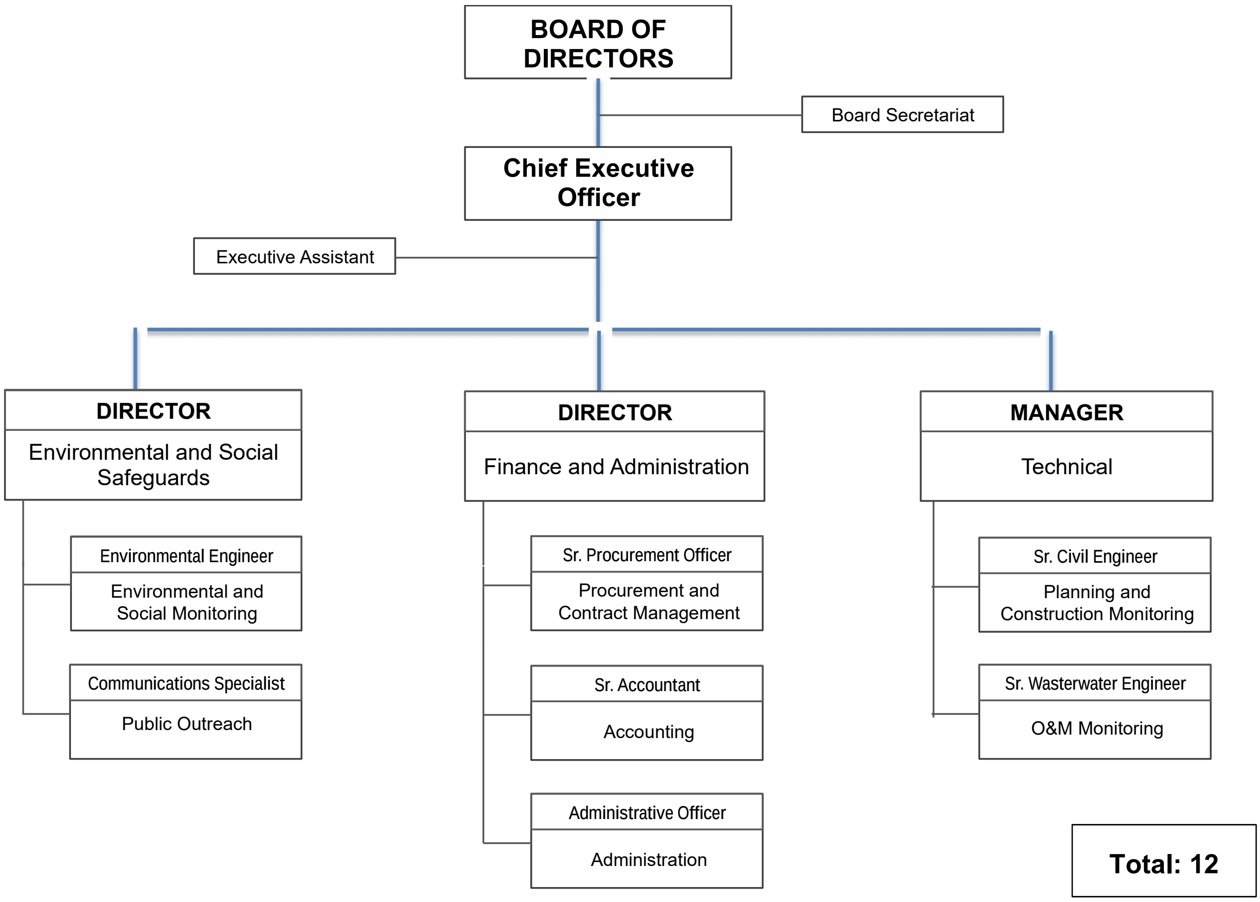
6) Project Implementation

- Delegate project implementation and project management tasks to the Project Implementation Unit (PIU) through MoA among SPMG, the ULB-Level SPV and the UPJN-GPPU;
- Undertake over-all monitoring of project implementation.

7) Project Operation

- Monitor the quality of sewerage services to be provided by the Concessionaire (O&M of STP and other sewerage facilities) based on the Concession Agreement, the Tripartite Agreement, the MoU and other binding contracts and agreements;
- Monitor the compliance of the Concessionaire with regulatory authorities' standards and regulations from the Central and State governments up to the ULB level;
- Link performance standards of the STP and other measureable performance indicators agreed upon with the payment of annuities;
- Develop market for treated water in the immediate vicinity / community of the ULB where STP is located;
- Undertake environmental, social, IEC and community participation activities as spelled out in the MoU, the Concession Agreement, the Tripartite Agreement, and other binding agreements/ contracts;
- Conceptualize/ plan and undertake capacity building activities for ULBs, if these are included in the MoU, the Concession Agreement, the Tripartite Agreement, and other binding agreements/ contracts.

The indicative organization structure of the ULB-Level SPV is proposed in Figure 13.4.2.



JICA Survey Team, March 2016.

Figure 13.4.2 Typical Organization Structure of ULB-Level SPV for Sewerage Infrastructure

13.5 Project Management Consultants

The Project Management Consultants (PMC) shall be engaged by the SPMG for the primary purpose of undertaking the detailed design of the specific projects(s), as well as ensuring proper, efficient and effective implementation of the projects identified in the project formation stage.

- The PMC will provide project implementation support to the SPMG, being the Implementing Agency, on technical and financial aspects of project implementation, as well as on project implementation issues to ensure the effective coordination and implementation of the Ganga Rejuvenation Project. As such, it shall assist in installing procedures, operationalizing procedures and establishing monitoring and reporting systems.
- The PMC will also provide project implementation support to the SPVs, with the expressed backing of SPMG, on the area of procurement management, that is, defining work packages, preparing contracts, and undertaking procurement for the PPP Contractor-Concessionaire and/or the O&M Contractor.

- The PMC will also work closely with, and provide implementation support to, the PIU, having been appointed by SPMG and SPV to manage, execute and implement the Project. It will complement PIU's method of project management – that is, establishing criteria for construction supervision, coordination and management and project performance monitoring. The PMC will also assist in sustainable capacity development of UPJN, VNN and the other ULBs included under the Project, particularly on capacity building and training, public enlightenment, information, education and communication (IEC) awareness for sanitation, and campaigns for household (sewer) connections to ensure that the project and programme objectives are achieved.

13.5.1 Proposed Tasks of PMC

1) For the SPVs
   - Assist the SPVs in finalizing the bidding documents for each of the Contract Packages of the Project;
   - Assist the SPVs in identifying and preparing its particular projects and/or subprojects by
     - Appraising subprojects,
     - Preparing subproject appraisal reports, and
     - Formulating bid packages.
   - Assist the SPVs with all aspects of procurement including tender document review, bid evaluation and selection of Concessionaires and/or Contractors;

2) For the PIU
   - Support PIU in finalizing the detailed design for the facilities to be constructed under the Ganga Rejuvenation Project;
   - Support PIU in technical matters such as reviewing and approving surveys, studies, subproject preliminary and final designs, construction drawings and estimates, approving contractor's works, review of variations, extra items and claims;
   - Assist PIU in project management and implementation, as well as construction supervision, such as:
     - Preparing annual work plans, staffing schedules, necessary budgets including equipment budgets, and detailed implementation schedule;

  - Providing guidance and support to PIUs for construction supervision including quality, cost and time controls
  - Providing assistance to PIU in supervising, coordinating and monitoring the work of the contractors and sub-contractors;
  - Verifying work measurement and certification of the contractor's interim bill and/or verification of final bill of payment; and
  - Reviewing "as built" drawings and completion certificates submitted by Concessionaire / Contractor.
- Assist PIU in setting up procedures, systems, standards, criteria and reporting systems for project management, implementation and monitoring of the project progress, such as:
  - Preparing an overall program performance monitoring system for the Project and assisting the PIUs in operationalizing it so that the physical progress of each project component is measured and delivered on time;
  - Inspecting and monitoring the progress of construction work of each contract package not only during construction but also during defect liability period;
  - Inspecting third party inspections, as required by the Client.
  - Monitoring the implementation of environmental and standards, safeguards;
  - Preparing, together with and/or on behalf of PIU, the project progress reports describing the physical and financial progress of the project, while underscoring obstacles to the quality and progress of the works, including the remedial actions taken. The progress report shall be submitted to GoI and JICA, and will also include the progress on implementation of the Loan Agreement;
  - Preparing and/or amending the existing procedures and guidelines for site supervision and quality control;
  - Setting the quality control procedures so that the quality of works conforms to the specifications and drawings; and
  - Finalizing quality control and assurance system including approval of source of material and certification.
- Assist PIU in implementation of social outreach and awareness on public health and sanitation, including IEC campaigns and community-based Ghat management programs;

- Provide advice to PIU for contractual issues including examining the Concessionaire / Contractor's claims for variations, extensions or additional compensations, etc and prepare recommendations for the approval;
- Assist the PIU and /or SPV in other tasks as assigned to it by the IA and EA.

13.6 Streamlining the Decision-Making Process

Decision making for procurement should both be strengthened and streamlined with the procuring agencies – SPMG for consulting services, and SPVs for the HAM-PPP Contractor-Concessionaire, focusing not only on downstream activities such as tender conditions, bid documents, eligibility criteria, bid evaluation, contract awarding etc.; but also on upstream activities like determination of technology, conceptual design, specification, "vendor" base identification, as well as post-tendering procedures such as contract management, payment, and monitoring after the award of a contract. This can be done through the following measures:

- Keeping itself well informed on the range of goods, services and works available before designing the tenders in order for the procurement process to achieve best value for money;
- Designing the tender process in a way that it maximizes/ enhances the potential participation of credible competing bidders;
- Defining requirements clearly and comprehensively, making it easier for potential suppliers to understand them, then prepare standardized/ consistent information across the submitted bids;
- Formulating the specifications and the terms of reference (TOR) focusing more on functional performance, meaning, on what is to be achieved rather than how it is to be done, thus encouraging innovative solutions;
- Carefully choosing its criteria for evaluating and awarding the tender since selection criteria affect the effectiveness and transparency of competition in the tender process as well as help avoid post-award challenges while rewarding innovation along with promoting competitive pricing; and
- Clearly spelling out the evaluation criteria in the tender documents by which evaluation should be carried out. Public opening should be mandatory, and the result of the tendering process should be put out in the public domain.

13.6.1 GoI Procurement Process

At present there is no legislation in India governing public procurement by the Indian government's ministries, departments and offices. However, the *Public Procurement Bill*, approved in 2012, is now undergoing further refinement before it can be formally legalized and adopted. The Bill is part of the

Indian government's continuing reforms in public financial management by creating a single overarching legislation to govern the procurement process. The jurisdiction of the Bill covers any Ministry or Department and any public sector undertaking of the Union government, or any company in which the government has a stake of more than 50 per cent. The Bill does thus not cover the procurement processes of the States and the local governments; however, the Bill will have a strong impact and influence over the State and local governments' own procurement processes.

