4

FEASIBILITY STUDY FOR PROJECT CITIES

4. FEASIBILITY STUDY FOR PROJECT CITIES

4.1 OBJECTIVES OF FEASIBILITY STUDY

The objectives of the feasibility study could be summarised as follows:

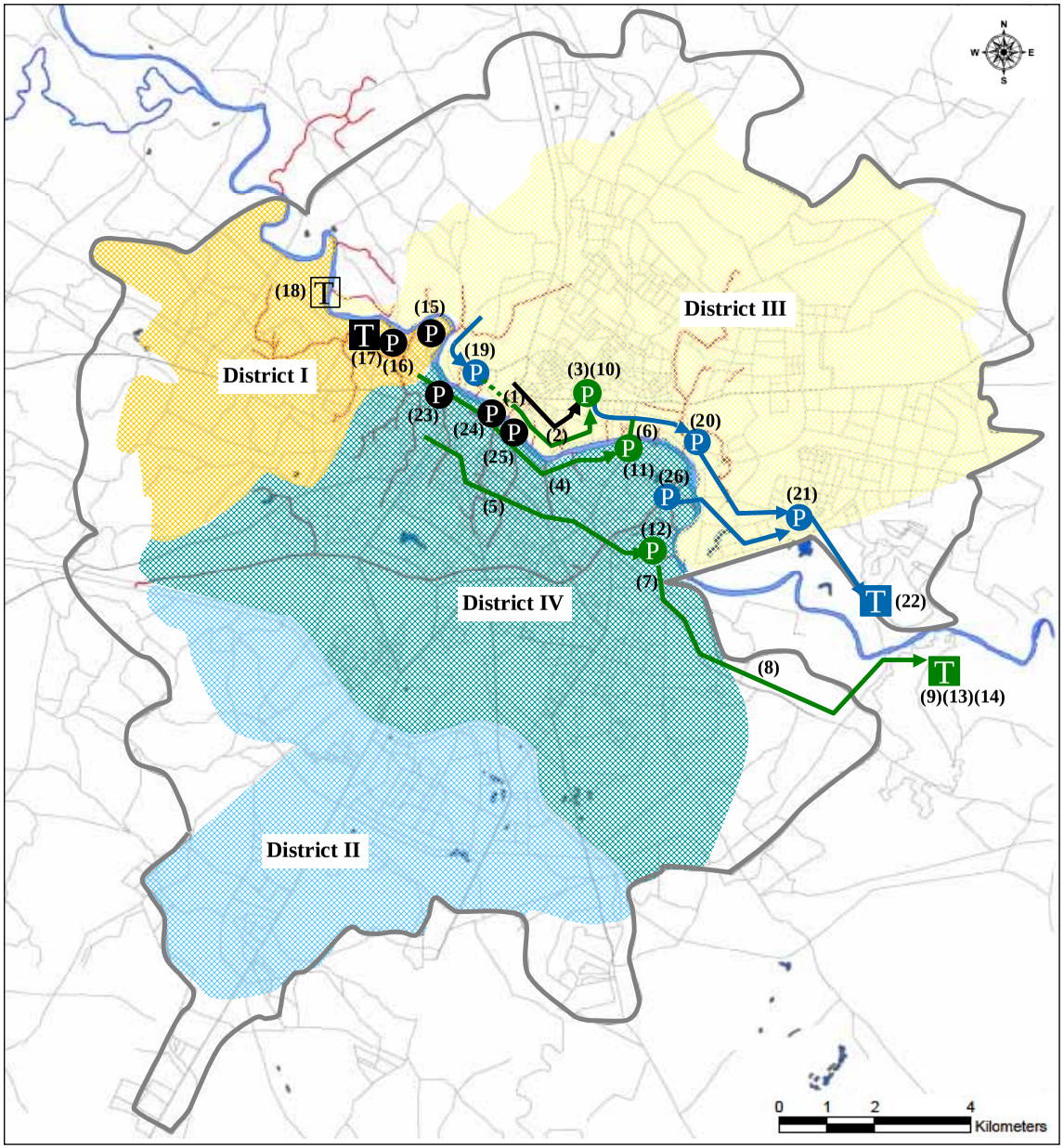
- To carry out field surveys to examine the technical feasibility of identified priority projects
- To analyse various project alternatives and recommend the preferred alternative
- To carry out preliminary design for the preferred alternative
- To calculate capital and O&M costs for the recommended alternative
- To carry out an EIA study
- To analyse the present institutional and O&M arrangements and recommend an institutional and O&M set up for the priority projects
- To develop a support programme of public participation and awareness for sewerage / non-sewerage schemes
- To evaluate economic and financial viability of the proposed projects.

4.2 FEASIBILITY STUDY FOR LUCKNOW

4.2.1 Sewerage Scheme

(1) Proposed Components for Feasibility Study

The JICA Study Team has prepared the Master Plan (M/P) for the Lucknow sewerage system. The Master Plan identified certain 'Priority Projects' that are to be implemented within 1-5 years of adopting the MP, with the aim of reducing the pollution load on the Gomti river passing through Lucknow. These proposed facilities are shown in Figure 4.1. These facilities shall work together with the major sanctioned and commissioned projects listed in the same table.



Legend

- Municipal Boundary
- Sewer
- Rising Main
- Pump Station
- Treatment Plant

Black : Existing Facility
Blue : Sanctioned Facility
Green : Proposed Facility

	Sewer / Rising Main	District	Status	Diameter / Length
1	Rising main of Mohan Meakin SPS	III	P	700 mm, 1.3 km
2	Trans Gomti trunk sewer	III	P	1300-1600 mm, 3.2 km
3	Rising main of Trans Gomti SPS	III	P	900 mm, 2.0 km
4	Cis Gomti trunk sewer	IV	E/R	750-2100 mm, 6.9 km
5	Cis Gomti relief sewer	IV	P	1200-2200 mm, 7.0 km
6	Rising main of Cis Gomti SPS	IV	P	1000 mm, 0.9 km
7	Rising main of Martin Purwa MPS	IV	P	1200 mm, 0.9 km
8	Sultanpur road trunk sewer	IV	P	2400 mm, 7.5 km
9	Rising main of TSPS at Mastemau STP	IV	P	1400 mm, 0.1 km

	Pumping Station	District	Status	Capacity (mld)	Remarks
10	Trans Gomti SPS	III	E/R	60	Average flow in 2015
11	Cis Gomti SPS	IV	E/R	50	
12	Martin Purwa MPS	IV	P	80	
13	TSPS at Mastemau STP	IV	P	100	

	Treatment Plant	District	Status	Capacity (mld)	Remarks
14	Mastemau STP (UASB + AL)	IV	P	100	Average flow in 2015
	Total			100	

Existing / Sanctioned Facility

	Facility	District	Status	Remarks
15	Sarkata Nala SPS	I	E	
16	Nagaria Nala SPS	I	E	
17	Daulatganj STP (FAB)	I	E	
18	LDA colony STP	I	(P)	Implemented by LDA
19	Mohan Meakin SPS	III	S	
20	Kukrail No.1 SPS	III	S	
21	Guari MPS	III	S	
22	Kakraha STP (UASB)	III	S	
23	Pata Nala SPS	IV	E	
24	Wazirganj Nala SPS	IV	E	
25	Ghasiyari Mandi SPS	IV	E	
26	GH canal SPS	IV	S	

E: Existing
S: Sanctioned
P: Proposed

R: Rehabilitation
A: Augmentation
Rp: Replacement

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PROJECT	LOCATION	Figure 4.1
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	Lucknow City	Proposed Sewerage Facilities for Feasibility Study (Lucknow)

(2) Design Data and Parameters

Project Design Horizon

The design period considered for sewers is 30 years (single phase). Civil works for pumping station facilities are designed also for 30 years, Electrical and Mechanical (E&M) works are designed for two-staged implementation, first stage up to 2015 and second stage up to 2030. Treatment facilities will be implemented in two stages as well. First stage would be up to 2015 and wherever flow increases / raw wastewater quality changes after 2015, the treatment facility would be augmented for the requirement of 2030.

Sewerage Districts Planning

The Master Plan has divided Lucknow into four sewerage Districts I to IV. All the priority projects identified in the Master Plan falls into two districts viz. III and IV.

Design Population

The population of Lucknow in 2003 is estimated as 2,463,000. The Master Plan has finalised the population growth rates overall for Lucknow. Growth rates for each district have been calculated based on the growth potential of the district. With these growth rates and with 2001 census figure as the base, the Master Plan has calculated population figures for each sewerage district; these are presented in the table below.

Table 4.1 Population Projection for Urban Area (Lucknow)

Sewer Service Areas	Population within Municipal Area		
	2003	2015	2030
District III	870,000	1,379,000	2,204,000
District IV	1,143,000	1,489,000	1,947,000
Lucknow F/S Area Total	2,013,000	2,868,000	4,151,000
District I	169,000	252,000	410,000
District II	281,000	485,000	863,000
Total	**2,463,000**	**3,605,000**	**5,424,000**

Water Supply Status

The main water sources for municipal supply are the Gomti river (from raw water pumping station located at Gaughat with treatment works at Aishbagh and Balaganj and deep tube-wells. In 2003, intake from the river was about 247 mld, from the deep tube wells was 195 mld and from hand pumps was 52. Hence, total estimated water production from municipal supplies in 2003 was 491 mld.

The per capita water consumption of municipal water calculates to 246 litres per capita per day (lpcd). This has been modified in the Master Plan, to account for water consumed from private supplies, unaccounted-for water (UFW) and industrial consumption. The final figures work out to 283 lpcd for 2003, 230 lpcd for 2015 and 173 lpcd for 2030 in core area.

Waste Water Quantity Generated

Per capita wastewater discharge has been arrived at in the Master Plan by applying a return factor of 0.7 to 0.8 on the per capita water consumption (lpcd). No increase has been made on account of ground water infiltration as the ground water table in Lucknow is generally deeper than sewer depths. The final figures for wastewater generated in the four districts are as follows:

Table 4.2 Waste Water Generated

(mld)

Sewer Service Areas	2003	2015	2030
Within Municipality			
District I	19.5	34.1	63.5
District II	32.4	65.5	133.9
District III	99.9	185.9	341.2
District IV	213.2	251.7	301.8
Sub-total	**364.9**	**537.2**	**840.6**

Design Flow for Sewers

The design flows for all trunk sewers have been calculated and specified in the Master Plan based on the population of the catchment area and connection ratios. These flows have been considered for preliminary design.

Pumping Capacity and Configuration

For large capacity plants (or critical facilities) equal capacity pumps (6 to 8) have been proposed, with 50% or more stand-by on peak flow, and 100% or more standby for non-peak flow.

Design Capacity for STP

As per the final sewerage system configuration adopted in the Master Plan, Mastemau STP is proposed for 100 mld (in 2015) to be augmented to 305 mld (in 2030).

Table 4.3 Design Capacity for STP

Location	Catchment Area	Capacity (mld)	
		Year 2015	***Year 2030***
Mastemau	District IV	100	305

Raw Sewage Characteristics

The raw sewage characteristics for the STP have been decided based on the ratio of flow tapped via nalas to the flow reaching the STP via piped sewers.

Table 4.4 Raw Sewage Characteristics

Parameter	Average Value
Minimum Temperature, ^{o}C	20
pH	6.0 - 8.5
Biochemical Oxygen Demand (BOD5), mg/l	250
Total Suspended Solids, mg/l	500
Faecal Coliform Count, MPN/100ml	2×10^{7}

Treated Effluent Characteristics

The effluent standards considered in the design of STPs, as specified in the Master Plan and in accordance with NRCD guidelines, are listed in the table below.

Table 4.5 Treated Wastewater Quality

Parameter	Value
pH	5.5 – 9.0
Biochemical Oxygen Demand, mg/l	< 30
Total Suspended Solids, mg/l	< 50
Faecal Coliform Count, MPN/100ml	<10,000

Wastewater Treatment Technologies

Treatment technologies with a proven track record in the country have been compared. The comparison is considered in view of the following constraints, to recommend the final treatment technology to be adopted:

- Land availability within the urbanised area is limited
- The city faces power cuts

Hence, treatment technologies preferred are those, which have less land area and power requirements and have a high reliability in face of power cuts. In general, either Waste Stabilisation Ponds or Upflow Anaerobic Sludge Blanket (UASB) with a suitable post treatment has been chosen, based on the requirement of the specific site.

(3) Summary of Proposed Sewerage Facilities under This Feasibility Study

A comprehensive Sewerage Master Plan has been prepared during the initial stage of this study. For planning purpose, the city is divided into four Sewerage Districts based on the topography. Proposed priority projects cover sewerage districts III and IV. District III is located on the Trans-Gomti side while district IV is on the Cis-Gomti side.

1) Sewerage District III

i) Rehabilitation of Existing Pumping Stations (Trans Gomti Pumping Station)

The existing pumping station was commissioned in the year 1970. It was designed to cater to the sewage generated in District III in Trans Gomti area. The installed pumping capacity was 360 lps. This pumping station has been out of order for more than four years and, presently, the entire flow received at the wet well is diverted to Gomti river. The existing civil structure is in a dilapidated state with various cracks all over the structure. The gates installed at the inlet sump have worn out due to non-operation. All the pumps have gone way beyond their life of fifteen years. Also, all the electrical installations have worn out due to non-operation.

Considering the requirement of additional capacity and poor state of existing facility, it is proposed to dismantle the entire structure and construct a completely new pumping station at the same location. Due to restriction of space, the present sump will also need to be dismantled and a new sump of higher capacity and required depth is proposed.
All the existing pumps shall be replaced with new pumps of required capacity. Also, all the existing electrical facilities require replacement. In addition, provision is made for instrumentation devices for optimum utilisation of pumping station.

From TGPS, sewage will be conveyed to Kukrail pumping station via a rising main of 900 mm dia. This rising main has already been sanctioned by NRCD under GoAP. In addition another rising main of 900 mm dia is provided to handle flow for the year 2015.

- 60 mld (average flow) in 2015
- Reconstruction of Trans Gomti Pumping Station (TGPS)
- Construction of rising main: 900 mm dia, 2.0 km

ii) New Sewers / Rising Mains proposed

Manhole survey of existing Trans Gomti sewer was carried out under the project. The existing sewer has insufficient sewage carrying capacity and is also defunct, not functioning. Rehabilitation of this sewer line will not be a cost effective measure. Hence a new gravity sewer starting from Mankameshwar Mandir road to Trans Gomti Pumping Station (TGPS) is proposed. The gravity sewer will convey flow from Mohan Meakin Pumping Station in addition to the flow in the catchment area of District III.

The new facilities proposed for this district are:

- Construction of new trunk sewers: 1300-1600 mm dia, 3.2 km.
- Construction of rising main: 700 mm dia, 1.3 km

2) Sewerage District IV

i) Recommendations for Existing Sewers

It is observed that the CGTS indicates varying degree of structural conditions from the primary assessment and the grades are most likely to be between grade III and V, which means they need immediate attention for rehabilitation. Since relaying of the damaged portions of CGTS in difficult due to heavy traffic road, its rehabilitation is proposed.

- Desilting and rehabilitation of existing trunk sewers: 750-2100 mm dia, 6.9 km

ii) Augmentation and Rehabilitation of Existing Cis Gomti Pumping Station

The existing pumping station was designed to cater to the sewage generated in District IV in Cis Gomti area and it was commissioned in the year 1970. There has been extensive wear and tear in the existing machinery at CGPS. The impellers of these pumps are badly damaged requiring maintenance on regular basis. This has led to drastic decrease in the pumping capacity of these pumps. UP Jal Nigam had got the discharge of one of the pumps measured by Forbes Marshall in Year 2003. The actual discharge reported was 150 lps at 12.0 m head as against 600 lps at 19.81 m head. Following observations were made during the visit to the pumping station.

Considering the requirement of reduced capacity and poor state of existing facility, it is proposed to dismantle the dry well and wet well completely and replace the same with new structures. However, the other existing allied buildings can be used in the future. All the existing pumps shall be replaced with new pumps of required capacity. Also, all the existing electrical facilities require replacement. In addition, provision is made for instrumentation devices for optimum utilisation of pumping station.

- 50 mld (average flow) in 2015
- Reconstruction of Cis Gomti Pumping Station (CGPS)
- Construction of rising main: 1000 mm dia, 0.9 km

In stage I, CGPS will convey its flow to the STP at Kakraha (located in Trans Gomti), which

is already sanctioned under GoAP (Phase II), via a 1200 mm diameter existing rising main which will be augmented by laying another rising main of 900 mm diameter pipe. However, in the stage II, the entire discharge from CGPS will be diverted to the proposed Cis Gomti relief sewer.

iii) New Sewers / Rising Mains and Pumping Stations proposed

Cis Gomti Relief Sewer

Hydraulic capacity of the existing Cis Gomti trunk sewer (CGTS) is found less than the required capacity to carry sewage generated in the core city area. It is proposed to reduce the sewage load from existing Cis Gomti trunk sewer and to lay another new interceptor sewer named "Cis Gomti relief Sewer". The proposed Cis Gomti relief sewer will convey sewage generated in the upstream area of sewerage district IV and it is also proposed to intercept partial sewage flowing through Pata nala, Wazirganj nala and Ghasiari Mandi nala. The sewage will be conveyed to the proposed new Martin Purva pumping station.

- Cis Gomti Relief Sewer: 1200 - 2200 mm, 7.0 km

Martin Purwa Pumping station

A pumping station is proposed at Martin Purwa, within the premises of LaMarteniere School, which will receive the sewage from the relief sewer and convey the same to proposed Sultanpur road trunk sewer near Dilkusha Crossing.

Total design flow:
- 80 mld (average) in 2015
- 250 mld (average) in 2030

Major works proposed:

- 9 pumps of 31.2 mld, 24 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Rising main: 1200 mm in dia, 900 m length

Sultanpur Road Trunk Sewer

Sewage pumped from the Martin Purwa pumping station will be brought up to the Dilkhusha crossing on the Sultanpur road through rising main. From Dilkhusha crossing up to the proposed STP site at Mastemau, sewage will be conveyed through Sultanpur road trunk sewer.

- Sultanpur Road Trunk Sewer: 2400 mm, 7.5km

Terminal Sewage Pumping Station at Mastemau STP

A terminal sewage pumping station is proposed at Mastemau STP site to maintain the hydraulics of the treatment plant. This pumping station will receive sewage from proposed Sultanpur road trunk sewer and convey the same to the inlet of STP at the required elevation.

Total design flow:

- 100 mld (average) in 2015
- 305 mld (average) in 2030

Major works proposed:

- 12 pumps of 30.5 mld, 26 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Rising main: 1400 mm in dia, 100 m length

iv) New STP proposed at Mastemau

This STP will treat the sewage to the desired standards and the treated effluent shall be discharged into Gomti river adjacent to the site. This treated effluent may also be used for irrigation purposes in the adjacent irrigation fields. This will reduce further exploitation of the ground water for the irrigation purpose.

Total design flow:
- 100 mld (average) in 2015
- 305 mld (average) in 2030

Process:
The technology for this site should:
- Minimise land area requirement
- Have low dependency on power for effective and reliable treatment of wastewater

A detailed techno-economic comparison of the various treatment technologies was carried out for choosing an appropriate technology. Life cycle costs were calculated for all the treatment technology options and UASB followed by Aerated Lagoons was found to have the least life cycle cost and is hence, recommended for Mastemau STP. Chlorination is proposed to meet the microbial quality of effluent standards. Irrigation canal is to be provided to utilise treated water. Further, exclusive power line is to be provided to avoid power cuts.

- UASB followed by Aerated Lagoon (AL) and Chlorination
- Capacity of 100 mld for 2015
- Sludge drying beds
- Irrigation canal
- Exclusive power line

(4) Project Cost Estimation and Implementation Schedule

1) Capital Cost Estimation of the Priority Projects

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated using Lucknow rates on the basis of Delhi Schedule of Rates taking localities and deflator into account. Furthermore, prices of items such as sewer pipes, reinforcing steel bars, manhole covers and so on that are not found in UPJN Schedule

or DSR are obtained by quotation. The following are cost estimation conditions for physical contingencies, engineering and project administration. The abstract of the capital cost is shown in Table 4.7.

- Physical contingencies: 5% of capital cost
- Engineering costs (detailed design (6%) and project management (5%)): 11 % of capital cost
- Project administration: 5 %

2) Implementation Programme

The implementation programme for the priority projects has been prepared assuming following conditions.

- Preparation of detailed project reports and tender documents for project component shall be completed within 2006 and 2007.
- Actual execution of various priority project components shall start from 2008.
- During execution, various project components shall be executed in parallel.
- UPJN, Lucknow, will acquire 100 % of the land required for construction of proposed sewage treatment plants and pumping stations before the commencement of tendering.

The implementation schedule of the total project works and the year-wise fund flow requirement is presented in Table 4.8.

3) Operation & Maintenance Cost Estimation

The O&M costs for sewers, pumping stations and sewage treatment plants including existing, sanctioned and proposed facilities for 2015 are estimated based on following two cases in terms of power supply conditions.

- Operation by power from grid (24 hours a day)
- Operation by power from grid (20 hours a day) and diesel (4 hours)

The estimated annual O&M costs for all major facilities for 2015 is summarised in the following table.

Table 4.6 Summary of Annual O&M Costs for 2015
(1,000 Rs./year)

Facility	Case-1 Grid Power Supply	Case-2 Grid Power Supply Supplemented by Diesel
(1) Sewers and Rising Mains	43,499	43,499
(2) Pumping Stations	192,253	281,269
(3) Sewage Treatment Plants	99,071	99,071
Total	**334,823**	**423,839**

Table 4.7 Summary of Preliminary Project Costs (Lucknow)

	Sewerage District	Capital Cost (Rs.)	Contingencies	Detailed Design	Supervision	Project Adminisrtation	Total Cost (Rs.)	Land Acquisition (Rs.)	Total Project Cost (Rs.)
			5%	6%	5%	5%			
SEWERAGE SCHEMES									
Construction / Replacement of Trunk Sewer									
Trans Gomti Trunk Sewer	III	97,768,000	4,888,000	5,866,000	4,888,000	4,888,000	118,298,000		118,298,000
CIS Gomti Relief Trunk Sewer	IV	444,132,000	22,207,000	26,648,000	22,207,000	22,207,000	537,401,000		537,401,000
Sultanpur Road Trunk Sewer	IV	421,879,000	21,094,000	25,313,000	21,094,000	21,094,000	510,474,000		510,474,000
Construction of Sewerage Pumping Station					0				
Rising Main of Mohan Meakin SPS	III	13,709,000	685,000	823,000	685,000	685,000	16,587,000		16,587,000
Martin Purwa MPS and Rising Main	IV	200,977,000	10,049,000	12,059,000	10,049,000	10,049,000	243,183,000	34,000,000	277,183,000
TSPS at Mastemau STP	IV	372,532,000	18,627,000	22,352,000	18,627,000	18,627,000	450,765,000		450,765,000
Construction of Sewerage Treatment Plant					0				
Mastemau STP (include irrigation channel)	IV	453,075,000	22,654,000	27,185,000	22,654,000	22,654,000	548,222,000	173,320,000	721,542,000
Rehabilitation of CIS Gomti Trunk Sewer					0				
Desilting, Detailed Investigation	IV	74,760,000	3,738,000	4,486,000	3,738,000	3,738,000	90,460,000		90,460,000
Rehabilitation	IV	346,949,000	17,347,000	20,817,000	17,347,000	17,347,000	419,807,000		419,807,000
Rehabilitation of Existing Pumping Station					0				
Trans Gomti SPS	III	70,374,000	3,519,000	4,222,000	3,519,000	3,519,000	85,153,000		85,153,000
CIS Gomti SPS	IV	71,664,000	3,583,000	4,300,000	3,583,000	3,583,000	86,713,000		86,713,000
Total		2,567,819,000	128,391,000	154,071,000	128,391,000	128,391,000	3,107,063,000	207,320,000	3,314,383,000

Table 4.8 Preliminary Implementation Schedule (Lucknow)

(Unit:)Rs. (Unit: Rs.)

	Capital Cost	Detailed Design Cost	Total Project Cost	2007	2008	2009	2010	2011	2012
				Capital and Detailed Design Cost Schedule					
Construction of Trunk Sewer									
Trans Gomti Relief Sewer	97,768,000	5,866,000	118,298,000	5,866,000	19,554,000	19,554,000	19,554,000	29,330,000	9,776,000
CIS Gomti Relief Trunk Sewer	444,132,000	26,648,000	537,401,000	26,648,000	88,826,000	88,826,000	88,826,000	133,240,000	44,414,000
Sultanpur Road Trunk Sewer	421,879,000	25,313,000	510,474,000	25,313,000	84,376,000	84,376,000	84,376,000	126,564,000	42,187,000
Construction of Sewerage Pumping Station									
Rising Main of Mohan Meakin SPS	13,709,000	823,000	16,587,000				823,000	6,855,000	6,854,000
Martin Purwa MPS and Rising Main	200,977,000	12,059,000	277,183,000	12,059,000	40,195,000	40,195,000	40,195,000	60,293,000	20,099,000
TSPS at Mastemau STP	372,532,000	22,352,000	450,765,000	22,352,000	74,506,000	74,506,000	74,506,000	111,760,000	37,254,000
Construction of Sewerage Treatment Plant									
Mastemau STP	453,075,000	27,185,000	721,542,000	27,185,000	90,615,000	90,615,000	90,615,000	135,923,000	45,307,000
Rehabilitation of CIS Gomti Trunk Sewer									
Detailed Investigation	74,760,000	4,486,000	90,460,000	4,486,000	74,760,000				
Sewer desilting, flow diversion and rehabilitation	346,949,000	20,817,000	419,807,000			20,817,000	115,650,000	115,650,000	115,649,000
Rehabiltation of Existing Pumping Station									
Trans Gomti SPS	70,374,000	4,222,000	85,153,000	4,222,000	35,187,000	35,187,000			
CIS Gomti SPS	71,664,000	4,300,000	86,713,000	4,300,000	35,832,000	35,832,000			
Total	2,567,819,000	154,071,000	3,314,383,000	132,431,000	543,851,000	489,908,000	514,545,000	719,615,000	321,540,000

(Unit:million Rs.)