The public procurement process is governed by the *General Financial Rules of 2005*,[13] particularly Chapter 5 (Works) and Chapter 6 (Procurement of Goods and Services) issued by the Government of India, Ministry of Finance. The issuance of the GFR 2005 is supplemented by acts, codes and manuals, such as: Manual on Policies and Procedure for Procurement of Works (2006), Manual on Policies and Procedure for Purchase of Goods (2006), Manual on Policies and Procedure of Employment of Consultants (2006), Standard Request for Proposals – Selection of Consultants, and Bidding Documents for Works.

In 2006, the GoI approved the National E-Governance Plan (NeGP), which was to lay the foundation and provide the impetus for long term growth of e-governance in India by setting up institutional mechanisms, core infrastructure and policies, and implement these in the Central, State and integrated service levels to create a citizen-centric and business-centric environment for governance. eProcurement is aimed at making government procurement simplified, transparent and result-oriented.

The eProcurement Mission Mode Project Portal consolidates all the tenders floated at various State Governments and Union Territories across the country, thereby enabling the establishment of a one stop-shop for all services related to government procurement. This procurement reform enhances the efficiency of procurement, reduces the cycle time and cost of procurement, and promotes transparency in Government procurement.

13.6.2 Procurement in NGRBA / SPMG

In 2011, NGRBA issued the *Procurement Manual* (revised 2013) which provides essential information, including step-by-step procedures on the procurement of goods, works and services for IBRD and IDA projects. The Manual was prepared for procurement officers at NMCG, SPMG and the project execution agencies to achieve the uniform system of procurement in all the States under the NGRBA

[13] The *General Financial Rules of 2005* is issued by the Government of India, Ministry of Finance, Department of Expenditure. It is a compendium of general provisions to be followed by all offices of Government of India while dealing with matters of a financial nature. The States base their own financial rules/ handbooks on the GFR, 2005.

program. The Manual is organized in two parts – Part 1 specifies the processes, methods and various value thresholds that shall be maintained; while Part II includes formats and documentation required in carrying out procurement activities under World Bank-assisted projects.

The procurement process follows these steps: (i) identification of need, (ii) developing specifications, (iii) estimating costs, (iv) securing approvals and funding, (v) determine procurement strategy, (vi) deciding tendering procedure, (vii) preparing request for tender, (viii) allowing time for submission of EOIs, (ix) issue tender documents, (x) receipt and opening of bids, (xi) clarifying receipts, if required, (xii) evaluation and awarding of contract, and (xiii) publishing, contract management and closure.

The revised Procurement Manual (2013) can be utilized/ applied for the procurement of consulting services to support the implementation of the JICA-assisted projects under the Ganga Rejuvenation Project. However, the forms/ formats, as well as the procedures/ process should be that utilized and required for projects undertaken under JICA assistance.

13.6.3 Procurement in Uttar Pradesh: Case of UPJN

The Government of Uttar Pradesh has issued the *Financial Handbook (Revised Edition, 1984)* that governs all financial transactions of the State government, including procurement of goods, services and works. The Financial Handbook is presently undergoing revisions.[14] The State departments and offices have their own procurement process, guided by the Financial Handbook.

The State of Uttar Pradesh has also implemented the e-procurement system under "Tenders Uttar Pradesh". This enables the tenderers to download the tender schedule free of cost and then submit the bids online through the Uttar Pradesh Government Tenders Information System.[15] Latest tenders are provided with the following information: tender title, reference number, closing date and bid opening date; while the latest corrigendums are also given similar information such as the corrigendum title, reference number, closing date and bid opening date.

The tenders information system services the entire U.P. government, thus a prospective tenderer can find tenders by location (area) or by organization by simply clicking on the drop down menu, "organization chain", to select the particular department or organizational unit of interest. The tenderer can also narrow down his choices based on "tender type", which has seven choices – auction, EOI,

[14] http://budget.up.nic.in/finhand1.htm, Retrieved 27 January 2016.

[15] https://etender.up.nic.in/nicgep/app, Retrieved 27 January 2016.

limited, open, limited open, single or test; or go to tender category", which has three choices – goods services or works. It a tenderer goes "product category" there are numerous categories to choose from, such as consultancy, civil works, pipe laying, repair and maintenance works and services, among many others.

In every case, the tender information system gives important information for each tender – the e-published date, the bid submission closing date, the tender opening date, and the title/ reference number/ tender ID.

One of the examples for procurement process is that of UPJN. Being a state corporation, UPJN has its own procurement process governed by its own Financial Handbook. Tenders are listed in its own website with the following tender information – district, category, tender number, tender date, last date of sale, opening date and tender file.[16]

1) Approval of Tenders

The approval in the procurement of goods, services and works is based mainly on the value of the tender, which passes through different levels of approval. There are several tender committees that tackle the procurement process, including technical and financial evaluation. These committees' levels are the Unit level, Circle level, Zonal level, and two Headquarter levels – one whose accepting authority is the Managing Director (MD) and the other whose accepting authority is the Chairman.

The approval system generally specifies the following: (i) The value of the tender; (ii) Officers involved; (iii) The composition of the Tender Committee; and (iv) The accepting authority. **Table 13.6.1** provides the range of the value of the tender, the officers / tender committee involved that deliberate on the tender, and the approval or accepting authority once a decision has been made.

Table 13.6.1 Approval of Tenders according to Value of Tender in UPJN

S.L.	Value of Tender	Officer(s) Involved	Level	Composition of Tender Committee	Accepting Authority
1.	Up to Rs.40,00,000.00	Executive Engineer (EE)/ Project Manager (PM)	Unit Level		EE / PM
2.	Rs 40,00,000.00 to 100,00,000.00	Superintending Engineer (SE)/ General Manager (GM)	Circle Level	SE and PM	SE / GM
3.	Rs 100,00,000.00	Chief Engineer, Zone	Zonal Level	CE and SE / GM/	CE Zone

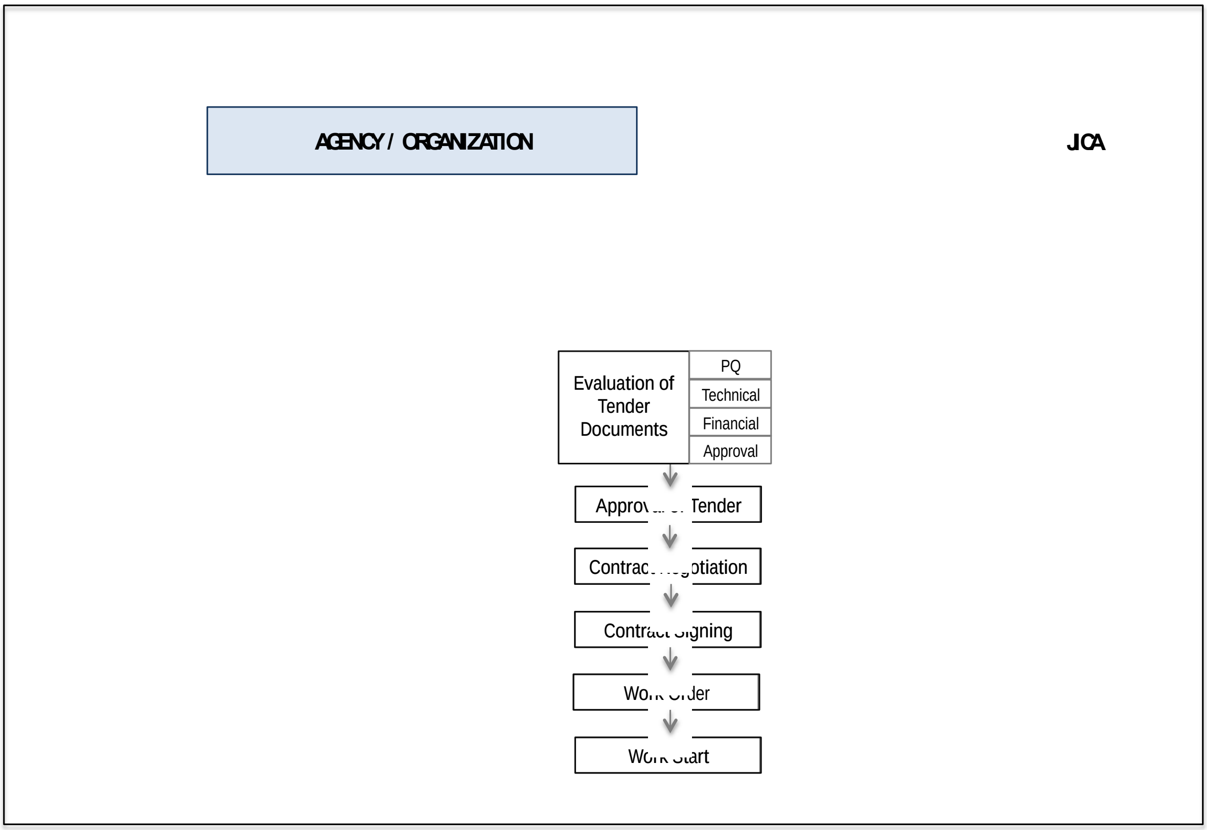
[16] http://www.upjn.org/ShowAllTender.aspx

	to 500,00,000.00	(CE)		PM/ EE	
4.	Rs 500,00,000.00 to 2500,00,000.00	Managing Director (MD)	HQ Level	MD/ CE Hq / CE Zone, SE/ GM and PM	MD
5.	Above Rs 2500,00,000.00	Chairman	HQ Level	Chairman, MD, CE Hq, CE Zone, SE / GM, and PM	Chairman

Source: Office of the Chief Engineer, UPJN Varanasi Zone, 18 December 2015.

2) Procurement Tasks

The procurement system for goods, services and works are generally the same in the Government of India, the States and the ULBs. What varies are the processing time and the limit(s) and level(s) of the approval authority. **Figure 13.6.1** presents the typical Project procurement tasks' flow, and this is also followed by UPJN.



Source: JICA Study Team, January 2016.

Figure 13.6.1 Typical Procurement Process in India

3) Streamlining the Processing Time

The procurement process and the decision-makers are set out in rules and orders. These are consistent with the Financial Handbook and in the manner that the departments in the State of Uttar Pradesh conduct procurement. Thus, according to UPJN, streamlining the decision-making process should be geared to properly managing the process effectively, and where feasible, in shortening the time it takes to accomplish each step or task in the procurement process.

Table 13.6.2 presents the project procurement tasks and the normal processing time per task for UPJN-GPPU that shows that, barring any problems, it would already take anywhere from 12.15 to 15.85 months to complete the project procurement process. It also indicates the target for streamlining the decision-making time involved in the procurement process for this Project without sacrificing quality in the preparation of tender documents, and thoroughness in the evaluation of bid documents.