Items	Total Project Cost	2007	2008	2008	2009	2009	2010
Capital Cost	2,567.82	0.00	543.85	469.09	513.72	719.62	321.54
Detailed Design Cost	154.07	132.43	0.00	20.82	0.82	0.00	0.00
Contingencies	128.39	0.00	27.19	23.45	25.69	35.98	16.08
Supervision	128.39	0.00	27.19	23.45	25.69	35.98	16.08
ProjectAdmin	128.39	0.00	27.19	23.45	25.69	35.98	16.08
Total Cost	3,107.06	132.43	625.42	560.26	591.61	827.56	369.78
Land Acquisition	207.32	207.32	0.00	0.00	0.00	0.00	0.00
Total	3,314.38	339.75	625.42	560.26	591.61	827.56	369.78

Detaied Design
Construction Cost

4.2.2 Environmental Impact Assessment

(1) Justification of the Project

Lucknow city's population is projected to double from 2.5 million in 2003 to 5.4 million by 2030. At present the total domestic wastewater load is about 365 mld vs. an installed treatment capacity of 42 mld. The amount of wastewater collected and diverted to treatment represents just over 10% of the total amount generated. Remaining wastewater is discharged in to Gomti river through open drains. The two largest drains are GH Canal and Kukrail nala.

Sanitation services are inadequate for city's present population. The sewer infrastructure is old, and poorly maintained. Many of the existing trunk sewers do not have sufficient hydraulic capacity for projected wastewater loads. New colonies are coming up from where wastewater goes either to old trunk sewer or directly to river through natural drains. In fact, the regular sewer system is lacking. Keeping in view the growth, a sound master plan for disposal and treatment of wastewater and its implementation is urgently required.

(2) Positive Benefits

Project benefits of the sewerage and pollution control projects is to ameliorate overall development and betterment of public health and hygiene coupled with upgradation of environmental management in the target project area through abatement of pollution; improvement of public health and aesthetics leading to improvement in quality of living and inducing economic growth.

(3) Key Impacts Identified and Mitigation

The overall identification of the negative impacts has been done by using a matrix table (Master Plan). As identified in the table, all the possible key negative impacts are associated with construction and operation of STP. The following key impacts are identified.

- Resettlement and economic activities due to the land acquisition
- Landscape change due to construction of STP
- Groundwater, surface water and soil contamination due to discharge of treated sewage that is not properly treated in STP and usage of dried sludge
- Odour problems due to operation

In addition to negative impacts in construction and operation phase, contingent impact or risks have been analysed. The identified risk of the project is disruption of power supply. In the city, power supply cut does occur, which causes breaking down of operation of STP and PSs.

1) Sewage Treatment Plant (Construction Phase)

The key potential impacts of construction phase of STP are loss of village houses, agricultural land and few trees and such impacts are long term. The other impacts of construction phase will be small in magnitude because of temporary nature and are expected to decrease gradually once the construction activity is completed.

a) Landscape Change (Visual Impacts)

Impacts

The construction of STP will alter landscape and change the land use of the area. The visual impacts at the construction site would be unaesthetic for the villagers.

Mitigation Measures

To minimise visual impacts and landscape change, provision of open space and plantation of trees in the surrounding area of the STP site is recommended. Plantation of trees in the open spaces would provide a visual comfort.

b) Land Acquisition

Impacts

The proposed Mastemau STP requires 70 ha. The resettlement is avoided by selecting appropriate site without displacement of villages, and 70 ha for the STP will be acquired in agricultural land. The STP site is located in Mastemau and Bakkas villages and the information of land owners has been collected during the field visit as shown in table below.

STP	Land use	Name of village	No. of land owners affected
Mastemau STP (70 ha)	Agricultural land	Mastemau	79
		Bakkas	60

Mitigation Measures

- Minimisation or avoidance of village displacement

As stated in the impacts, the site for the STP has been properly selected and no village displacement will occur.

- Appropriate Compensation

Land is normally acquired under the provisions of the Land Acquisition Act, 1894 that is general and basic law in the country for the acquisition of land for public purposes and companies. This Act was comprehensively amended in the year 1984, taking into consideration the recommendations of the Law Commission, the Land Acquisition Review Committee.

There are two types of compensation. Monetary compensation has to be provided to direct Project Affected Persons (PAPs) if their houses have to be acquired and demolished. It has to be provided also to indirect PAPs for their agricultural land to be acquired. Alternate land has to be provided to displaced persons for their resettlement. If land for resettlement can not be provided or PAPs are not willing to resettle in the new resettlement site, then monetary compensation has to be provided to direct PAPs for their homestead (i.e. residential) land to be acquired.

c) Socio-cultural Environment

Impacts

The proposed site does not have any national monuments / national parks / reserve forests. However, a small temple is located in the proposed STP sites at Mastemau (Lucknow).

Mitigation Measures

This aspect has been studied carefully while designing the layout of the STP. The boundary

of the STP has been drawn up such that the temple lies outside the proposed STP campus.

2) Sewage Treatment Plant (Operational Phase)

Overall, the predicted adverse impacts during the operational phase will be minor as compared to the construction phase. During the operation phase all the beneficial impacts of the project will be realised.

However, treatment works will not perform satisfactorily unless they are operated and maintained properly. Malfunctioning of the system would pose risks of health hazards. Hence, this system should be operated and maintained properly by trained technicians. Following preventive measures should be adopted:

- Provision of two power supply lines
- Provision of generator sets at sewage treatment site
- Provision of diesel for the generator sets
- All spare parts should be readily available in case of emergency
- Provision of adequate maintenance staff with accessories
- Regular training of system staff, skilled technicians and craftsmen
- Proper operating budgets and attractive salaries

a) Ground Water Quality

Impacts

The potential source of ground water contamination would be of three kinds; percolation of wastewater from the bed of the STP, percolation from the canal where treated effluent will be discharged and percolation from the agricultural land where wastewater is applied.

Wastewater in the aerated lagoon, which will be basically water-tight, may percolate through the underlain soil layer by seepage and pollute the ground water table of the nearest unconfined upper aquifer. These aquifers are connected with a number of open wells from which nearby villagers draw water for drinking and other purposes. There is some possibility that the aquifer is contaminated by partly treated wastewater.

Mitigation Measures

First and foremost, care should be taken to ensure adequate treatment to meet the discharge standards.

It has been planned that the aerated lagoon and treated water channel is lined with waterproof material to avoid seepage of wastewater in the lagoon into the soil and thus contamination of ground water.

It has also been planned that chlorination facility will be installed in proposed STP and therefore any bacterial contamination will not occur in the irrigation canal and through land application of treated effluent. If the STP is well functioned and wastewater is appropriately treated, the groundwater in the aquifer is remote from any contamination. Removal of pathogens is the prime objective in treating wastewater for re-use.

b) Treated Effluent Use

Impacts

The treated effluent from the proposed STP will be discharged into the river and/or irrigation canal. This effluent would be rich in phosphate and nitrate and therefore contribute increased fertility of the agricultural land and increased area of irrigated land. This would be a positive impact to the nearby villagers.

The effluent quality of the proposed STP will comply with the national standards and thus no negative impact is foreseen on Gomti river or the proposed canal. However, the project has to be aware of the following impacts as well.

If a large concentration of inorganic salts or the metals are contained in the treated effluent, it will eventually affect the growth of the crops.

Toxic substances such as heavy metals that might be present in the irrigation water stay as alimentation in the soil and then absorbed into vegetation. Taking in such vegetables might harm human health.

Quality of soil governs the pattern and quality of the vegetation. The different heavy metals in the treated effluent will be adsorbed by the soil grains, which may affect the vegetation and crop quality. This may lead to a negative impact to the soil.

Insoluble inorganics make soil more firm, and obstruct absorption of water. And excess organics in irrigation water may give direct effect to the cultivated land, and indirect effect as abnormal growth due to lack of oxygen in the water. This eventually gives negative influences to vegetation.

Mitigation Measures

As it is proposed that the treated wastewater of proposed STP may be reused for irrigation purposes, treated wastewater should meet the required standards for irrigation re-use. Also treated water quality should be monitored carefully so as to meet the discharge standards effectively.

With regard to application of sewage for land farming the ‘Manual on Sewerage and Sewage Treatment’, CPHEEO, Ministry of Urban Development, Govt. of India, provides guidelines on characteristics of irrigation waters. These include conductivity, salinity, sodium absorption ratio, chlorides, boron, etc. In addition, the manual provides maximum permissible concentrations of toxic heavy metal, etc.

c) Sludge production and disposal

Impacts

The sludge production will be to the tune of several tens ton/day from the STP. It will be dried on the sludge drying beds. During the drying process, there will be nuisance of insects and odour around the sludge drying beds.

The dried sludge may be given or sold to farmers as manure if it could be handled properly by them. The value of sludge as an organic fertilizer has long been recognized and this offers reduced fertilizer costs to the farmer. Besides, the dry sludge will be disposed of in specified landfill sites.

Mitigation Measures

The sludge from the STP should be disposed of in an environmentally acceptable manner. The sludge should be dewatered in sludge drying beds and the dried sludge is proposed to be used as fertilizer in the nearby agricultural lands since it is biological in nature and has soil quality enhancing properties.

Nuisance of insects can be minimised by spraying insecticides on sludge drying beds, also by proper maintenance of sludge drying beds and proper drainage. The precautions should be taken in handling and disposal of the sludge.

Monitoring of the quality of the sludge is required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials.

The effectiveness of the sludge production for agricultural/vegetation use is not constant to any crops. Use of the sludge production at the region must be done with soil observation of its effect to avoid negative effects to crops. After the observation period, recommended method of the use should be established and educated to the local farmers. Parameters of soil observation monitored are Zinc, Copper, Total Carbon, Total Nitrogen, Phosphate and pH.

Use of the sludge product must be done strictly under the continuous monitoring of sludge product's contents especially the toxic substances.

d) Odour Production

Impacts

There is a possibility of bad odour in the case of UASB reactors and sludge drying beds proposed at the site of Mastemau, if the STP is not properly operated / maintained.

Mitigation Measures

To mitigate this, the width of peripheral green belt at Mastemau STP site has been increased. All required pollution prevention measures should be considered and implemented. Besides, the normal mitigation measures about dried sludge shall be taken to minimise odour problems although the impact is minimal in the STP that is located in remote area.

(4) Analysis of Alternatives

Different treatment processes are available for biodegradation of organic material present in domestic wastewater. Individual treatment process has its own limitation and advantage in terms of land requirement, environmental impacts, power consumption and operation and maintenance.

Several treatment processes have been selected for detailed evaluation before finalising the suitable one that would be environmentally, technically and financially viable option. A treatment technology of UASB followed by Aerated Lagoon (AL) and Chlorination has been selected for the Mastemau STP. The major constraints in comparison are land availability and operation and maintenance cost.

(5) Contingency Impacts and Mitigation

1) Contingency and Risk

The major risks that can result in breakdowns and disruptions are described below.

Power Supply

One of the main reasons for disruption during the operation phase of the treatment works is power cuts.

It is recommended that the new treatment plants and pumping stations receive their power supply through dedicated feeders from two different power sources. It is also suggested that standby power generators are provided to ensure at least minimum services in case of prolonged power cuts, and also that cost of diesel be built into the O&M costs. Also the sewage treatment technology chosen should be able to survive short spells of power cuts.

Electric & Mechanical Equipment Disruptions

Operational disruption due to E&M equipment can be avoided by proper preventive maintenance activities and provision of adequate spare parts and stand-by equipment. O&M manuals should be available in the treatment plant with training of the operation staff for the new plant.

2) Contingency Measures Plan

Contingency measures plans have been prepared for:

(i) sewage treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (i.e. maintenance, etc. or breakdown);
(ii) discharge of sub-standard wastewater into the environment from treatment plant which could cause a significant public health impact, and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.
(iii) accidents which may occur while laying sewers or during construction of the treatment works;

(6) Environmental Management Plan

The success of the Environmental Mitigation Plan depends on the efficiency of the organisational set up responsible for the implementation of the programme.

For a sanitation project of this magnitude, the Environmental Management Plan needs to be entrusted, in both the construction and the operation phases, to an Environmental Management Cell (EMC), and regular monitoring of various environmental parameters is also necessary to evaluate the effectiveness of the management programme so that necessary corrective measures could be taken in case there are some drawbacks in the proposed programme. Thus, the Environmental Management Plan will consist of:

- Setting up an EMC to implement the mitigation measures in operation phase,
- Ensuring proper operation and maintenance of the treatment works,
- Ensuring proper maintenance of the sludge drying beds and the disposal of dry chemical sludge in a proper landfill site,
- Monitoring the waste and treated water quality,
- Monitoring the built in pollution control equipment, for vehicles and equipment, and
- Maintaining tree plantations around the pumping stations and the periphery of the sewage treatment plant.

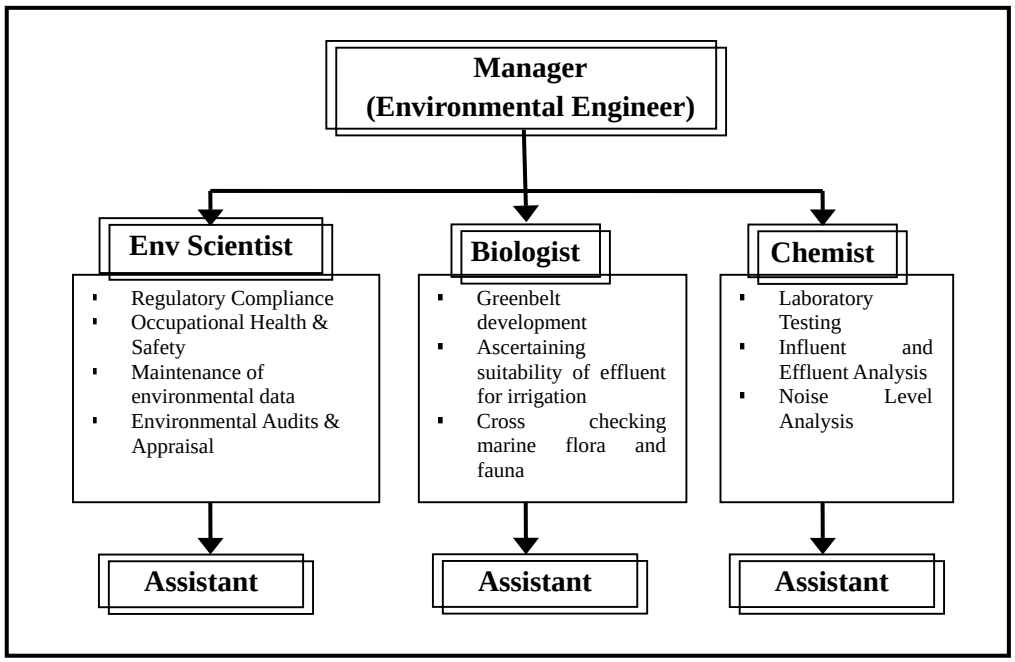
(7) Environmental Management Cell (EMC)

The Environmental Management Cell will be part of the staff in charge of the operation and maintenance of the sewerage works, since the laboratory will be housed at the treatment plant site. But this staff will be in charge of the overall management of the environmental aspects of the Sanitation

Project.

Under the supervision of an Environmental Engineer, the EMC will comprise an Environmental Scientist, a Chemist and a Biologist, plus three assistants, as shown in the following organisation chart. The main functions of the EMC will be:

- Collecting water, air, soil and sludge samples,
- Analysing the samples collected or getting analysis done from outside sources,
- Preparing and updating a database of environmental parameters,
- Implementing the environmental control and protective measures,
- Controlling the sludge treatment, disposal and re-use,
- Collecting statistics of health of workers and the population of surrounding areas,
- Ensuring the development and maintenance of the green belts,
- Monitoring the progress of implementation of Environmental Management Programme,
- Co-coordinating the environment related activities within the project as well as with outside agencies.



(8) Monitoring Plan

To evaluate the effectiveness of the Environmental Management Plan, regular monitoring of the important environmental parameters as follows will be taken up by UPJN/JS in environmental testing laboratory.

1) Water quality
2) Air quality and odour
3) Noise
4) Green belt and compensatory plantation

(9) Environmental Training

The environmental monitoring plan will be successful only if trained and skilled staff implements it. The training of the qualified staff should be necessary not only in day-to-day operation and maintenance of the treatment plant, but also in environmental aspects.

It will be essential to involve the staff that will be responsible for the execution of the Environmental Management Plan, in the construction phase, as well as to train the staff in practicing the mitigation actions and the day to day monitoring programmed during the operation phase. The training should include:

- Basic concepts of pollution control techniques in the various methods of sewage treatment,
- Operation and maintenance of the sewage treatment plant,
- Emergency preparedness to handle adverse situations,
- Principles of wastewater analysis,
- Other environmental monitoring techniques,
- Development of green belt and its maintenance,
- Sewage farming, and
- Communication with farmers and general public.

This training is different from the mandatory training required for operation and maintenance of the sewage treatment plant.

4.2.3 Non-Sewerage Scheme

(CTC Programme and Constructed Dhobighat Programme)

The objectives of this study are to formulate programmes of development/ management of Community Toilet Complexes (CTCs) and Constructed Dhobighats (DG); to assess the technical, institutional, financial and economic viability; and to assess the environmental and social soundness of the proposed programmes.

The objective of the proposed programmes is to improve slums and DGs' sanitary conditions, thus improving water quality of rivers.

The shortcomings in the operation and maintenance (O&M) of existing CTCs in slum areas and DGs are causing serious problems in proper functioning and general sanitation in the surrounding areas. O&M aspect is one of the main factors to be considered in formulating sustainable programmes of CTC and Constructed DG. Keeping this in mind and on the basis of the assessment of existing conditions of the target areas and facilities as well as the needs and demand of slum dwellers / Dhobis, the proposed programmes are formulated.

The proposed programmes adopt a needs-driven and community-driven approach in planning, implementing, operating and maintaining the facilities and suggest that the O&M is facilitated through local CBOs/SHGs or local Dhobi Associations. Implementation by this approach will make the programmes technically, financially, socially and culturally viable.

For successful implementation of the programmes, the following are required:

- Involvement and assistance of NGOs/Consultants for training and monitoring
- Regular monitoring, evaluation and feedback on the functioning of CTCs and Constructed DGs by Nagar Nigam in coordination with SUDA, DUDA and representatives of CBO/SHG.
- Appropriate implementation steps as follows to ensure involvement and training of CBOs/SHGs or Dhobi Associations:

Step 1: Needs survey of slum / Constructed DG
Step 2: Creation of CBOs/SHGs/ Dhobi Association
Step 3: Planning and designing
Step 4: Selection of location of CTC/Constructed DG including land acquisition clearance
Step 5: Construction
Step 6: Training of CBOs/SHGs/ Dhobi Association during construction
Step 7: Operation and maintenance
Step 8: Monitoring, evaluation and learning
Step 9: Feed back

Creation of a CBO/SHG for O&M of CTCs has not been attempted earlier. Therefore, it is proposed that a pilot project to manage CTC through CBO be implemented and a good model for O&M of CTC be created before implementing full-scale project. Similarly, to manage the improved or new facilities of Constructed DGs in an appropriate manner, the functioning of the existing Dhobi Associations will require improvements through a process of capacity building. This capacity building will be also tested through a pilot project. This model project can then be extended to other proposed facilities.

One of the important constraints relating to O&M is the lack of funds. To make the project financially feasible, a minimum monthly charge of Rs. 70 per household, is required to be levied along with subsidy for electricity and sludge disposal costs (where applicable) by the local bodies and part of manpower costs being provided by the community through voluntary activities. This level of user charge was assessed affordable and acceptable even for low-income communities as their willingness to participate in the project is very high. Besides, if the facilities are well maintained and kept clean the willingness to pay will improve and the project will become financially more viable.

The estimated monthly user charge per member for O&M of a Constructed DG is Rs. 35 to Rs. 92. Based on the results of the primary survey, which indicated a willingness to pay user charges up to Rs. 100 per month, the project is expected to be financially feasible.

If following factors are considered in the proposed facilities, the projects are expected to be technically feasible and would also ensure adequate O&M of the facilities.

CTCs
- Constant water supply for flushing and cleaning of water closets (seats)
- Sufficient capacity of storage tank for constant water supply
- Regular electricity for tube well and lighting

Constructed DGs
- Appropriate design and quality of construction to ensure no leakage
- Constant water supply
- Amenities (toilet, rest room, safety measure, shed, etc.)

Land availability for both CTC and Constructed DG facilities is the most critical aspect for the feasibility study. The result of a rapid survey to assess the land availability in ten of slums indicated that the land for CTC could be made available in many of the slums. These lands are mostly owned by the various Government bodies and efforts have been made to select lands without any disputes or encumbrance. However, more detailed surveys are required to decide the best location by matching the demand for CTC and the availability of land. A detailed study should be done at the detailed design stage with the help of hired NGO/Consultants and communities.

The project shall generate tangible and intangible benefits as follows:

- Environmental benefits are expressed through reduction of pollution load caused by open

defecation

- Health-related benefits include reduction of the incidence of water-borne diseases resulting from poor sanitation
- Economic benefits include productive gains, secondary economic benefits and developmental impact due to improved health and reduced health costs
- Social or equity benefits include gender, regional and income-related equity through appropriate sanitation for women and girls who are most affected by poor sanitation
- Institutional benefits are expressed to strengthen the CBO/SHGs through capacity-building

The proposed facilities and total capital costs in these programmes are summarised in the following table.

Table 4.9 Cost Estimation for Non-Sewerage Scheme (Lucknow)

Lucknow	No of Proposed Facilities	Total Cost (Rs.)
CTCs		
10 Seater	120	85,020,000
20 Seater	24	29,664,000
Sub-total	144	114,684,000
Constructed DGs		
New CDG	4	20,000,000
Improvement works	3	1,050,000
Sub-total	7	21,050,000
Total		**135,734,000**

STUDY SUMMARY FOR PROPOSED PROGRAMMES (LUCKNOW)

Community Toilet Complex (CTC) Programme in Slums	
Existing situation	• The total slum population is estimated as 1.01 million; there are 647 slums in Lucknow. • Lack of adequate sanitation facilities has led to a high incidence of water-borne diseases. • There are 143 existing CTC out of which 135 are operational • CTCs are operated and maintained by NGOs, DUDA (both through contractors) and other private contractors. • Main problems of existing CTCs – lack of cleanliness and adequate maintenance. • 26 per cent of the slum population, based on the sample survey, practice open defecation. • 32 per cent of the slum dwellers, who do not have any toilet facilities, are willing to pay Re. 1 per usage; 30 per cent are willing to pay Re. 0.50 (sample survey). • 86.2 per cent of the slum dwellers expressed willingness to participate in O&M of CTCs (sample survey).
Proposed Design Options	• A seat (water closet) is designed to be used by 30 users per day. • The maximum travel distance for a user from his or her place of residence to the CTC should be less than 500 m. • 10-seater or 20-seater CTC with required amenities are recommended. • The preferred wastewater disposal option is connecting the CTC to a sewer line; in its absence, a septic tank and soak pit is recommended.
CTCs Needs	• The total number of new CTCs was estimated on the basis of need assessment (number of persons practicing open defecation) and the percentage thereof willing to pay user charges obtained through sample survey. • Total number of new CTCs is estimated as 144; 120 nos. of 10-seater and 24 nos. of 20-seater.
Capital Costs	• Total capital cost of 144 CTCs is Rs. 114.7 million spread over 5 years.
Benefits	• Reduction in river pollution • Health and environmental benefits • Improved sanitation in slums decreases the incidence of water-borne diseases and thereby improving productivity • Women and children are the biggest beneficiaries
Recommendation	• O&M by Community-Based Organisation (CBO) or Self-Help Group (SHG) • Voluntary participation of project beneficiaries in O&M to reduce O&M costs especially the wages payable to a caretaker • Electricity costs and de-sludging (where applicable) to be covered by Nagar Nigam • Monthly user charge of Rs. 60 to 90, or a per day charge of Rs. 2 to 3 per family • Implementation of a pilot project first to create model O&M through CBO/SHG • Training centre for O&M to provide hand-on training to the members of the CBO, and facilitate extension of the model project to full-scale • Need assessment for CTCs to be conducted for each location at the time of commencement of the project
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, CBOs/SHGs • Participation of member(s) of CBO/SHG in construction supervision • Day to day O&M by CBOs/SHGs comprising members of the community benefiting from the project

Constructed Dhobighats (CDG) Programme	
Existing situation	• 13 traditional riverside Dhobighats and 3 Constructed Dhobighats • About 960 Dhobis use traditional river-side ghats • Dhobis satisfied with existing CDG, but want improvement in amenities • Chemicals used by Dhobis include detergents, solvents, bleaching agents, dyes etc.; high incidence of skin diseases • High willingness among Dhobis to participate in O&M of CDG • The existing CDG are being managed by respective Dhobi Associations • Current O&M not satisfactory; problems related to leakages, broken pumps, poor sanitation conditions etc.
Proposed Design Options	• One cubicle is required for 6 washer-men; 3 shifts in a day and each washer-man use the ghat once in 2 days. • It is desirable that a washer-man is not required to travel more than 2 km from his residence • As for wastewater disposal, sewer connection is preferred but if unavailable open drain connection is selected and the latter is being tapped for diverting the wastewater to treatment plant. • No on-site treatment is recommended since high capital and operation & maintenance costs and the complicated process of treatment and considering current power supply situation in the city.
Needs of Constructed Dhobighat	• 4 new Dhobighats, each with 50 cubicles, proposed • Improvement of existing 3 CDG
Project Costs	• The total capital cost is estimated to be Rs. 21 million.
Benefits	• Reduction in river pollution • Health and environmental benefits • This project shall ensure access of quality services to the affected communities • Properly designed facility will reduce the incidence of diseases among the Dhobis thus enabling them to work for greater number of days (improved productivity) • Capacity building and training to Dhobi Associations
Recommendation	• O&M by Dhobi Associations; capacity building necessary in existing ones • Monthly user charge of Rs. 35 to 90 per member, depending on percentage of usage and number of cubicles in the CDG, to provide coverage for O&M costs be collected for adequate O&M of facilities. • Implementation of a pilot project first to create model O&M through CBO/SHG
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, Dhobi Associations • Participation of member(s) of Dhobi Association in construction supervision • Day to day O&M by Dhobi Association

4.2.4 Public Participation and Awareness

(1) General

For the sound operation and maintenance of sanitation facilities at city scale, generally, 'Public Participation' is indispensable. The construction and operation of such systems alone will not attain desired improvement in environmental sanitation, public health, surrounding environment and abatement of pollution of river water bodies. Therefore, greater public awareness on the health and environmental impacts, importance of those systems and facilities among communities, and the encouragement of their positive participation in the share of the obligation is essential. This would help work out problems related to operation and maintenance and long-term sustenance of these systems and facilities.