Table 13.6.2 Streamlining Procurement Tasks Processing Time

SL	Task			By	UPJN-GPPU						Contractor		JICA	
					Preparation (Days)		Publication (Days)		Processing (Days)		Processing (Days)		Processing (Days)	
					Normal	Target	Normal	Target	Normal	Target	Normal	Target	Normal	Target
1.	Preparation of Bid Documents	1.1	Request for Proposal (RFP)	UPJN-GPPU	30		30-45		-		-		-	
		1.2	Prequalification (PQ) Documents		30		90-120				-		-	
		1.3	Tender Documents											
2.	Preparation of Contractor's Proposal			Eligible Contractors	-		-				30-45		-	
3.	Evaluation of Tender Documents	3.1	PQ Evaluation	UPJN-GPPU	-		-		15-20		-		-	
		3.2	Technical Evaluation	UPJN-GPPU	-		-		20-30		-		-	
		3.3	Approval of Technical Evaluation	UPJN-GPPU	-		-		15-20		-		-	
		3.4	Cost / Financial Evaluation	UPJN-GPPU	-		-		10-15		-		-	
4.	Approval of Tender			UPJN HQ Tender Committee	-		-		10-15		-		-	
5.	JICA Concurrence			JICA India	-		-		-		-		21	
6.	Contract Negotiation /Bank Guarantee Submission			UPJN-GPPU	-		-		10-15		-		-	
7.	Contract Signing			UPJN-GPPU	-		-		07-10		-		-	
8.	Work Order			UPJN-GPPU	-		-		07		-		-	
9.	Work Start / Mobilization			UPJN-GPPU	-		-		30		-		-	
				Total (More or Less)	60 days or 2 months		120-165 days or 4-6 months		30 to 45 days or 1 to 1.5 months		131-169 days or 4.4 to 5.6 months		21 days or .75 months	

13.6.4 Considerations on Procurement Process of SPV

The Planning Commission, through its Secretariat for PPP & Infrastructure, has issued the third revision of the "Model Request for Qualification (RFQ) Document" in 2014. This incorporates the results of experiences in implementing the first set of guidelines, as well as includes best practices after the said document was issued in 2007. It is the expected that Ministries and autonomous bodies of the Central Government will follow these Guidelines, and that the State Government are to adopt the same to enhance the possibilities of fair, transparent and competitive selection of bidders for delivery of successful PPP projects in infrastructure.[17]

The guidelines are also expected to be followed by the SPV. The guide's framework is not only broad and generic, which makes it easy to adopt; but is also flexible enough to make it project-specific. The guidelines are aimed at allowing for objective and expeditious decisions. Furthermore, it ensures the efficient, competitive and economic delivery of services and the selection of bidders for those undertaking infrastructure projects within the PPP umbrella in a selection process that is fair and transparent. The features of the guidelines are as follows:

- Bidding process is typically in two stages – first being the RFQ or EOI stage, and the second is the RFP stage;
- The RFQ stage should aim at shortlisting and prequalifying applicants who will be asked to submit financial bids in the RFQ stage; therefore, only credible bidders should be prequalified;
- Guidelines should be transparent to eliminate collusion or cartelization, and avoid or eliminate conflict of interest;
- The number of bidders to be shortlisted / pre-qualified should be set at around six to seven, and to be qualified set to the international practice of around three to four bidders;
- Balance in serving the objective of prequalifying a reasonable number of bidders at the RFQ stage should be kept in mind when identifying eligibility criteria;
- The guidelines provide sufficient flexibility to add project-specific conditions by the project authorities;
- The evaluation criteria for shortlisting bidders are divided into two:

[17] Planning Commission. "PPP Request for Qualification: Model RFQ Document", 2014.

  - Technical capacity where experience will be a major measureable indicator such as project and construction experience in the specified sector; and
  - Financial capacity where minimum net worth (25% estimated capital cost of the projects for which bids are to be invited) is the major measureable indicator of sufficient financial strength; and
- In terms of the "stake of consortium members", it is suggested that each member should hold at least 26 percent of the equity of the project SV, and should also hold equity to at least 5 percent of the total project cost for a period of two years after the commissioning of the project.

CHAPTER 14 Pilot Project

<Objective of the Study>

Pilot project for direct Ganga purification method was studied.

<Result of the study>

From the stand point of maintenance and operation, EBB and Iron and Charcoal method were proposed for the Pilot Project. EBB unit was taken as possible process with less maintenance work and less operation cost in the CPHEEO than Iron and Charcoal. Pilot Project by employing EBB is proposed to be conducted in the upstream of Varuna river in consideration of status of flow and O&M of the facility, since it is difficult to select Ganga River as project site for Pilot Project in terms of flow, water depth and O&M for the facility.

<Issues>

River direct purification is under jurisdiction of Irrigation Department. Although DPR was produced by Survey Team and submitted to UPJN, no action has been taken by India side so far..

14.1 Current Status of the Rivers and Necessity of Water Quality Improvement

Feasibility of pilot projects for direct purification of river water was examined in the study with investigating the river flow rate, water quality, and velocity. Study on the references and making hearing investigation to the relevant authorities and contractors were made, and the draft DPR was submitted to UPJN and NMCG in September 2016 according to an agreement in the July mission in 2016, however no comments were provided to JICA survey team.

First of all, treatment of the entire flow for all the season is impossible in terms of flowrate. Second, water level variation between dry season and rainy season is about 12meters which will make all the efforts to maintain the facility nothing in rainy season. And during the rainy season, Ghats are submerged under water with any facility on the bottom of the river or along the river side to be submerged in the deep water and no maintenance work will be possible in the rainy season. After the rainy season, large volume of sediment will be found on the structures of the Ghats and floors. It will need a lot of labour works to remove/clean the grits and soils from the Ghats. Machines, if used, they will be found broken down. Further, in the rainy season the facility will be exposed to danger of wash-out by the strong flow and burial by the grits and silt.

Water Buffalos are another problem. Around hundreds of water buffalos are found along the Ganges just upstream of the Ghats. They usually stay and do water bathing along the river side of the Ganges. If the treatment facility is installed along the river, they will break the structures/devices back and force from the river.

Thus, application of direct purification for the Ganges River is deemed not realistic because of the reason above. If the facilities for the direct purification are planned, Ganges must be avoided and tributaries will be the candidates. Refer to 13.3 for detailed discussion in terms of installation of the facility in the Ganges river.

Scope of the implementation of direct purification of the Ganges River will be decided through the pilot project by which the effect of the measure will be monitored, and it will be proposed through the discussion with UPJN and JICA.

14.2 Concept for the Direct Purification System

A proposal is to conduct the direct purification to a tributary like Varuna River to confirm the effect of the measure. After the confirmation of the effect the methods can be developed to the tributaries in the Ganges.

1) Process of direct purification of rivers
There are physical purification process, biological process, and combined process of physical and biological process. In the selection of the process, economics in terms of construction and operation & maintenance, process performance and necessity of the foot print for the process was examined.

From the construction cost, power requirement and maintenance work, Gravel Contact Oxidation Process and Special Bio Block are preferred.

Table 14.2.1 Outline of water purification process

Process	Advantage	Disadvantage
Gravel Contact Oxidation Process	*High removal efficiency of BOD & SS for low incoming load *Less energy requirement *Easy O&M	*Low removal efficiency of BOD & SS for high load *Large foot print *Clogging by grits
Plastic Contact Oxidation Process	*High removal efficiency of BOD & SS for low incoming load *Less energy requirement *Smaller foot print than Gravel Contact Oxidation	*Low removal efficiency of BOD & SS for high load *High material cost *Low removal for soluble matter

Aerated Gravel Contact Oxidation Process	*Applicable to high incoming load(20mg/l) and high soluble BOD *Organic matters and must smell removable	*Power required *Aesthetic issue by foaming
Aerated Plastic Contact Process	-Ditto-	*Power required *Aesthetic issue by foaming *High material cost
Plant Purification	*High removal efficiency of N & P *Less energy requirement	*Applicable depth shallow *Need harvesting
Special Bio Block	*High removal efficiency of BOD & SS for low incoming load *Less energy requirement *Easy O&M	*Procurement of Blocks

Gravel bed contact purification process is the most applied process for direct purification in Japan. Special Bio Block was examined in terms of water purification performance in India Delhi and result was published in the CPHEEO in India.

Field study of the Block was conducted in the water channel of 3.2km long with channel width 1.5m. The technology was developed by Japanese private company and patented in USA and Japan. Since the process does not need blowers, electric power and maintenance work as well, it is befitted to the condition in developing countries. Once the advantage of the method is recognised, it can be developed in the tributaries along the Ganges improving the status of water quality in the Ganges River. Table14.2 shows the comparative outline of the processes.

Table 14.2.2 Performance of river purification process

Process	Condition	Applicable Site		Parameter (%)				
		River	Separate Channel	BOD	SS	Coliform	T-N	T-P
Gravel Contact Oxidation Process	BOD:<20-30 mg/l	OK	OK	50-80	65-90	50-90		50-90
Plastic Contact Oxidation Process	BOD:<20-30 mg/l	OK	OK	50-80	65-90	50-90		50-90
Aerated Gravel Contact Oxidation Process	BOD:<20-30 mg/l	N/A	OK	75-90	75-95	50-95		
Aerated Plastic Contact Process	BOD:<20-30 mg/l	N/A	OK	75-90	75-95	50-95		
Plant Purification	BOD:<20-30 mg/l	N/A	OK	30-50	30-80	25-75	50-75	25-50

Eco Bio Block	BOD:<200mg /l	Depends	OK	50	75	54	50-80	50-80

Special features of the Special Block are shown as follows (Source: Pamphlet Manufacturer of the Block):

- Biological purification method using aerobic Natto bacteria and porous concrete block which contains Natto bacteria inside the block.
- Aerobic environment is needed for the level of survival for fishes
- Past record in the experiment in New Delhi: BOD removal=32.4%、TSS removal =62.5%
- No power needed

Special Block (Eco Bio Block)

Source: Manufacturer's Pamphlet

Figure 14.2.1 Special Block Field Experiment in New Delhi

From these examination, employing special block for the pilot project for the river purification will be the solution in terms of construction cost and operation & maintenance work.

2) Removal of Floating Solid Waste

Small tributaries are usually very crowded with the residents and wastes are dumped in the channels. Removal of such wastes is also needed in such situation at the same times. Installation of screenings and waste collection point is the common practices for the issue. Corporative work by resident people will be necessary before the installation of the equipment for the Pilot Project.

14.3 Location Condition and Appropriate System

14.3.1 Main Stream of Ganges

Most favourable location for the installation of the units of the pilot projects will be in the main stream of the Ganges, for example just in front of Ghats showing advantages of the treatment to the residents and tourists. It will enable to show the presence of the units in the water and will also be able to show the improvement of the water quality to the public in terms of improvement of turbidity/transparency of the water and living water creatures such as aquatic mammals and fishes to the public. It will be the best presentation of the Clean Ganga.

Current status of the Ganges in front of Varanasi is summarised as follows:

(1) Flowrate: $4,100m^3/sec$, at annual average flow
(2) Velocity: 3.0m/sec
(3) Water Level: Dry season +62.000m, High High Water Level +74.000m
(4) Width of the Ganges: Approx 400m in dry season

However there are problems as follows:
(1) Big variation of flow rate and water level between dry and wet season,
(2) Tremendous flow of grits in the water and thick sediment on the river bottom,
(3) Difficulty of maintenance and operation of the units installed under water due to depth and variation of the water depth,
(4) Difficulties to supply power for the motor when electro-mechanical devices are used for the treatment,
(5) Frequent black outs by which generators are needed for the backups occur,
(6) Concentration of BOD_5 is not high enough for the electro-mechanical treatment and
(7) Presence of a lot of water buffalos

Variation of water depth just before the Ghats is usually 10 m between dry season and wet season. The devices installed in the river must stand both of the static and dynamic water pressure in rainy season. After the rainy season, mountain of grits is seen on the Stages of the Ghats. The grits are sent from upstream by the water flow and it must be cleaned before the ceremony at the Ghats. If the installation of the devices is conducted on the bottom of the river, the devices will be buried under the grits or washed away by the hydraulic forces in the rainy season. The big difference of water level between dry and rainy season will cause maintenance and operation problem if the devices are installed on the bottom of the river in case of malfunction. If the electro-mechanical machine is used for the treatment of the water, power is needed for the operation. In Varanasi City in which black outs frequently happens, engine generator with the fuel supply system will be indispensable to guarantee the treatment. The system itself will need a lot of maintenance work. Installation of the treatment system under the main stream has a lot of problems and it will have little advantage for the water quality improvement. Other problems are derived from the points. Even the tributaries or nallas are in the same condition. Issue of water depth and grits must be taken seriously.

14.3.2 Assi nalla

Assi nalla is a channel of drainage of the Varanasi district 2 and 3. Since sewerage construction is not completed yet, only raw sewage is flowing. Since dwellings along the nalla is very close to the channel and densely constructed. Access points for heavy machine of the construction work to the stream from the shore are very difficult to find out. DO in the water shows almost zero in Assi Nara which is very severe condition for the devices such as Special Blocks which is capable of partly treatment of the sewage. After the construction work of the Varanasi district 2 and 3 under the GAP II project, the water of the flow will be improved in terms of all water quality parameters. It will be worthwhile to plan river purification in Assi nalla then.

14.3.3 Varuna River

Origin of Varuna river is in Janhai City with a length of 50km from the Ganges river. Water quality of the river is far better than Assi nalla. Many kinds of fish and aquatic creatures are found in the river. A lot of catfish and carps are caught in the river. Varuna river flows in the district 2 in which sewerage construction is underway.

According to the result of the water quality survey, the water quality in the Ganges becomes bad right after the confluence of the Varuna. For example pH decreases 8.35 to 7.9, DO drops from 6.8mg/l to 5.3mg/l, BOD rises from 2mg/l to 7.4mg/l, Coliform rises from 11,000 to 14,000 in December 2015. At the same period in Varuna, BOD was 8.4mg/l, DO 4.2mg/l and Coliform 33000. The fact shows that there is possibility to improve the water quality in the Varuna

Ground height of the point at the upstream is high enough around 70m which is not influenced by the water level in the Ganges. In addition, access points to the river from the shore can be found very easily along the Varuna.

14.4 Selection of Subject River

From the discussion in 13.3, Varuna River was selected and proposed for the Pilot Project.

14.5 Process Selection

1) General

General ground level varies from 71m to 80m. For example, Varanasi city is situated above 80 m height from the sea level. Geologically it is situated in the alluvial Gangetic plains and nature of soil is mixture of clay and fine sand.

2) Preferred Processes for the objective

Gravel Bed Treatment System is common in Japan however, as shown in the comparison table, from the stand point of maintenance and operation, Special Blocks method were proposed for the Pilot Project from the point of view of less maintenance work and less operation cost.

14.6 Plan of Pilot Project

14.6.1 Process Selection

Processes for the Pilot Project were selected as Special Block as discussed in the former section.

14.6.2 Installation Point and Maintenance Work

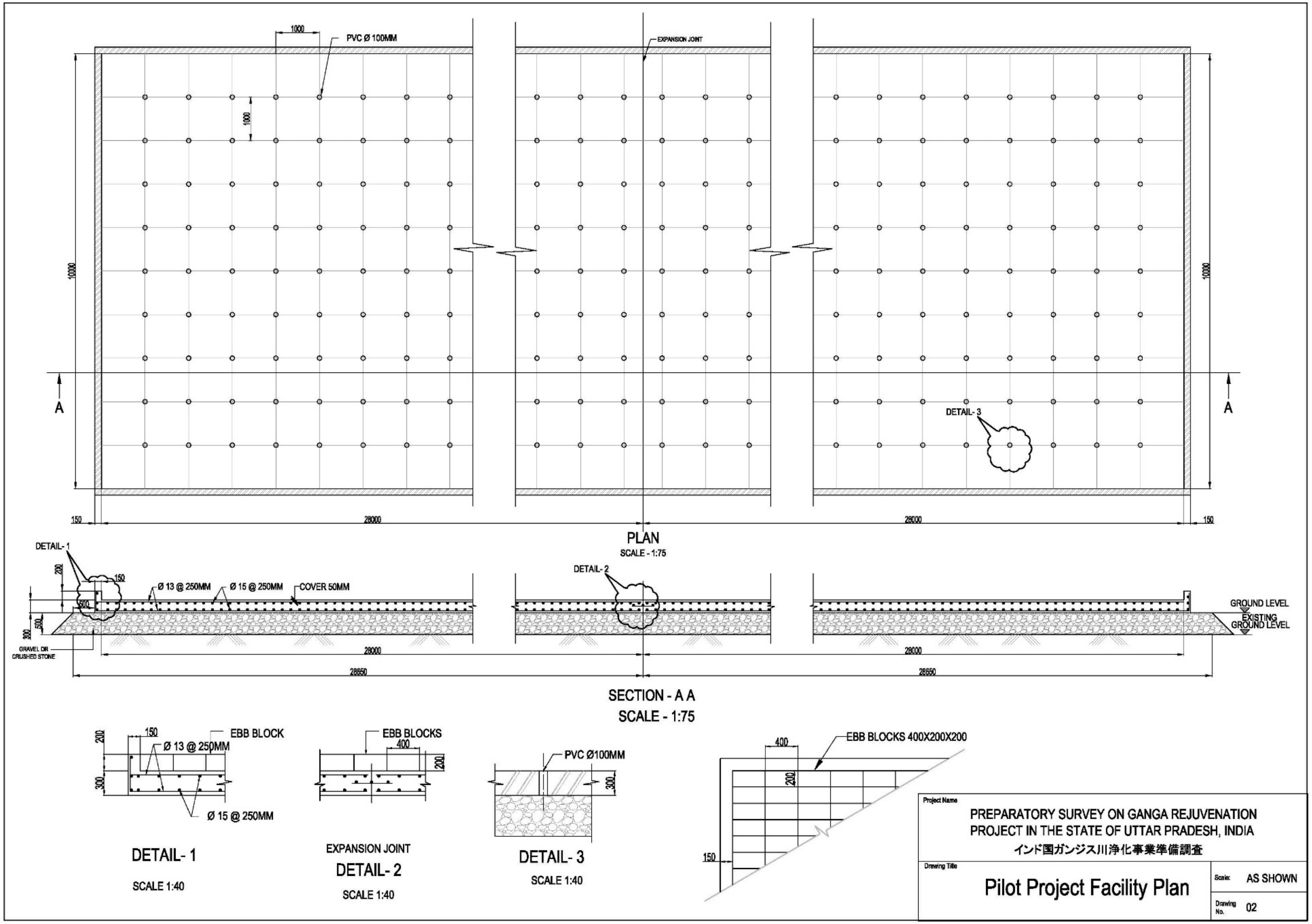
Installation of the units in the Ganges River is not appropriate in terms of construction and operation & Maintenance. Installation points are planned along the Varuna River with the elevation higher than altitude of 74 m from the discussion in the section 14.3. Installation point must be the outer course of the bend of flow to avoid covered by sand and grit as shown in the drawings. (Inner course of the bend will be easily buried by sand) Depth of installation shall be shallow enough considering the maintenance work in dry season. Maintenance work will be made manually using water jet or scoops after the wet season.

14.6.3 Quantity of the Special Block and Structure of the Unit

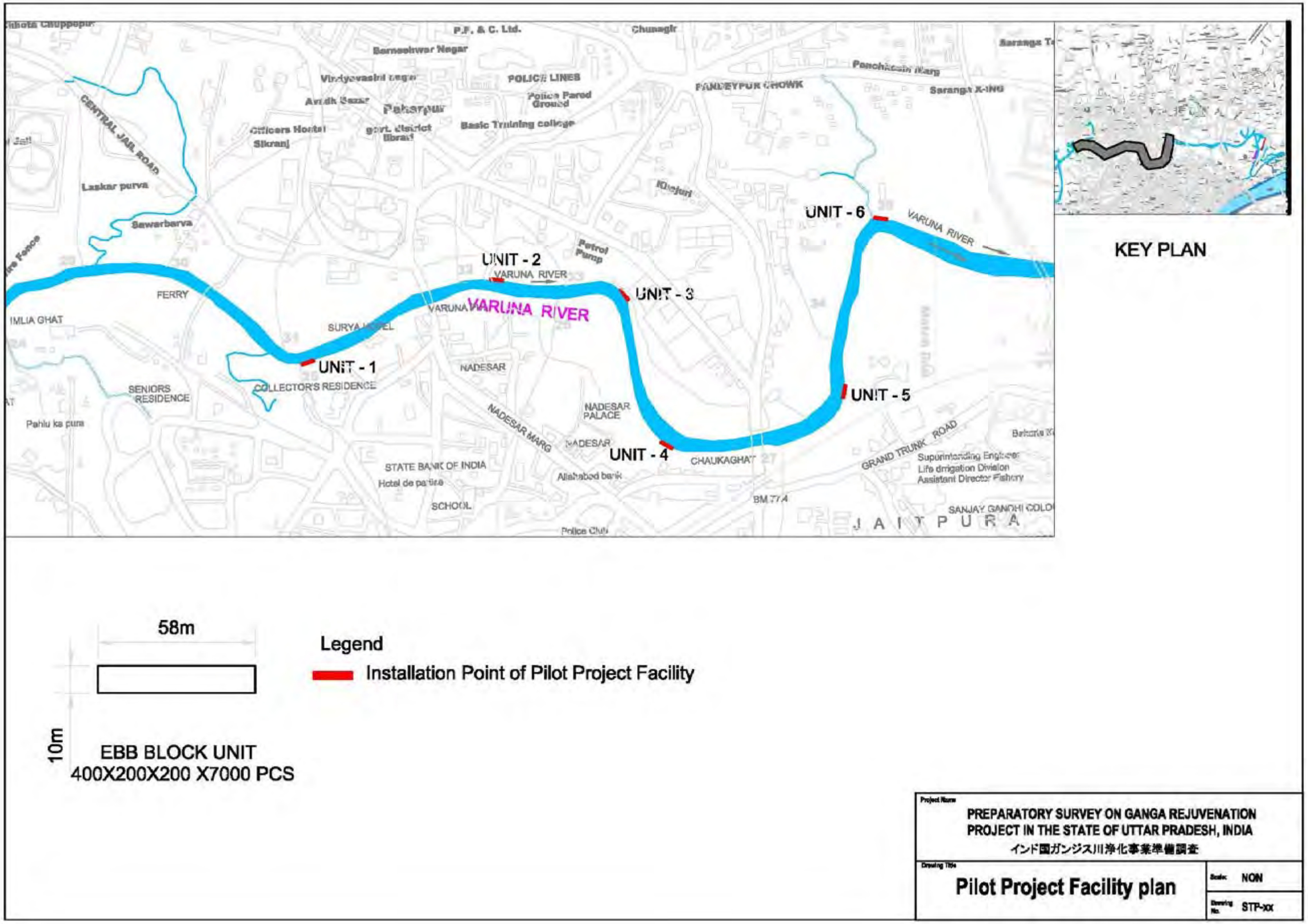
Unit Structure is a RC bed for the special blocks with following dimension:

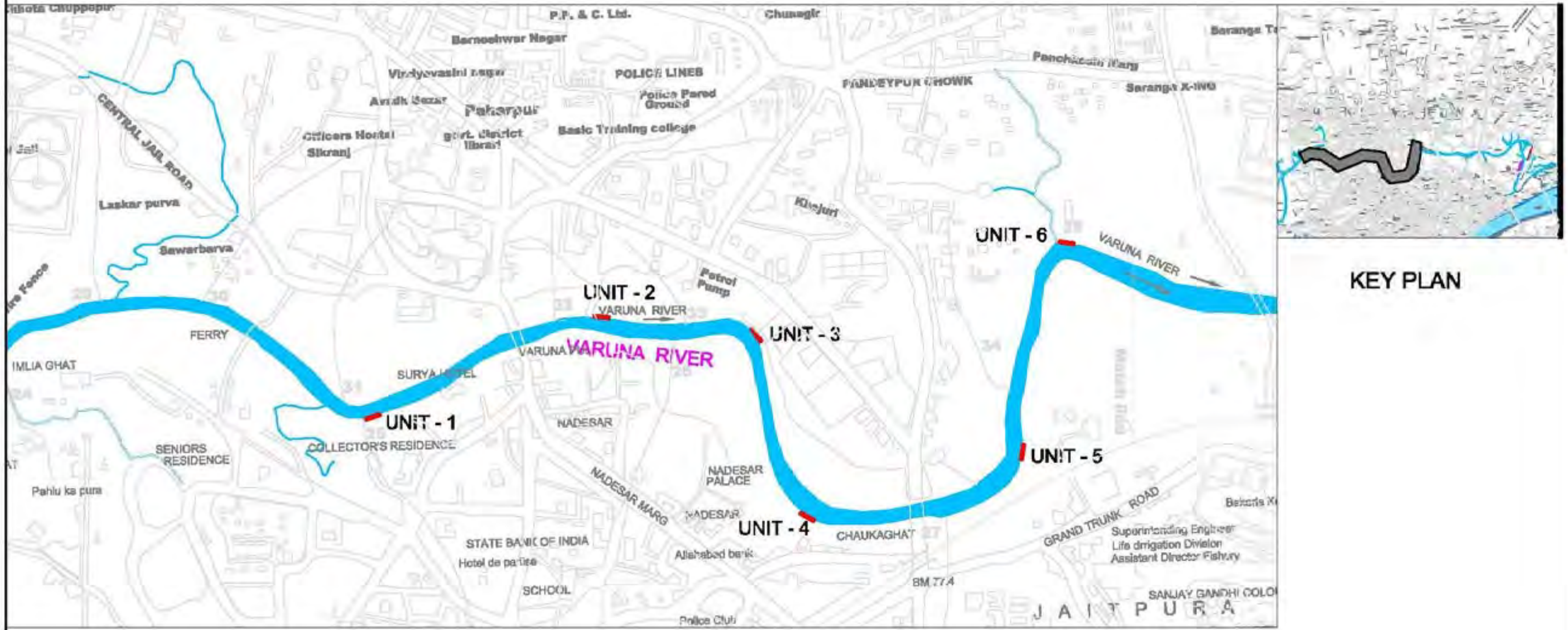
- 6units of W 10.0m x L 56.0m with 7000 pcs of special blocks

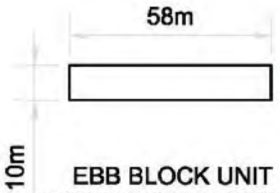
From the guideline of the manufacturer, detention time in the river was decided as about 5 to 6 hours for proper treatment. Assuming velocity in the river is 0.2 m/s and average depth is 1.0m, 4000m water course was selected with several bends of river as shown in the drawing. Approx 40,000 pcs of the blocks were planned in the 4000m considering the setting points at the bends of the river as mentioned in 14.6.2.


PVC Ø 100MM
1000
EXPANSION JOINT
10000
A
DETAIL- 3
150
28000
PLAN
SCALE - 1:75
DETAIL- 1
DETAIL- 2
Ø 13 @ 250MM
Ø 15 @ 250MM
COVER 50MM
GROUND LEVEL
EXISTING GROUND LEVEL
GRAVEL OR CRUSHED STONE
28650
SECTION - A A
SCALE - 1:75
EBB BLOCK
Ø 13 @ 250MM
Ø 15 @ 250MM
DETAIL- 1
SCALE 1:40
EBB BLOCKS
400
EXPANSION JOINT
DETAIL- 2
SCALE 1:40
PVC Ø100MM
DETAIL- 3
SCALE 1:40
EBB BLOCKS 400X200X200
Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA
インド国ガンジス川浄化事業準備調査
Drawing Title
Pilot Project Facility Plan
Scale: AS SHOWN
Drawing No. 02

14.7 Location of Units Installed in the Varuna River





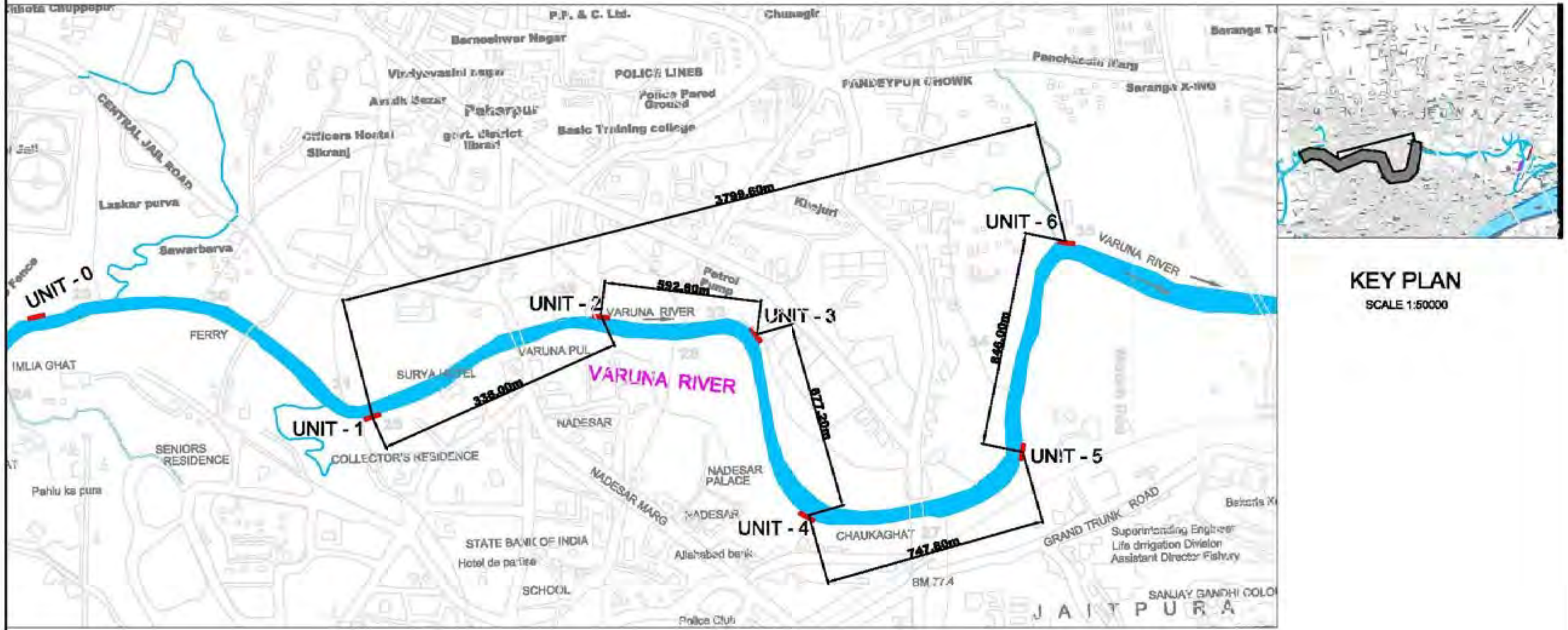


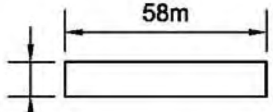
EBB BLOCK UNIT
400X200X200 X7000 PCS

Legend

Installation Point of Pilot Project Facility

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA インド国ガンジス川浄化事業準備調査		
Drawing Title: Pilot Project Facility plan	Scale:	NON
	Drawing No.	STP-xx





EBB BLOCK UNIT
400X200X200 X7000 PCS

Legend
Installation Point of Pilot Project Facility

UNIT - 0 = Charcoal- Iron Device
UNIT 1 to 6 = EBB Block Unit

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA インド国ガンジス川浄化事業準備調査	
Drawing Title: Pilot Project Facility plan	Scale: 1:20000 Drawing No. 01

14.8 Cost Estimate

The cost estimation for the In-situ Water Cleaning Facility was prepared and is summarized in the following tables. Latest labour and material rates were taken and also the Schedule of Rates for the year 2014-15 Sanction by GM, GPCU, U P Jal Nigam, Varanasi vide order no. 1407/11-02/45 dtd 02/05/ was referred for the cost estimation purpose. The Capital cost of the In-situ Water Cleaning Facility is estimated as Rs 13.05 Crores.