Therefore, in this study, the JICA Study Team has:

1. Proposed the elaborated programmes on related activities and campaigns to promote public participation and heighten public awareness (PP/PA).
2. Analysed the existing formal and informal institutions in these cities that participate/had been participating in PP/PA programmes and suggested an institutional framework for successful implementation.

This is based on participatory techniques and the concept of the 'hygiene education', which has been prepared in the Master Plan and specifically responds to each event proposed in the Feasibility Studies in the four cities. Within this framework the programmes have been designed into two sets. Set I addresses the proposed priority projects and set II comprises regular activities to follow the hygiene education concept. The end achievable of these sets is to generate willingness to pay for the facilities and create awareness to a level that people participate for a cleaner river.

Whereas Varanasi and Allahabad are very religious and have emotional linking to the river, Kanpur and Lucknow are more urbanised. These and other distinctive characters and target groups for the four cities have been analysed and their flavour adequately addressed in the programmes.

(2) Programmes

Set I describes the necessary programmes that have to be undertaken in accordance to the timings of the projects (sewerage and non-sewerage). These include:

Committee (SPC) Meetings	To monitor the progress of work on PP/PA (once in every month)
Necessary Publicity Programmes	To advertise widely the information on the projects through the mass media and printed materials to general public
Necessary Explanatory Meetings	To discuss with communities and stakeholders about PP/PA activities
Demonstration Programmes	In accordance with the priority projects of sewerage and non-sewerage works, demonstration programmes shall be launched

Set II includes programmes that run parallel to the first set and shall communicate the ideas on health, sanitation and better living environment in accordance with the hygiene education concept in the M/P. The programmes shall broadly constitute:

Entry point Activities	To build a platform for initiating the programmes
Regular Publicity	To keep the message fresh in the minds of the people
Yearly Campaign	A yearly campaign should be implemented in accordance with public participatory approach and the stepwise planning as discussed in Master Plan
Clean River Day and Clean River Week	To raise the awareness on river cleaning
Regular activities in slums and Dhobighats	To formulate the community-based organisation for O&M of the facilities created.

Further for ground implementation communication tools and communication activities have been detailed. A mix of all the activities and tools shall constitute a programme and the appropriate mix shall be selected by the implementing agency as per the guidelines given in the TOR and budgetary allocations that have been made.

Communication Tools

1) Media	**Contents**
Press	Press Conferences, Press Releases, Articles, Advertisements
Television	Talk Shows, Advertisements, News
Other Publicity Materials	Hoardings, Banners, Posters, Pamphlets, Hot Air Balloons
2) Other Means	
Theme Plays, School Programmes, Information Kiosks, Power Point Presentations, Documentary Films, Information Van, Site Visits, Shram Dan	

Summary of Activities for Communication

Communication Activities	**Intended Target population**
Focus Group Discussions (FGDs)	Lawyers, Doctors, Professors, Religious Leaders, Political Personalities, Municipal Officers, RA's and other Professionals
Transect walks/Padyatras	Women and Youth
Workshops	Beneficiaries and future beneficiaries of priority projects
Swasthya Mela in city	General Public encouraging women in particular.
Health Camp for slums	Slum community
School Programmes	School Children
Programmes for women	Women
Information Mela	Beneficiaries and future beneficiaries of priority projects
Competitive Programmes	Clubs, industry houses, hotels, private hospitals

(3) Implementation Structure

In the institutional front after analysing the institutional structures it is felt that there is no structure at present that takes care of the PP/PA activities in the state or the city. Therefore, for implementing the works Health Officer in the Nagar Nigam will be the main authority answerable to the Municipal Commissioner and provided with additional technical staff to support on the programme. This addition of technical staff is very important because at present the Nagar Nigam does not have a qualified person to deal with the PP/PA issues and monitor its progress.

The hierarchy of the implementation structure is as explained in Figure 4.2. The emphasis at the implementation level shall be on the Nagar Nigams of the four cities.

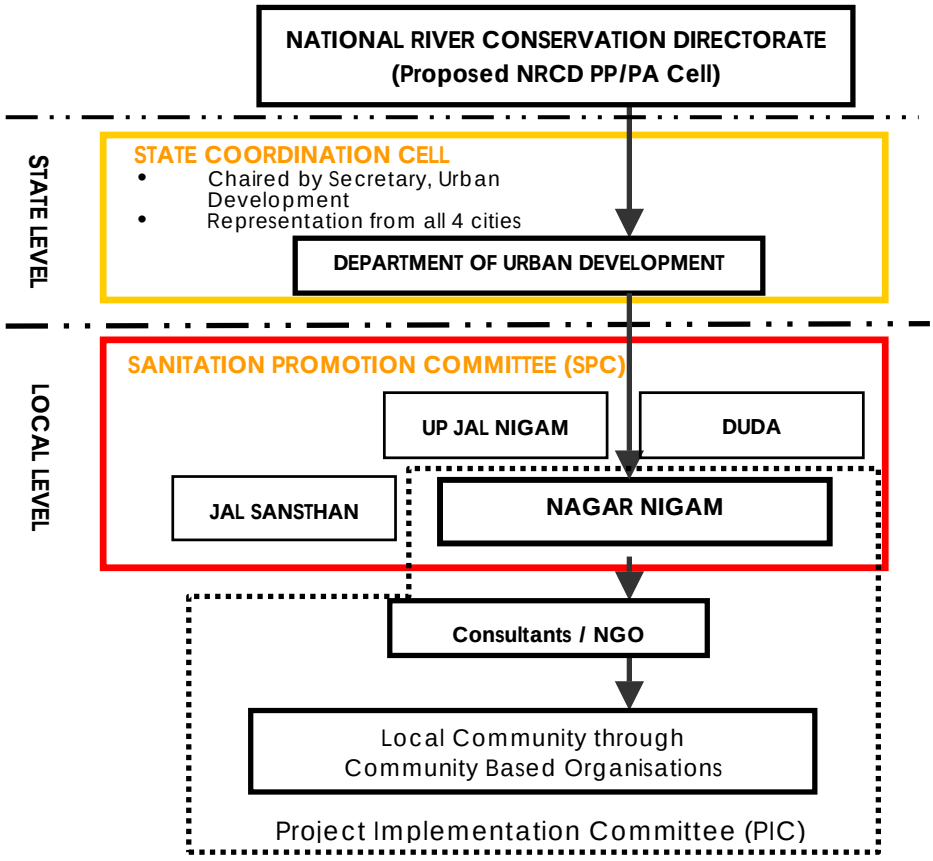


Figure 4.2 Proposed Organisational Structure of the Implementing Agency

(4) Monitoring and Evaluation

There will be two parallel monitoring and evaluation structures for the entire PP/PA programme:

i) Implementing Agency - Prepare reports on the progress of work based on monthly reports from the local consultant and send to NRCD PP/PA Cell (NPPAC).

ii) Community - On the people's side the groups of communities (ward committees and the citizens committee in each city) will report to Project Implementation Committee (PIC) and PIC will report to State Co-ordination Cell. These reports will be sent on quarterly basis.

Such a system will ensure that a check is maintained on the works that are being undertaken and the budgets allocated are utilised properly. Evaluation of Programme will be done in the regular State Co-ordination Cell meetings and once a year evaluation reports are a must.

For the purpose of evaluation, a set of Impact Indicators shall be developed by the local consultant that henceforth shall be circulated to the PIC, NN and the local groups who all shall rate the programmes. The essential function of the impact indicators is to evaluate the effectiveness of PP/PA programmes.

- Operational – Measure information provision, feasibility, and duplicity of each
- Effect – Direct and indirect influences

On the basis of reports and evaluation of the PP/PA Programme, necessary changes in the content and direction of the programme will be made, if required, to make it more effective.

(5) Project Costs

Table 4.10 Cost Estimation for PP/PA (Lucknow)

(Rs.)

Items	Lucknow
Activities SET I	1,104,000
Activities SET II	33,507,000
Fixed Costs (Equipments for NN)	3,810,000
Administrative Activity	14,335,000
Total	**52,756,000**

4.2.5 Operation & Maintenance and Institutional Development Programme

(1) Management Responsibility for Environmental Public Services

The major administrative units that are closely related to water quality management under GAP present hierarchic tiers of the national, the state (Uttar Pradesh State Government) and the municipal levels of organisations. There are two major groups of organisations: One group including Development Authority and Nagar Nigam is associated with urban development and the second group including UP Jal Nigam and UP Pollution Control Board is associated with environmental conservation and pollution control. Both groups are administratively separate entities butcoordination amongst these organisations is vital for implementation of NRCP activities.

The division of responsibilities amongst local and state organisations, for development and maintenance of sewerage collection and treatment systems is summarised as follows:

Table 4.11 Management Responsibilities for Environmental Public Services

Management Responsibility	Organisation	Functions
• Master planning	UPJN	• Physical infrastructure (water supply, sewerage and pollution control) • Capacity and location of facilities
	DA	• Spatial arrangement • Land use • Population projections
	UPJS	• Physical infrastructure for water supply facilities • Capacity and location of facilities (water supply)
• Design and construction	UPJN	• Sewerage infrastructure for river pollution abatement Action Plans. • Water supply and sewerage infrastructure for urban development
	DA	• Infrastructure for new development areas
	HDB	• Infrastructure for state housing developments
• Operation and maintenance	UPJN	• Trunks sewers • Interception and treatment works • Storm water pumping stations • Compliance with environmental regulations
	NN	• Storm water drains • Solid waste disposal
	JS	• Sewers and pumping stations • Water supply treatment and distribution works
• Pollution control and monitoring	UPPCB	• Monitoring and preventing entry of polluted wastewater (if they do not meet discharge standards) into nalas and rivers. • Regulating industries

Currently, sewerage facilities are planned, constructed and maintained by many parties without

effective coordination. UP Jal Nigam is constructing interception and diversion facilities and sewage treatment plants (downstream facilities) to improve river water quality and Urban Development Agency, Housing and Development Board and Development Authorities is constructing branch sewers (upstream facilities) as and while they develop new urban areas and housing complexes.

Jal Sansthans as well as Nagar Nigams are legally responsible for the sewerage service but they are, in practice, doing only maintenance of the upstream facilities as long as the funds are available. The downstream facilities are operated and maintained by UP Jal Nigam.

Various parts of the sewerage system are constructed, operated and maintained by various organisations for various purposes different from each other. The existing sewerage system has neither been planned, envisaged nor conceived as an integrated one. As a result, inefficient facilities have been constructed and maintained insufficiently without a definite ownership.

(2) Key Issues

There are several institutional and financial weaknesses that adversely affect the quality and extent of sewer coverage as well as ability to provide adequate operation and maintenance. The key issue are summarised as follows:

1) No master plans for urban infrastructure

There is no master planning for physical infrastructure. The absence of a master plan leads to the fragmented and uncoordinated implementation of infrastructure by several implementing agencies, each fulfilling their immediate short-term objectives. As a result several schemes cannot be integrated into the main trunk sewer network.

2) Lack of single point responsibility

Several implementing agencies at state and local levels are developing land and infrastructure in the city. Their efforts are not well coordinated, especially in the absence of a master plan. Although taxes and water charges are collected at the local level, accountability to the citizens for sewerage and drainage problems is obscured by the lack of single point responsibility. Similarly, accountability for achieving water quality objectives is unclear.

3) Insufficient revenue for O&M

Municipal Corporations have the power to implement a tax for water, and a separate sewer/drainage tax. These taxes are based on the annual rental value of the property, which does not reflect the real value of the property. Municipal Corporations also collect revenue from the sale of water through their Jal Sansthans; however the State Government controls the water tariff. Municipal Corporations are allowed to pool all sources of revenue to finance maintenance and development of municipal infrastructure. The revenues are at present insufficient to cover O&M costs.

UPJN has no such source of revenue. It depends on state funding to operate and maintain facilities. At present, local Jal Sansthans are expected to operate all new assets created by other implementing agencies however they do not in general have the required financial or human resources. As a result most Jal Sansthans have refused to accept responsibility for O&M of assets created by UP Jal Nigam.

(3) Improvement of Operation and Maintenance

1) Current O&M Status

The current maintenance practices are reactive rather than preventive and routine as per manual. Most

of the maintenance is carried out in response to customer complaints related to overflows etc. These problems are normally resolved by clearance of blockages in the sewer. There is no evidence of a planned regime of cleaning or inspection of the system. Any repairs to the system arise from problems noted during blockage clearance or from customer complaints. Besides this, record keeping is highly limited and in some cases even inaccurate.