Table 14.8.1 Cost Estimate for In-situ Water Cleaning Facility

1	In-situ Water Cleaning Facility	Cost Rs in Lacs
1.1	Cost of Gravel Work 320m3/unitx6unitsx4300Rs	82.56
1.2	Cost of Rebar works 10.9t/unitx6unitsx71000Rs	46.43
1.3	Cost of Concrete works 174m3/unitx6unitsx3500Rs	36.54
1.4	Cost of Porus Concrete Blocks (140x50)pcsx6unitsx2500Rs	1,050.00
1.5	Cost of PVC pipe 55x9x0.3mx6unitsx1000Rs	8.91
1.6	Cost of EXP.J 10mx6unitsx1200Rs	0.72
	Sub Total for In-situ Water Cleaning Facility	**1,225.16**
3	**Provision for survey, investigation, preparation of DD and tender preparation and supervision charges etc.**	**80.00**
	TOTAL	**1,305.16**
4	**Total Annual O&M Cost for ten years for In-situ Water Cleaning Facility**	**23.00**
Grand Total including O&M cost for 10 yrs		**293.38**
	Say	**15.98 Cr**

Detailed cost break up for Civil, mechanical, electrical and instrumentation items is provided in Vol II of this Report. Annual operation and maintenance cost has been estimated as Rs. 0.23 crores including maintenance, chemical, manpower and power cost.

Table 14.8.2 Annual Operation and Maintenance Cost

S. No	Component	In-situ Water Cleaning Facility (Lacs)	Remarks
1	Manpower Cost	1.80	Labours 10x1month/yr 600Rsx10x30
2	Cost of Chemical & Sludge Disposal	-	-
3	Maintenance Cost	21.00	Refilling New Blocks of 2%- 1050Lacs x 0.02
4	Power Cost	0.2	Water Jet Machine for Grit Cleaning on the Facility 6.1Rs/kWH x 1x8x30
Annual O & M cost =		**23.00**	

Table 14.3 O&M Cost for 10 years

S.No.	Year wise O&M Cost	Cost in Rs. (Lacs)
1	Year 1	23.00
2	Year 2	24.22
3	Year 3	25.50
4	Year 4	26.85
5	Year 5	28.28
6	Year 6	29.78
7	Year 7	31.35
8	Year 8	33.02
9	Year 9	34.77
10	Year 10	36.61
Total O&M Cost for 10 Years		**293.38**

Estimated Escalation Rate: 5.3%

14.9 Environmental and Social Impact Assessment of works

During DPR stage, an Initial Environmental Examination (IEE) was conducted to determine impact on environment as a result of the implementation of the project. No significant adverse impact was found for either the environment or social aspects. Further, An Environmental Impact Assessment (EIA) is not required as per findings of an Initial Environmental Examination (IEE). This IEE done at the DPR stage is considered as the final environmental assessment of the project. Summary of the IEE prepared at the DPR stage is given in table below.

Table 14.9.1 Evaluation and Conclusion of IEE study during construction and operation phase.

Environmental Element	Construction Stage	Operation Stage
Social Environment		
a. Planned Residential Settlement	D	D
b. Involuntary resettlement	D	D
c. Substantial changes in the way of life	D	D
d. Population increase	D	D
e. Drastic change in population composition	D	D
f. Changes in bases of economic activities	D	D
g. Occupational changes and loss of job opportunities	D	D
h. Increase in income disparities	D	D
i. Adjustment & regulation of water or fishing rights	D	D
j. Increased use of agrochemicals	D	D
k. Outbreak of endemic diseases	D	D
l. Spreading of endemic diseases	D	D
m. Residual toxicity of agrochemicals	D	D
n. Increase in domestic and other human wastes	D	D
Natural Environment		
a. Change in vegetation	D	D
b. Negative impact on important or indigenous fauna and flora	D	D
c. Degradation of ecosystems with biological diversity	D	D
d. Proliferation of exotic and/or hazardous species	D	D
e. Change in surface water hydrology	D	D
f. Change in ground water hydrology	D	D
g. Water contamination and deterioration of water quality	D	D
h. Water eutrophication	D	D
i. Noise and vibration	D	D
j. Odour	D	D
k. Damage of landscape	D	D
l. Traffic	D	D

14.10 Implementation Programme

Execution of the project shall be done in 3 phase. In phase one DPR shall be approved in first three months. The second phase is of tendering which will consists of various activities including preparation and issue of PQ document and its evaluation, tender document preparation, approval by NRCD, issue of tender document to pre-qualified Bidders and evaluation of tender , and work award. The second phase is planned to be completed in 6.5 months. The third phase is the execution stage is construction. This phase is planned to be completed in 6 months. Total project duration is 15.5 months.

CHAPTER 15 VARANASI CONVENTION CENTRE

<Objectives of the Study>

As an initial stage of consideration, basic information was collected and the concept of Varanasi Convention Centre was studied based on DPRs submitted by India side..

<Result of the Study>

The proposed building aims to address the requirement for a convention centre that will facilitate for hosting conventions on a grand scale. Architectural plan, HAV facilities and exhibit plan were comparatively studied with the Sapporo Convention Centre in Japan for the DPR plan of VARANASI COMMONS which was submitted July 2016.

<Design Proposal>

The survey team proposed Design Concept based on the motif of culture, history, heritage, industry, tourism and regional characteristics and the plan was made to fit to the natural condition and surrounding environment. Ornate appearance may be avoided and in this context, façade of Mughal style is recommended to express the heritage and history of Varanasi. Further discussion to develop the concept was handed over to "Data Collection Survey on Varanasi Convention Centre in India" starting from September, 2016.

15.1 Introduction

15.1.1 General

The name Varanasi originates from the names of the two rivers from north and south Varuna, flowing in Varanasi and Assi, a small stream near Assi Ghat. The old city is located on the north shores of the Ganges, bounded by its two tributaries: Varuna and Assi. Varanasi also known as, Benares, Banaras, or Kashi, is a North Indian city on the banks of the Ganges in Uttar Pradesh, India, is one of the oldest inhabited city in the world. Varanasi lies along National Highway 2, which connects it to Kolkata, Kanpur, and Delhi. Varanasi is located at an elevation of 80.71m in the centre of the Ganges valley of North India, in the Eastern part of the state of Uttar Pradesh. By road, Varanasi is located 797 kilometres (495 mi) south-east of New Delhi, 320 kilometres (200 mi) south east of Lucknow, 121 kilometres (75 mi) east of Allahabad, and 63 kilometres (39 mi) south of Jaipur. VNN was planning to construct (scrap and build) Varanasi Convention Centre (VCC) adjacent to city hall, which was posed for the consideration under Japanese ODA assistance.

Based on communication between both governments, the project started to be considered as one of the components under proposed "Ganga Rejuvenation Project". The JICA mission was dispatched to understand the current status of consideration with JICA survey team. The points to be covered in DPR was clearly submitted by the mission.

As a result of the discussion in the mission, DPR as of May 2016 was revised and submitted in July 2016. Study regarding VCC in this chapter deals with review of the updated DPR as of July 2016 by domestic and field survey during end of June 2016 to end of July 2016.

After the work has been completed under the the scope of the study, further discussion was handed over in September 2016 to "Data Collection Survey for Varanasi Convention Center in India" by JICA.

15.1.2 Objectives

The proposed building aims to address the requirement for a convention centre which will facilitate for hosting conventions on a grand scale. The survey aims to clarify the concept work of VCC and requirement/issues to be clarified to consider for Japanese ODA assistance based on the examination of DPR. Recommendations were made for the plan of VARANASI COMMONS which was submitted in July 2016.

15.2 Issues on DPR of the VARANASI COMMONS

Main issue for VARANASI COMMONS was confirmed and described/studied for the DPR as follows:

(1) Architectural Planning

1) Compliance to the law

Compliance to the legal system and construction standards of the country should be made and reflected to facility planning and design. Laws and regulations must be precisely described in the DPR.

<u>In the DPR, there were 3 options and only the Option 1 was compliant with the standard for FAR and ground coverage in India. For this reason, only Option 1 can be adopted as the eligible plan. This method for the selection is not suitable for the comparative study to select best plan from the alternatives.</u>

2) Basic concept/Zoning plan/Traffic line

Layout plan in the site lot must be decided based on the block plan which was made from the required area for each facility. Coordinative plan with the peripheral zone shall also be planned in terms of landscape, environment information, commercial facilities, neighbouring parks and other public facilities. Plan of traffic line between the centre and other landmarks should be incorporated in the plan. Since the facility shall be a symbolization of Ganga Rejuvenation, exhibition of river ecosystem and river purification facility is to be displayed inside.

3) Plot plan.

Plot plan is the base for the design of architecture. Specific points to be covered in the Plot Plan is as follows:

・Required rooms to be planned in terms of purpose of use, operation and maintenance(O&M) and organization of O&M, shall be the appropriate sizes.

・The plan shall be conducted to clarify the flowing line of user, pedestrian, vehicles and operation and maintenance work.

・Each room shall be designed based on the usage condition and particular condition for the room.

・Clearance from the existing building.

・Simultaneous interpreter room

<u>In the Plot Plan, Mayor’s Office and Accommodation for guests are included, which may be out of scope according to communication between two governments.</u>

4) Plan of flowing line

Study on the flowing line of facility user, operation and maintenance, equipment carrying in and out should be shown on the plan.

5) Layout Plan and Façade (Elevation)

The layout plan and structure shall be provided based on the motif of natural/neighbouring environment and design concept of culture, history, heritage, industry, tourism and characteristic of the region.

Façade (Elevation) shall not be planned employing folly design but using motif of tradition and history of Varanasi. Plural plans shall be provided in the DPR for the comparison/examination.

For the Layout Plan, Issues were identified as follows:

<u>MAYOR’S OFFICE</u>

Construction of MAYOR’S OFFICE is planned in the VCC plan. Since Mayor’ office may be out of scope and shall be an independent structure from the VCC, building plan needs required revision.

<u>Accommodation</u>

9 rooms on 3rd floor is accommodation It is recommended that the utility of the rooms is changed appropriately or revise the plan.

6) Section plan

Required space of each room shall be secured just enough on the basis of the requirement from the function of the room. Necessary height of each room shall be studied and reflected to the DPR, for example traffic of large busses. These points are not described in the DPR.

7) Finish Plan

Finish inside and outside the facilities should be decided considering the smooth work environment by the maintenance based on the material durability, corrosion resistivity and economics. Comprehensive tables of finish should be provided in the DPR.

8) Structure Plan

The structure plan should be planned considering the balance of safety, constructability and economics in consideration of the environment of the site, ground condition, and function of a use and scale of each room.

In consideration of the building to be a lifeline facility which must secure a city function at the time of the disaster, it is necessary to design the structure safer than general buildings.

Plan of alternatives for the structure studied/classified should be provided in the DPR. Appropriateness of the adopted substruction/foundation of the Convention Centre should be presented by the result of geo-survey.

9) Disaster Prevention Plan

It is required to be a lifeline facility that facilitates safe just in case as well as usual safety securing for the users. Disaster prevention measures of that purpose shall include the daily preservation standard of facilities and standards for disasters and other damages. Standards established in the laws and regulations shall be strictly in compliance. Safety standards must be provided in the DPR

10) Universal design

Social capital maintenance in the near future will highlight the followings: "high quality that can support variety of needs of all people", "the material richness". The idea of universal design and its implementation will become the basic approach to the society maintenance future.