From discussions and site visits, it could be stated that maintenance management (for sewerage as well as for water supply) is undertaken on an ad hoc basis. Site work is not always carried out in an organised way. Indeed, at some of the sites, it was not very clear, who was the in-charge official(s). Working practices observed were not in accordance with The Manual on Sewerage and Sewage Treatment (i.e. The Manual on Sewerage and Sewage Treatment, Second Edition prepared by the Expert Committee constituted by the Ministry of Urban Development, Government of India, and published in 1995). During maintenance works, the safety was either non-existent or of very poor quality.

2) Collection System O&M improvements required

Ideally all elements of a sewerage system should receive the highest levels of maintenance to ensure its performance. However, this is an unrealistic aspiration for any sewerage authority to contemplate.

There are three broad policy options:
- Purely reactive
- Totally planned
- Selective planned/reactive

A more appropriate and cost-effective approach is to achieve a balance between planned and reactive maintenance in providing an acceptable and reasonable level of service.

Many parts of a sewer system operate quite satisfactorily with minimum maintenance. The key to a cost effective maintenance strategy is the recognition that maintenance and rehabilitation programmes should retain as much as is practicable of the existing network by a combination of optimising hydraulic performance and the use of renovation. Therefore regular inspection and assessment is required to identify those elements of the sewer system that will require attention on a regular and planned basis. Elsewhere the sewers only need to be dealt with on a reactive basis.

<u>Immediate priorities</u>

- Establish System Records and Maps

  There is an immediate need to collect and to store centrally all existing records of the sewerage network by setting up a comprehensive computerised database at the local level. This database is typically referred to as a sewer inventory.

- Inspect Critical Sewers and Assess Conditions

  A comprehensive survey of critical sewers is required in order to:
  - Develop the sewer inventory data
  - Assess the physical condition of sewers
  - Identify critical sewers and priorities
  - Identify maintenance, rehabilitation or replacement needs

- Upgrade Pumping Stations O&M Procedures

The primary objective of operating and maintaining a pump station is to keep the station in continuous operation in order to prevent sewage overflows to the environment and flooding in upstream reaches of the incoming sewers. The following activities are critical to the successful operation of pumping stations:

- Developing equipment operation and maintenance manuals
- Developing procedures for normal, abnormal, and emergency conditions
- Developing systems for recording daily operating conditions
- Establishing systems for recording equipment maintenance and breakdown history

Long term needs

Long-term measures in line with standard international practices are given in the main report and need to be integrated into a long-term maintenance programme, summarised in the table below:

Table 4.12 Outline of Sewerage Maintenance Programme

Type of activity	Description
Sewer inventory	GIS base maps, data collection, updating
Sewer survey and inspection	Cleaning, CCTV inspection, assess condition, identify critical sewers
Routine inspection & cleaning	Follow-up routine cleaning, CCTV survey
Emergency blockage clearance	Sewer clearance
Sewer & manhole repairs	Emergency repair
Planned maintenance & rehabilitation	Sewer replacement or other rehabilitation technologies
Service connections	Check and repair of existing connections, Installation of new connections
Control of storm water discharge into sewers	Identification of connections, remove connections

3) Treatment facilities O&M improvements required

Operation and maintenance improvements should initially be carried out at the existing sewage treatment works, but this work will effectively be a training ground for establishing procedures and an organisation capable of running the proposed future sewage treatment works.

Accurate records should be maintained which give full details of the design criteria and sizes of treatment units, etc. and comprise a diary of every significant event at the works. These records should be checked on each routine supervisory site visit. The records should include comprehensive details, with drawings and service manuals, for all electrical and mechanical components indicating their dates of manufacture and installation, and a detailed service/maintenance history for each unit. Detected faults should be recorded and reported to ensure that remedial action will be taken as soon as possible to have the faults rectified. Other routine O&M requirements are listed in the main report.

4) Contracting Out

Strengthening the capacity of local Jal Sansthan for O&M of sewerage system is recommended, however, ‘contracting out’ can make good sense economically in the alternatives given below. A decision regarding what tasks/components will be ‘contracted out’ and for what total periods needs to be treated as an urgent matter, as it will greatly influence the staffing requirements of the new sewerage division to be created within JS.

- Contracting out sewer inspection surveys to establish the sewer inventory
- Contracting out design, tender document
- Contracting out sewerage construction supervision

- Contracting out sewage treatment construction supervision
- Contracting out sewerage operation and maintenance
- Contracting out sewage treatment operation and maintenance

The operation and maintenance of the proposed new sewage treatment works for a fixed period could be included as part of a 'turn-key' design and construction contract. Even if it is decided to let some tasks out to another public agency (e.g. UPJN) or to private sector contractors, the Sewerage Authority (NN/JS) should always retain overall responsibility for and should closely control and supervise the work carried out by others, and so it will still require competent managers and supervisors.

(4) Institutional Development and Capacity Building

1) Institutional Development Programme

A single agency should cover the entire sewerage system; from planning to operation and maintenance; from house connection to sewage treatment plant. By this way, comprehensive and organised sewerage will be attained. To achieve this objective, Institutional Development Programme (IDP) was proposed in the Master Plan. The contents of IDP, which have been identified in the Feasibility Study, are as follows:

Framework	Contents
Organisational strengthen	Create and organise sewerage division on basis of objective, principles and guidelines
Operational resource development	Stocktaking of sewerage facilities (asset list), current status of them
Human resource development	Recruitment and training of engineers, operators and business handlers
Financial resource development	Identify or create financial source or revenue source

2) Future Management Structure

The responsibility for O&M should rest with a single sewerage authority that should be integrated with the existing Jal Sansthan. However, in the context of this Report, the proposals made are, for clarity, for the management of sewerage functions only. Several of the technical services, administration and financial functions can be provided by the existing water supply departments. The recommended organisational structure is represented here:

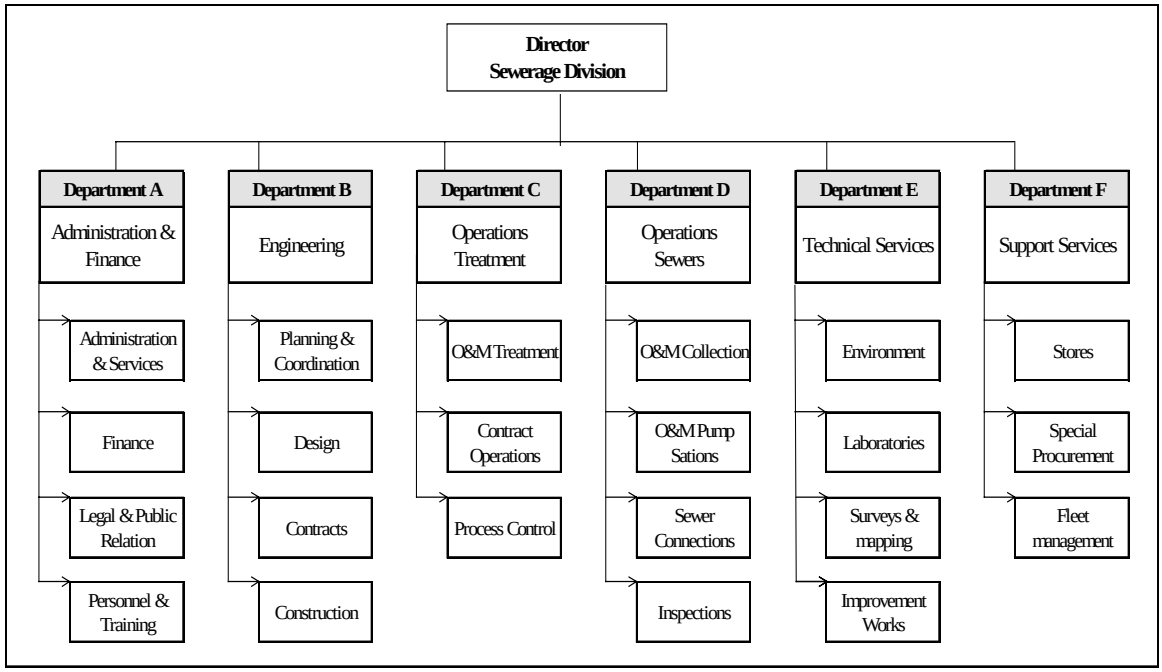


Figure 4.3 Future Management Structure

3) Methodology for setting up proposed new organisation

The following are a methodology for setting up the proposed new organisation.

STEP 1: Decide responsibilities of the Sewerage Division

STEP 2: Decide personnel requirements for Managerial level

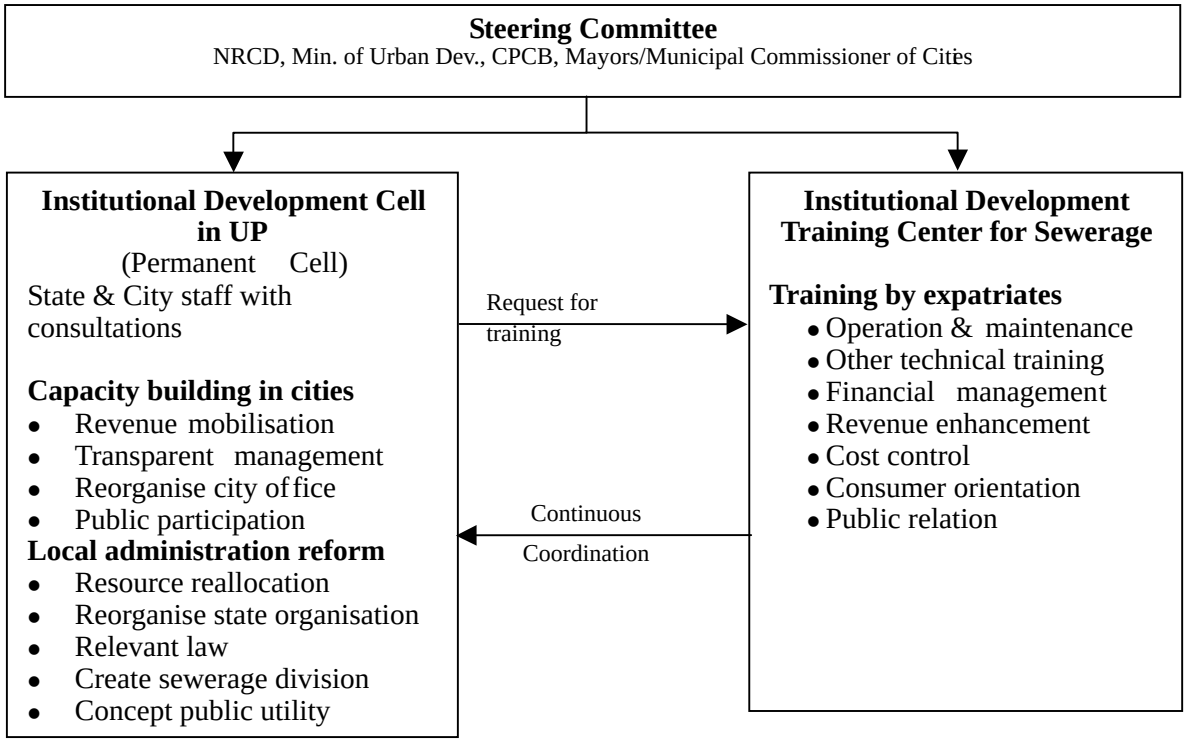
STEP 3: Locate office space and other practical details for management structure

STEP 4: Decide personnel requirements for Worker level

STEP 5: Chalk out policy framework

4) Institutional Development Programme

To implement IDP, Institutional Development Cell (IDC) should be created in the UP State Department of Urban Development. It is also suggested that an "ID Training Centre for Sewerage" should be established at the national or state level to satisfy the training needs for the personnel. Staff shall be selected from the State Government (UP Jal Nigam) and city offices (Nagar Nigams and Jal Sansthans). The implementation structure is presented in the following figures.



5) Institutional Development and Capacity Building (IDCB)

The strategic action plan for Institutional Development and Capacity Building (IDCB) is primarily identified and summarised as presented in Table 4.14.

(5) Cost Estimation of IDCB

Table 4.13 Cost Estimation for IDCB (Lucknow)

(1,000 Rs.)

Sr.	Description	Cost
1	IDP Consultancy Services	70,700
2	Training	84,000
3	Infrastructure Enhancement	33,300
Total		**188,000**

Table 4.14 Action Plan for Institutional Development and Capacity Building (IDCB)

Sr.	Objective	Action	Agency
A. Financial Sustainability			
1	1. Reduce Costs	Measures to reduce power consumption have to be implemented.	Organisation
2		Reduce number of non-technical staff.	Organisation
3		An "on the job" training should be implemented to increase the productivity of the personnel.	Consultant
4		The expenditure - "Interest/dividends" on Government capital – has to be reduced/eliminated, if possible.	Organisation
5	2. Increase Revenue	• Carry out property survey along with the size and type of water connection and broaden the tax net in the short term. • As a long term planning strategy, create a GIS database of the existing properties, water and sewerage system and integrate this database with the property permission applications.	Consultant Consultant
6		Along with the property survey, a re-assessment of the property values should be carried out to have realistic basis for property tax.	Consultant
7		• Start the process of water and sewerage charges based on dual criteria of property tax and size of water connection. • Initiate, a study to evaluate the implementation of metering over the entire city.	Consultant Consultant
8		The whole billing system has to be computerized and the staff to be trained to undertake this assignment.	Consultant
9		Formulation of the incentive scheme, based on the amount collected and the number of bills collected	Organisation
10		Carry out a detail study to assess the market for selling the by products generated from the STP	Consultant
11		As a long-term strategy, the JS should pursue the UP Government to link the tariff with the cost of production, specifically the cost of electricity charges.	Organisation/ Consultant
B. Institutional Capacity Building			
12	Human Resource Development	Determine the requirement of technical manpower and recruit/ contract requisite manpower	Consultant
13		Identification of the training needs, development of training programs and selection of the training institute.	Consultant
14		Conduct a detail study to identify the opportunities for public private partnership programs	Consultant
15	Infrastructure Development	Procure hardware and software for creating a sewerage system inventory and develop a GIS based sewer application for visual interpretation.	Consultant
16		Procure engineering equipment for proper maintenance of the sewerage system.	Consultant
C. Communication			
17	Communication	Establish a comprehensive and reliable communication system between the organisations involved and PMC.	Consultant
D. Institutional Development			
18	Institutional setting up	Establishment of Sewerage Division in Jal Sansthan and Nagar Nigam	Organisation/ Consultant
19		Capacity Building of City Office (Nagar Nigam)	Organisation/ Consultant

4.2.6 Summary of Total Project Costs and Implementation Schedule

The project costs of Sewerage, Non-sewerage, Public Participation and Awareness and Institutional Development Programme for Lucknow are summarised in the table below.

Table 4.15 Summary of Project Cost by Components (Lucknow)

(Million Rs.)

Item	Capital Cost	Physical contingencies, Engineering, Project administration	Land Acquisition	Total Project Cost
Sewerage Scheme	2,567.8	539.3	207.3	3,314.4
Non-Sewerage Scheme	135.7	33.9	0.0	169.6
Public Participation and Awareness	-	-	-	52.8
Institutional Development Programme	-	-	-	188.0
Total	**2,703.5**	**573.2**	**207.3**	**3,724.8**

The implementation of the total project and year wise fund flow requirement is presented in the table below.

Table 4.16 Summary of Project Implementation (Lucknow)

(Million Rs.)

Item	Total Project Cost	2007	2008	2009	2010	2011	2012
Sewerage Scheme	3,314.4	339.7	625.4	560.3	591.6	827.6	369.8
Non-Sewerage Scheme	169.6	9.3	37.2	54.6	35.8	32.7	0.0
Public Participation and Awareness	52.8	11.1	9.0	8.7	8.4	7.6	8.0
Institutional Development Programme	188.0	37.6	56.4	56.4	18.8	9.4	9.4
Total	**3,724.8**	**397.7**	**728.0**	**680.0**	**654.6**	**877.3**	**387.2**

4.2.7 Water Quality Estimation With Project

Estimated water quality with project and without project scenarios for 2015 is compared in the table below. The without scenario includes the project sanctioned and in process of sanctioned. The future water quality is estimated for the Gomti river at the city barrage and the downstream of effluent discharge point of the proposed Mastemau STP.

Table 4.17 Comparison of With and Without Project in year 2015

Item	Without Project [1)]	With Project
(1) Up stream of the barrage		
Estimated wastewater generated in 2015	247 mld	247 mld
Treatment capacity in 2015 [2)]	56 mld	56 mld
Diverted to other district	120.3 mld	191 mld
Untreated wastewater in 2015	70.7 mld	0 mld
Percentage of untreated wastewater in 2015	28.6 %	0 %
Estimated BOD discharge (untreated + treated)	22.89 ton-BOD/day	1.68 ton-BOD/day
BOD concentration at upstream (u/s) of city (assumption)	2.5 mg/l	2.5 mg/l
BOD contribution to the river (if treated water is used for irrigation)	+19.4 mg/l (+18.0 mg/l)	+1.4 mg/l (+0.0 mg/l)
BOD concentration at downstream (d/s) of city (if treated water is used for irrigation)	21.9 mg/l (20.5 mg/l)	3.9 mg/l (2.5 mg/l)
(2) Down stream of proposed STP		
Estimated wastewater generated in 2015	224.9 mld	224.9 mld
Treatment capacity in 2015	345 mld (sanction)	445 mld
Untreated wastewater in 2015	0 mld	0 mld
Percentage of untreated wastewater in 2015	0 %	0 %
Estimated BOD discharge	33.24 ton-BOD/day	15.03 ton-BOD/day
BOD concentration at u/s of city	20.5 mg/l	2.5 mg/l or 3.9 mg/l
BOD contribution to the river (if treated water is used for irrigation)	+1.9 mg/l (+0.0 mg/l)	+7.6 mg/l *3 (+0.0 mg/l)
BOD concentration at d/s of city (if treated water is used for irrigation)	23.8 mg/l (+20.5 mg/l)	11.5 mg/l (2.5 mg/l or 3.9 mg/l)
Environment for bathing	Large volume of wastewater will be discharged in the Gomti, by which unhygienic condition for bathing will be further degraded.	All wastewater is intercepted and treated before entering the Gomti. Bathing environment will be improved.
Protection of water source of drinking water	Effect of wastewater discharge in the city on the upstream of the municipal water intake will be kept continued and thus the water quality at the water supply source will be further degraded.	The wastewater discharged in the city reach will be intercepted and treated and thus the source will be protected.
Water quality of effluent of proposed STP	Bacterial pollution will be increased because of no disinfection facility	Chlorination will be applied to both existing and proposed STPs. Bacterial pollution will be reduced.

Note:
1. The sanctioned project includes 345 mld STP construction at Kakraha and is assumed to be implemented.
2. Additional 14 mld STP is planned by Development Authority.
3. The dry flow of the Gomti river is used for analysis.
4. BOD concentrations of untreated and treated wastewater of 300 mg/l and 30 mg/l are used for analysis.
5. As the wastewater generated upstream will be diverted to the proposed STP downstream, BOD contribution to the river is higher than the without project scenario.

If the project is implemented (with project scenario), 100 % of the wastewater discharged to the river will be intercepted and treated in 2015 while if the project is not implemented (without project scenario) 71.4 % of generated wastewater upstream of the city barrage is treated, and the rest of wastewater is discharged and finds its way to the Gomti degrading river environment in Lucknow. The

preliminary estimation shows that the BOD concentration at downstream of the city will be 23.8 mg/l without the project, and 11.5 mg/l with the project if treated water is discharged to the Gomti and 20.5 mg/l without project or 2.5 mg/l with the project if treated wastewater is not discharged to the Gomti but used for irrigation.

4.2.8 Economic and Financial Evaluation

(1) Economic Evaluation

Economic benefits of the proposed project are identified as follows:

1) Increment of willingness to pay (WTP) for improvement of water quality of the river Gomti estimated by Contingency Valuation Method (CVM)
2) Increment of WTP for improvement of sewage treatment systems estimated by CVM
3) Saving of medical expenditure due to decrease of suffering rate of water borne diseases derived from the improvement of water environment
4) Increase in saving due to decrease of suffering rate of water borne diseases also derived from the improvement of water environment
5) Contribution to regional economy derived from incremental increase of bathing population at the ghats along the river Gomti, and
6) Agricultural benefit from utilisation of treated effluent for irrigation.

Following table shows their estimated unit values.

As of 2004 Price Level

WTP for Improvement of Water Quality of the river Gomti	WTP for Sewage Treatment Services	Incremental Saving of Medical Expenses due to Decrease of Suffering Rate of Water Borne Diseases		Incremental Saving of Salaries/Wages due to Decrease of Suffering Rate of Water Borne Diseases		Contribution to Local Economy Derived from Bathing Population From Regular Users	Agricultural Benefit (Paddy + Wheat)
		Outpatient	Inpatient	Outpatient	Inpatient		
(Unit: Rs./Annum per House Hold)						(Unit: Rs./Annum per person)	(Unit: Rs./Annum per hectare)
354	1,974	10.7	135.5	4.3	12.5	17,852	6,494

Annual economic benefits for (1) above can be estimated by basic unit multiplying the entire households (HHs) in the project area, for (2), (3) and (4): the number of HHs connected, for (5): the incremental bathing population, and (6): the incremental irrigation area (ha).

Using annual cash stream of economic costs and benefits, the following results of economic evaluation are obtained. The EIRR is estimated at 5.4 %.

Index	Discount rate 10 %	Discount rate 5%
NPV	-760 million Rs.	154 million Rs.
EIRR	5.4 %	5.4 %
B/C	0.77	1.02

(2) Financial Evaluation

Sewerage projects are public works and their financial viability cannot be worked out using standard financial evaluation techniques as they cannot generate profit or expect cost recovery as their objective. The main objective of such project is to provide better living conditions to the residents of the city and

also make the environment clean and friendly. Hence it cannot be evaluated as a commercial project for cost recoveries and profit objectives.

The financial evaluation is made only for operation and maintenance cost recovery. The project is financially evaluated preparing a cash stream. The required user charge to recover the entire O&M and replacement cost assuming exiting bill collection rate is estimated at Rs. 3,219/per annum per household. The estimated average current sewer charge per bill is Rs.573 per annum. The required user charge is about 5.6 times higher than the current charge level and slightly higher than the estimated maximum affordability to pay of Rs. 2,775.

The amount of revenue generated from taxes and charges by the Service Provider, Lucknow Jal Sansthan, can cover only around 21 % of the total O&M cost in 2015 under existing conditions.

(3) Case Study for Improvement of Financial Situation

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.

- Improvement of billing and bill collection
- Utilisation of the by-products of sewerage system
- Others such as improvement of accounting system

Following figure shows the conservative projection of the number of the entire household in the city area, the households in the sewer area, the sewer connected household (or sewer charge billing household) and sewer bill collected households until the target year 2015 based on existing collection rate. As seen in the figure, there is a high potential to increase sewer connection and improve sewer charge collection efficiency.

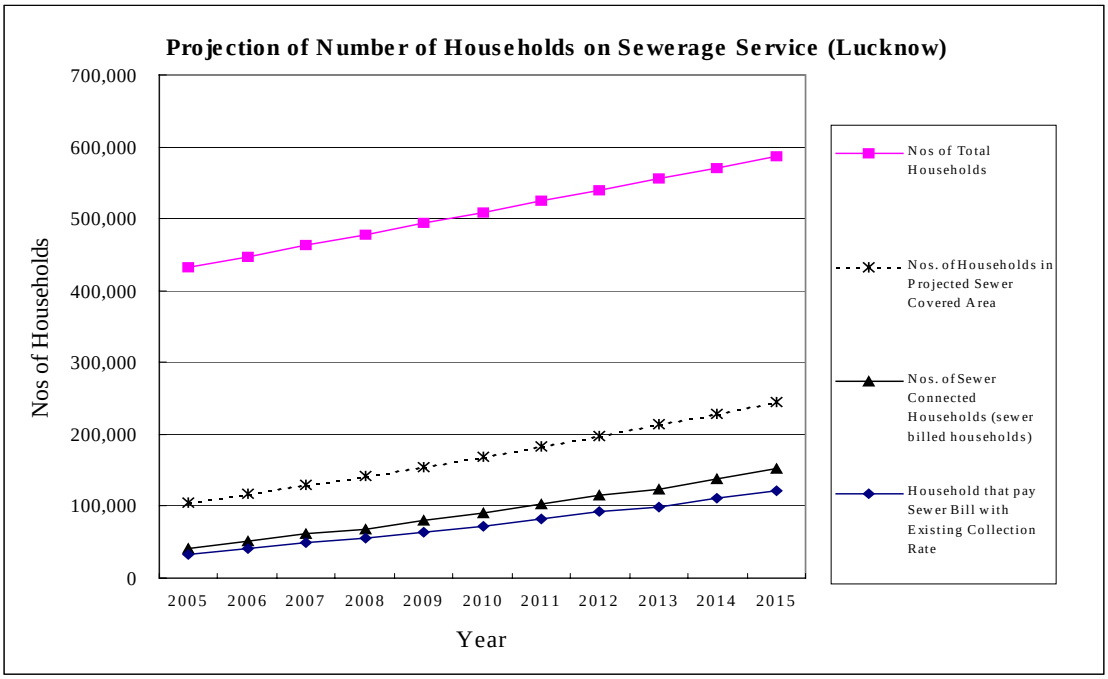


Figure 4.4 Number of Total Households in the City, Household in the Sewerage Service Area, Sewer Connected Household and Sewer Bill Collected Households

Following table shows a result of the case study taking into account the additional sources of revenue and improvement in the charge collection rate and charge level and sewer connection rate.