These facilities shall have 7 following universal design principles as viewpoints.

1) Facilities to be available to anyone equally (equitableness)

2) Facilities to be having high flexibility for the users (flexibility)

3) To be simple in use for anyone

4) Information necessary for anyone to be coming effectively, timely and easily comprehensive

5) To be a design safe for anyone (safety)

6) To be usable by little power easily without forcing anyone physical difficulties

7) To secure space and the size for easy use (space security)

.Study on the above must be shown on the DPR

(11) Trade Facilitation Centre and Craft Museum

Trade Facilitation Centre and Craft Museum have been constructed in Varanasi. Competitive nature of the on-going Trade Facilitation Centre and Craft Museum, Varanasi must be studied in terms of usage and manner of operation.

15.3 Discussion and Recommendations

15.3.1 Comparative Study of VCC with SCC

Since VCC will be planned as a component of Ganga Rejuvenation Project, sustainability in the future is indispensable. As a basis of examination and confirmation, planning of SAPPORO CONVENTION CENTRE (SCC) was taken in this comparative study.

The SCC is located in Sapporo City in Japan with a population of 1,910,000. Management is entrusted private with annual utilization rate of more than 70 %. The centre has a lot of facilities such as large halls to small meeting rooms with plural function. (Population in VNN is 1,435,113 in 2011)

(1) Study of Facility

Scale/size, appurtenant facilities, layout, flow line of VCC in the DPR were studied in comparison with the SCC in terms of functions employed.

Comparison table of 6 functions were developed in Table 15.4.1 for ①Auditorium, ②Seminar Hall, ③ Gallery/Exhibition/Display Area, ④ Reception, ⑤ Office, ⑥Vocational Training Centre.

Table 0.1 Comparison of VCC and SCC

	Varanasi Convention Centre (DPR) as of July 2016	SAPPORO Convention Centre	Remarks
① Auditorium	・Auditorium (1200 m^2—for 1000 capacity) Furniture: Fixed chair Utilization: Theatre	・Conference Hall (692 ㎡—700 capacity) Furniture: Movable chair Utilization: Theatre and others Appurtenant equipment: 6 languages simultaneous translation booth, 80 gallery seats, multi screens ・Main Hall for bigger conference (2607 ㎡—2500 capacity) Furniture: Movable chair Utilization: Theatre and others Appurtenant equipment: simultaneous translation booth, multi-screens, briefing room, lifting stage	Appurtenant equipment for international conference are necessary for VCC. Movable chairs are recommended in the Auditorium.
② Seminar Hall	・Seminar Hall 4 rooms (170 m^2 x 2) & (220 m^2 x 2)	・Hall (240 m^2, 193 capacity) ・Meeting Room-A (283 m^2) ・ Meeting Room-B (328 m^2) to be separated in 2 to 4 rooms ・ Meeting Room-C (83 - 86 m^2) x 2 rooms to be separated in 2 rooms ・ Meeting Room-D (172 m^2) x 2 rooms to be separated in 2 rooms ・ Meeting Room-E (50 m^2) ・ Meeting Room-F (21 - 40 m^2)	Splittable rooms shall be planned in VCC with storage for the furniture
③ Gallery/Exhibition/ Display Area	・Gallery/Exhibition/Display Area (625 m^2 x 1 room) (760 m^2 x 1 room) Utilization form: permanent gallery for the culture and science of India ・Multipurpose Hall (Open Space 625 m^2) ・Hall (Open Space 800 m^2) Total 2,810 m^2	・Main Hall (2,067 m^2) ・Conference Hall (692 m^2) ・Mid-sized Hall (533 m^2) Utilization form: Multiple uses Appurtenance: Movable table, chairs, store room Total 3,292 m^2	Since Exhibits of Sewerage technology and ecosystem in the river as well as river purification technologies will be made in the facility, utilization form of the facility shall be reconsidered if the total area of exhibits is fixed. Store rooms shall be constructed for the storage of furniture, exhibits, and etc. Carry-in entrances are necessary for equipment and exhibits for Multipurpose Hall.
④ Reception	・Hall (800 m^2)	・Main Hall (2,067 m^2) Utilization form: 800 capacity for party	Hall and Multipurpose Hall are thought to be utilised as reception. Catering space linked with kitchen shall be set

	・ Multipurpose Hall (625 m^2)	・Conference Hall (692 m^2) Utilization form: 330 capacity for dinner ・Mid-sized Hall (533 m^2) Utilization form: 210 capacity for party	along with store room for table and chairs.
⑤ Office	・Office Space (200 m^2)	・Office Space (300 m^2) Service space for citizens with Office Space, Information Space and Nursing Space	Since Office Space in the VCC is planned underground, utilization for citizen's use is considered to be difficult. It is desirable to set such function in the entrance lobby on Ground Floor for the common office work, information and services for the citizen.
⑥ Vocational Training Centre	・Training Hall (800 m^2) ・Seminar Room (300 m^2 x 2 rooms) Total 1,400 m^2	・Business supporting rooms (50 m^2 x 8 rooms, 60 m^2 × 3 rooms) ・Industrial Information room (170 m^2) ・Small Seminar rooms (100 m^2 × 2 rooms) ・OA Seminar room (90 m^2) ・Seminar room (180 m^2) ・Rest room (30 m^2 × 2 rooms) ・Green room (40 ㎡), Storage (40 m^2 × 2 rooms) ・Multi-purpose room (220 m^2) Total 1,620 m^2	Although size and capacity seem appropriate, splittable rooms for other uses are recommendable.

(2) Flow Line

Comparison of flow lines of VCC and SCC was conducted as follows:

① User Flowline

VCC plans the rooms as splittable spaces while SCC plans the rooms as consecutive ones.

② Service Flow line

VCC: Cluster Type (Dispersed rooms connected by corridor and hall)

SCC: Linear Type（Rooms distributed along the flow line）

③ Main Entrance

There are two entrances in basement and ground floor in VCC plan. Main entrance of the VCC is uncertain. From the layout of COMON/SPILL OUT SPACE, basement is considered as the main however, ground floor is the main from 3D view.

④ Common space

Although independence of each space is prioritised in the plan of VCC, high mobility in the plan which enables various utilization is required as seen in the SCC plan.

Having high mobility in the plan is recommended on this convention centre in terms of flowline of the users and safety for the users at the disaster.

(3) Layout Plan

MAYOR'S OFFICE and Accommodation should be isolated from the subject structure.Cost Estimates

In the cost estimates, validity of the rate is required. In the DPR of VCC, other than Item A (Cost of Building) grounds of rates for TOTAL (B～F) must be clarified and submitted as evidences. The rates are considered to come from "CENTRAL PWD PLINTH AREA RATES (1.10.2012)" for Total A. TOTAL (B～F) and loaded centage must be studied for clarity.

Validity of the cost estimates of VCC was conducted in the manner using the example of SCC shown below:

① Reference:

SPON'S ASIA - PACIFIC CONSTRUCTION COSTS HANDBOOK 4TH EDITION 2010

② Trial computation:

Rates from "Hotel 5 stars, City Centre" in the table by Spon 2008, From Table 15.4.2

- Japan (JPY400,000/m^2)
- India (JPY96,226/m^2)

Then, Japan:India≒4.2:1.0

Actual cost of SCC is as follows

SCC JPY565,000/m^2

Conversion to the VCC is made as follows:

VCC JPY134,523/m^2

Conversion rate: 1.75Rs/JPY

- JPY134,523/1.75=76,870Rs/m^2 ----- (A)

VCC DPR Rate

DPR Cost/Gross Floor Area=21142,88,531Rs/27,782.6 m^2□76,100Rs/m^2-----(B)

Thus, VCC DPR rate is considered to be close to actual SCC rate.

Table 0.2 Comparison of Building Unit Cost by SPON (4th Quarter, 2008)

(Unit: JPY)

Type of Building		Japan	India
	Rate	Yen 1.00	Rs. 1.99
Factories for owner occupation	m^2	160,000	26,713
Secondary/middle schools	m^2	220,000	13,903
Private sector apartment building	m^2	210,000	33,366
Prestige/headquarters office, high rise, air-conditioned	m^2	350,000	47,071
Hotel, 5 star, city centre	m^2	400,000	96,226

(4) Implementation Program

Example of SCC in Japan is described as follow:

D/D: 12 months, Tender assistance:3 months, Construction: 26 months, Commissioning: 6 months,

Total 47 months from the start of DD

(5) Construction

1) Securing the space for the work and flowline

2) Environmental management plan

3) Temporary work plan

4) Hazard and Safety

15.3.2 Exhibit of River Purification Facility

Exhibit of River Purification Facility will be an indispensable facility for the VCC. SCC was taken as a sample for the facility, since it has the same function inside.

(1) Significance of River Purification and sewerage

VCC shall have the function of provision of correct knowledge to citizen in this project. It will be established to show river purification process and sewerage close to people who visit the VCC. In this context, plan of exhibit facility of river purification process/sewerage is proposed as exhibits.

(2) Planning of exhibits

Science Museum for Sewerage in Sapporo City is suggested for a sample of the facility.
Outline of the facility is shown below:

1) Objectives

   The facility was opened to propagate mechanism of sewerage and its roll to conservation of the environment through sewerage in Sapporo in May 1997.

2) Facility

   Structure: RC , 1200m2

   Cost: 1,100,000USD

3) Management

   Managed by public with no charge to users

4) Exhibits

   Global environmental issues

   Roll of Sewerage to the issues

   Outline of Sapporo sewerage

5) Number of Visitors

   Over 700,000 by 2014

   43,989 in 2015

15.3.3 Design Proposal

Design Concept based on the motif of culture, history, heritage, industry, tourism and regional characteristic shall be established to fit to the natural condition and surrounding environment. Ornate appearance will be avoided and in this context, façade of Mughal style is recommended to express the heritage and history of Varanasi as shown in the photos below:

<Hyumayun>

<Lahore>

<Vaishnava>

<Taj Mahal 1>

<Taj Mahal 2>

<Agra Mirza Ghiyas Beg>

15.3.4 Building Services

Building Service is an important function of the VCC in terms of amenity, safety and cost. It is recommended to include the following items in the DPR in terms of building service:

(1) Power Control Method

Decrease of power consumption and O&M cost for long, middle and short term shall be planned based on the standard for power administration

(2) Selection of Equipment and System

Optimum selection shall be made for decision of main equipment and HVAC according to the specification, function, O&M, CAPEX, OPEX and LCC.

(3) Layout of MEP room

Decision of rational plumbing route and effective O&M flowline shall be planned

(4) Green Building Measures and Certification

94 points of GRIHA 5 Stars shown in the DPR shall be achieved

15.3.5 Structural Consideration

In the DPR, description regarding the structure is not found. Structural consideration is necessary as follows:

(1) Structure shall be designed as SMRF structure and condition of Zone 4 shall be applied in the structure computation in terms of safety and sustainability.

(2) Geotechnical report must be referred for the foundation design

(3) Items of "SUPERSTRUCTURE, COMPUTER PROGRAMS, 2 MATERIAL PARAMETERS, 3STABILITY LIMIT STATE, 4SERVICEABILITY LIMIT STATE, 5 TYPES OF FOUNDATIONS＆SBC, 6 DESIGN CODES, STANDARDS AND REFERENCE DOCUMENTS" shall be followed in the DPR

15.4 Proposal for VARANASI COMMONS

(1) Basis of the proposal

Based on the discussion and recommendation, proposal for OPTION 1 of VARANASI COMMONS in terms of Zoning, Site Plan and Floor plans was made for development of the plan.

Points for planning are summarised as follows:

1) Since mayor's office is out of scope for ODA project, intended end use for the rooms should be examined and changed to another one.

2) Competitive nature of the on-going Trade Facilitation Centre and Craft Museum, Varanasi must be studied in terms of usage and manner of operation.

3) Coordinative plan with the surrounding City hall, public parks, athletic fields and

residential with the centre and additional construction plan of roads and parks should be planned for harmonious area establishment.

4) Since description of design condition and specification is lacking in the DPR, additional information should be incorporated to make the DPR comprehensive.

(2) Development of plan of OPTION 1

Since plan of OPTION 2 and 3 in the DPR is not legally justified, only OPTION 1 was covered in the study. Improvement of the OPTION 1 is developed in this section.

Proposal for improvement of the plan

Consideration for maintenance and operation is needed in terms of indoor condition including plan of building services. Explicitness and simplicity is needed from the viewpoint of the guests as follows:

- Cleary setting of main entrance of the facility together with the doorways for each facility
- Site lot is deemed to be the same location with the OPTION 1
- Built-in function of service for citizen shall be equipped in administration office with easy access
- Arrangement is needed for the plan of building and structure for the underground parking area and superstructure
- Consideration of the revenue to secure the sustainability of the centre

Layout plan

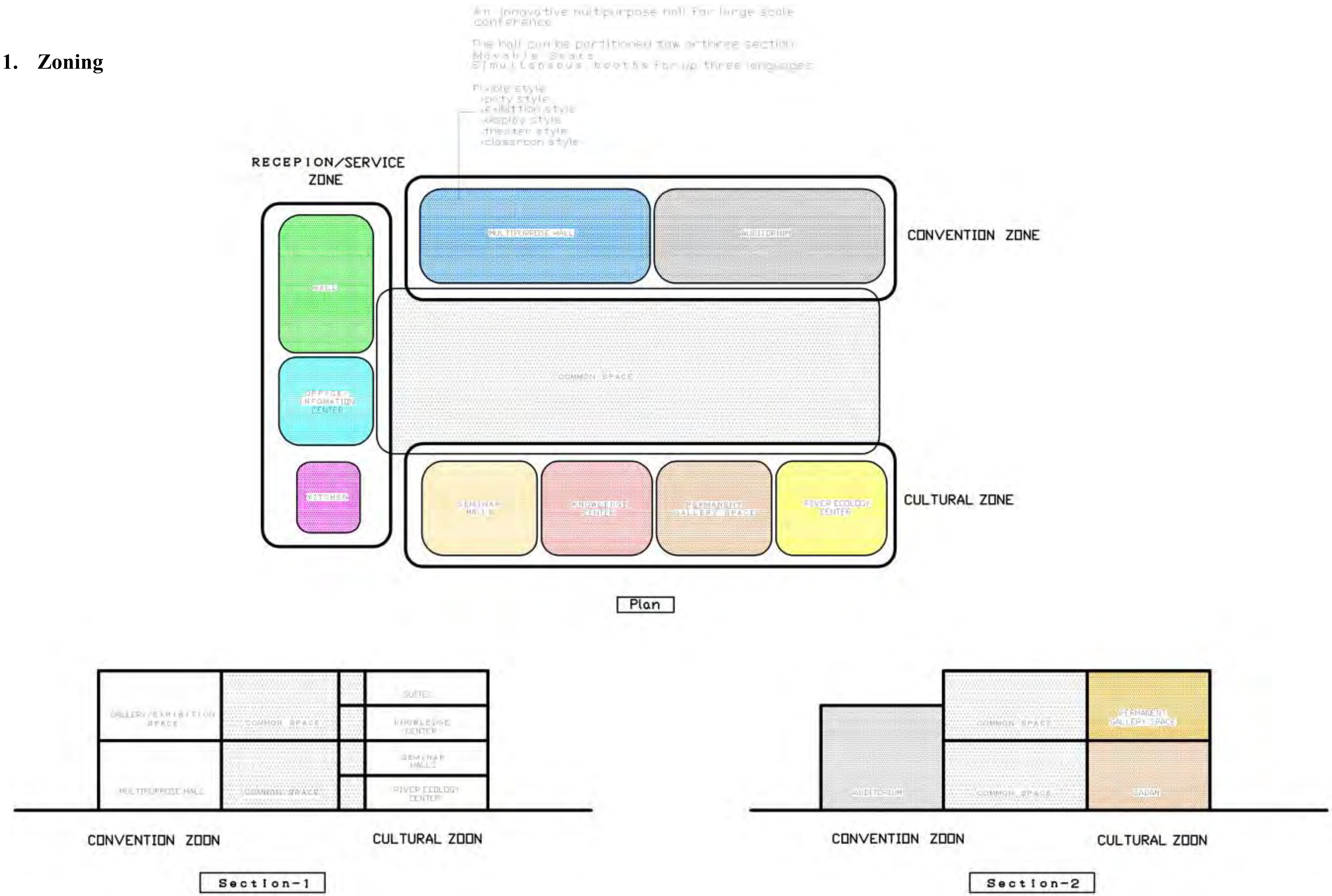
The main point of the concept of the layout plan of OPTION 1 is deemed to be whether all-inclusive public space becomes interactive space. Specific planning such as common space or reception hall is needed in order to realize the interactive space along with the landscaping plan. Although the function seems introduced in the inner court in the Option 1, interactivity with other spaces is not felt from the manner of approach from south side. As a proposal for the plan, Images are shown in the figures (1.Zoning, 2.Site Plan, 3.Floor Plans) In the plan, both culture zone and convention zone were set as a symbol of interactive space.

(1) The lot for the centre is expanded in comparison of the precedent DPR. Confirmation of boundary of the lot is necessary.

(2) Cooperative planning with the SADAN is needed.

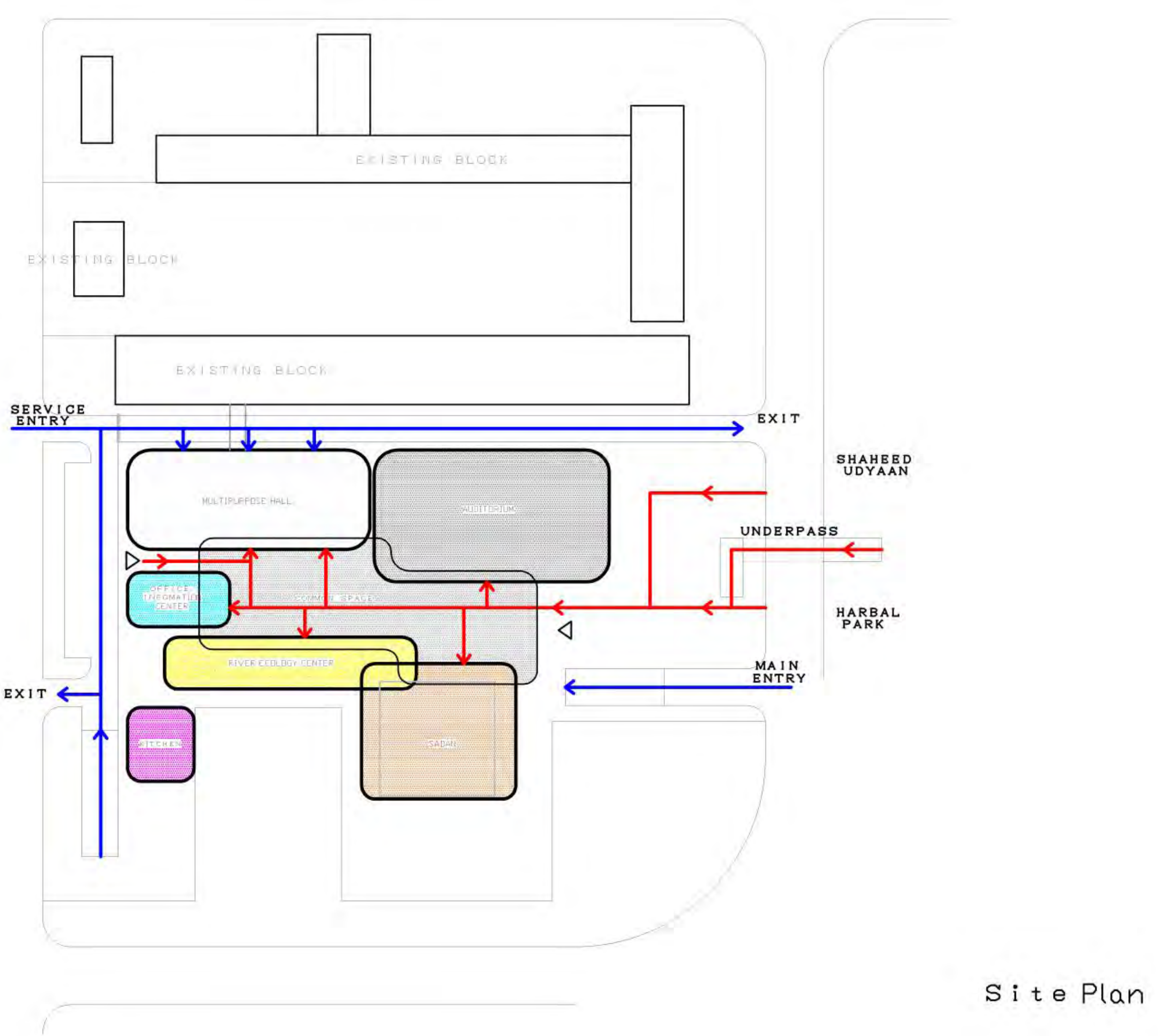
(3) Security is another point for the planning of doorways of facilities with various utilization forms. Dispersed doorways method needs studies on securing spaces and flow line analysis of users, vehicles, buses and other service vehicles for superstructure as well as basements.

1. Zoning



ZONING

2. Site Plan


EXISTING BLOCK
EXISTING BLOCK
EXISTING BLOCK
SERVICE ENTRY
EXIT
SHAHEED UDYAAN
MULTIPURPOSE HALL
AUDITORIUM
UNDERPASS
OFFICE INFORMATION CENTER
COMMON SPACES
HARBAL PARK
RIVER ECOLOGY CENTER
MAIN ENTRY
EXIT
KITCHEN
SADAN
Site Plan

3. Floor Plans