Table 4.18 Summary of Case Studies for Recovering of O&M Cost

Case in Sewer Charge level	Total O&M Cost required	Base Case		Case - 1				Case - 2			
					Optional Sources				Optional Sources		
		Revenue from sewer charge	Amount to be borne by State Transfer	Revenue from sewer charge	Revenue from treated water sales	Revenue from sludge sales	Amount to be borne by state transfer	Revenue from sewer charge	Revenue from treated water sales	Revenue from sludge sales	Amount to be borne by State Transfer
Million Rs./year											
Existing	334.8	69.4	265.4	76.5	1.9	6.8	249.6	99.9	1.9	6.8	226.2
50%	334.8	104.1	230.7					149.9	1.9	6.8	176.2
100%	334.8	138.8	196.0					199.9	1.9	6.8	126.2
230%	334.8	229.0	105.8					329.8	1.9	6.8	-3.7
Conditions		Exiting sewer collection rate		1) 5% increase of sewer charge 2) 5 % increase of collection rate 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)				1) Increase in bill collection rate to 90 % 2) Increase in connection rate to 80 % in sewered area 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)			

Note:

City	Existing Collection Rate of Bills	Existing Charge Level (Rs./Bill/ Year)	Affordability to Pay based on the income level: 1.5 % of average annual income per HH (Rs. per annum)
Lucknow:	80%	573	2,775
Kanpur:	50%	1,221	1,648
Allahabad:	56%	265	1,964
Varanasi	78%	112	1,889

Case-2		Case-1	
Estimated percentage of house connection in the sewer area	40%	charge	0.05
Estimated percentage of household in the sewered area	24%	collection	0.05
Estimated percentage of bill collected household out of total households in sewer area	48% in 2015		
Proposed collection rate	90% fixed		
Proposed connection rate	80% fixed		

Assuming the connection rate of 80 % in sewer area and the bill collection rate of 90 %, the amount to be borne by the State transfer will be reduced from Rs.265 million to Rs.226 million.

In this case, if the charge level is increased by 50 % (1.5 times of the existing charge level of Rs.573/HH per annum, in other words, if the charge level is revised to Rs.860/HH per annum), the amount to be borne by the state transfer will be reduced to Rs.176 million.

Furthermore, if the charge level will be increased by 230 % (3.3 times of the existing charge level, in other words, the charge level will be revised to Rs. 1,890/HH per annum), the revenue and O&M cost will be balanced. Even at this charge level, the revised charge will be within the affordability to pay for sanitation (Rs. 2,775/HH per annum).

From this viewpoint, a revision of the charge level is strongly recommended by means of not only the revision of the existing tariff system but also the reassessment of the Annual Rental Value of properties since the charge level is closely linked with the Annual Rental Value of properties.

(4) Recommendations

To improve financial feasibility of the project, following measures are recommended:

1. Improvement of billing and bill collection, consisting of:
   - Increase in tax net
   - Reassessment of property values and annual rental value
   - Reduction of process time per bill
   - Increase in productivity by introducing incentive schemes

2. Utilisation of by-products, consisting of:
   - Treated water for irrigation
   - Generated sludge as fertiliser

3. Finding of government subsidy or other financial source for operation and maintenance cost

4.2.9 Stakeholder Meeting in Lucknow

(1) Objective of the Stakeholder Meeting

In accordance with the JICA guideline of Environmental and Social Considerations, a stakeholder meeting was held for the purpose of informing the feasibility study (F/S) project for Lucknow city to the stakeholders and public. The objective of stakeholder meeting was to encourage the recipient governments to take appropriate considerations of environmental and social factors in the project.

The meeting was organised by Department of Urban Development, Government of UP, and under this, Lucknow Nagar Nigam, UP Jal Nigam, Lucknow Jal Sansthan had the responsibility to hold the meeting in collaboration with the JICA Study Team. The organisers in consultation with JICA Study Team decided the range of stakeholders to be invited to the meeting and following stakeholders were selected:

- Elected Public Representatives
- Ministries and Govt. Agencies
- Project Affected People
- Officers of UP State Government and State Undertakings
- International Organisations and Donors

- NGOs
- Well-Informed Persons / Experts
- Media

(2) Joint-Meeting

Before stakeholder meetings, a joint preparatory meeting was held on 28th January 2005 to present and discuss the contents of the project and the procedure of the proposed stakeholders meetings in three towns and resort necessary modification based on the feed back of the discussions with counterpart agencies of Nagar Nigams, Jal Sansthans, UP Jal Nigam officers of three cities. Besides, representatives from Govt. of UP also participated in the meeting.

(3) Press Release

To inform about the Stakeholder Meetings and brief on the project contents to the general public, press releases to newspapers were conducted on 29th January 2005.

(4) Stakeholder Meeting

Based on the guideline, a stakeholder meeting was held at Lucknow. The details are as below:

- Date: 2nd February 2005
- Venue: Scientific Convention Centre
- Participants: Over 200 participants from various stakeholders

The key issues raised by participants and reaction of the organisers/JICA Study Team are as below:

Question	Answer
The STP that has been proposed in Mastemau Village will certainly effect the environment of the village and a large part of their land will be taken for this project. Whether any facilities have been proposed to the villagers to compensate for their contribution?	For the villagers of Mastemau, where STP is proposed non-sewerage measures could be considered in the project.
A sewage pumping station has been proposed at Martinpurwa in this project, but there is no sewer line in Martinpurwa locality. Is there any proposal to lay sewer line in this area?	As to Martinpurwa the likely generation of the wastewater from this area has been accounted for while designing the facilities. However secondary sewerage is not a component in the Priority Projects but should be laid by the local government as per the policy of Govt. of India.
What criteria have been decided to select the location of Dhobi ghat?	Location of Dhobighat will be decided with the consultation of Dhobi Associations and Nagar Nigam.
How the O&M cost of the infrastructure will be met? Whether any increase in the sewerage tax will be proposed? If yes then how much?	The O&M cost should be raised by the service provider (the City Government) by rationalization of tariff and tax structure, increasing the efficiency of collection and collection rate along with bringing all the users within the tax-net. However along with the above devolution of State resources will be necessary. For the institutional strengthening and financial management, Institutional Development Programme (IDP) has been proposed in the plan which should be implemented by the State Govt. / City Govt. during the first Stage of the Master Plan along with the implementation of the Priority Projects for the facilities.
Industrial waste is being discharged into Gomti river in Lucknow as well as at up stream of the city. Whether this type of flow has been taken into consideration while formulating the plans?	It is mandatory that every industry should dispose their waste after proper treatment. Use of public money to treat industrial wastewater is not proper. The Pollution Control Boards are monitoring the treatment of industrial effluent to the prescribed standards

Comment from participants:

- Master Plan Trunk Sewers, Pumping Stations, Treatment Units and disposal should be planned, designed, constructed, operated and maintained by a SINGLE AUTHORITY.
- There is no State policy for the land acquisition, so it is suggested that we should formulate comprehensive rehabilitation policy with special provisions of income restoration [for this we can have a look of World Bank Policy on Rehabilitation]
- Setting up of pollution monitoring stations U/S & D/S of Gomti river to evaluate the performance of the project.
- Assurance of Maintenance Fund from Govt. of UP.
- Some advised that in the coordination committee of this project LDA and UP Housing & Development Board should also be included as they are very much connected with planning and execution of colonies and houses.
- Most of the villagers of Mastemau are poor and holding a little area of land, a large area of fertile land has been proposed to be acquired. What type of facilities will be given to the farmers and or what rate the land will be acquired?

The answers to the comments are attached in Volume IV-1, Part VI.

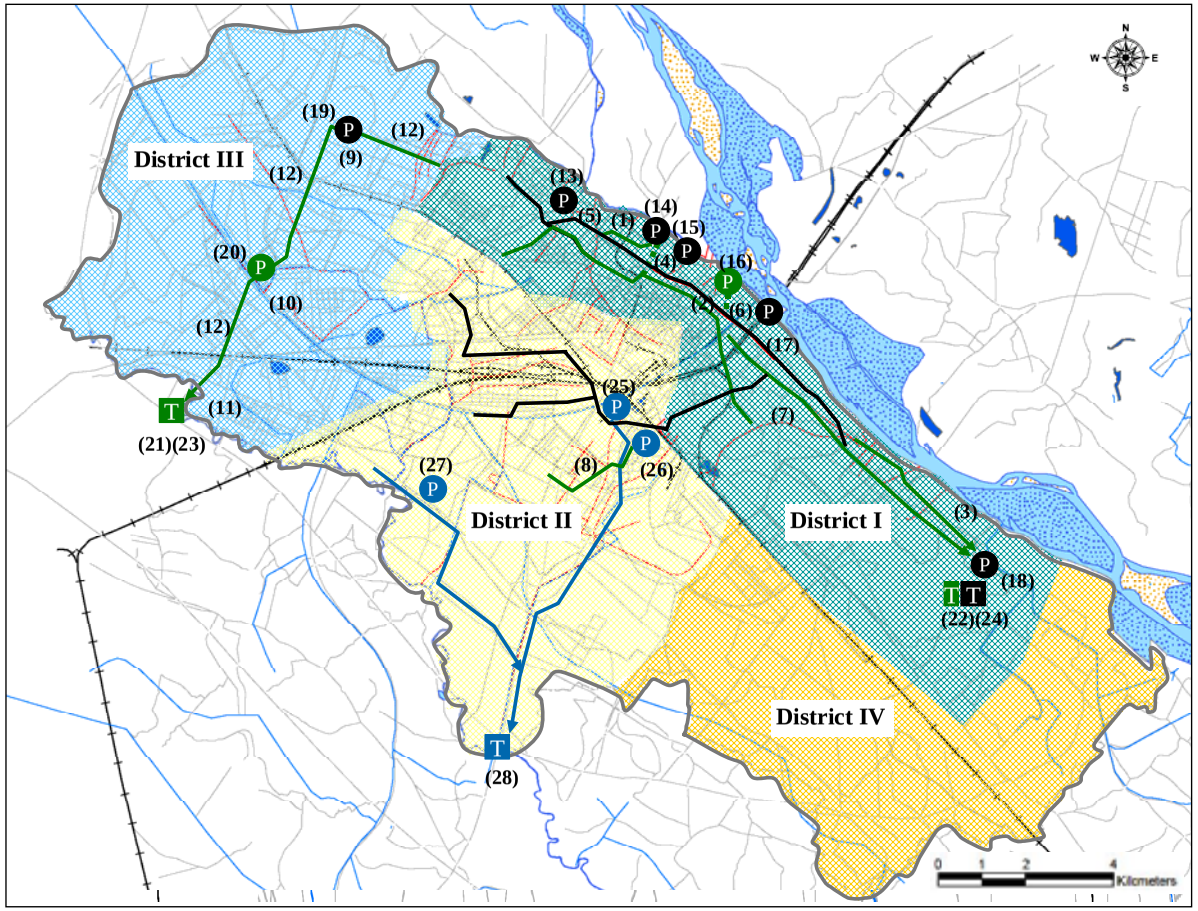
The minutes of meeting, participants' list, comments from participants and answers from the organisers were made available to the public at the offices of LNN, UPJN and LJS. The same are also available to the public in JICA Study Team's Homepage.

4.3 FEASIBILITY STUDY FOR KANPUR

4.3.1 Sewerage Scheme

(1) Proposed Components for Feasibility Study

The JICA Study Team has prepared the Master Plan (Master Plan) for the Kanpur sewerage system. The Master Plan identified certain 'Priority Projects', which are to be implemented within 1-5 years of adopting the MP, with the aim of reducing the pollution load on the Ganga river at Kanpur. These proposed facilities are shown in Figure 4.5. These facilities shall work together with the major sanctioned and commissioned projects listed in the same table.



Legend

- Municipal Boundary
- Sewer
- Rising Main
- (P) Pump Station
- (T) Treatment Plant

Black : Existing Facility
Blue : Sanctioned Facility
Green : Proposed Facility

	Sewer / Rising Main	District	Status	Diameter / Length
1	Sewer from Sisamau nala to Parmat SPS	I	P	1600 mm, 1.5 km
2	Sewer from Rawatpur to Cantonment area	I	E/Rp	700-2200 mm, 9.9 km
3	Sewer in Jajmau tannery area	I	E/R/Rp	Rehab: 300-1600 mm, 8.4 km Replace: 1600 mm, 1.0 km
4	Rising main of Parmat SPS	I	P	1000 mm, 1.6 km
5	Rising main of Nawabganj SPS	I	P	450 mm, 1.5 km
6	Rising main of Bagwatdas ghat SPS	I	P	400 mm, 1.2 km
7	Existing trunk sewer in District I	I	E/R	Desilting: 700-2200 mm, 9.2 km Rehab: 700-2200 mm, 5.8 km
8	Existing trunk sewer in District II	II	E/R/Rp	Rehab: 838 mm, 1.6 km Desilting: 838 mm, 2.4 km Replace: 700-2000mm, 3.8 km
9	Rising main of Lakhanpur SPS	III	P	600 mm, 0.65 km
10	Rising main of Pnki SPS	III	P	1200 mm, 0.26 km
11	Rising main of MPS at Panka STP	III	P	1400 mm, 1.5 km
12	New trunk sewer in District III	III	P	600-2000 mm, 14.2 km

	Pumping Station	District	Status	Capacity (mld)	Remarks
13	Nawabganj SPS	I	E/R	8	Average flow in 2015
14	Parmat SPS (Existing)	I	E/R	54	
	Parmat SPS (New)	I	P	50	
15	Muirmill SPS	I	E/R	5	
16	Bhagwatdas Ghat SPS	I	P	9.1	
17	Guptar ghat SPS	I	E/R	4	
18	Jajmau SPS	I	E/R	226	
19	Lakhanpur SPS	III	E/R	22.5	
20	Panki SPS	III	P	80	
21	MPS at Panka STP	III	P	120	

	Treatment Plant	District	Status	Capacity (mld)	Remarks
22	Jajmau STP (ASP)	I	E/A	173	Average flow in 2015
23	Panka STP (UASB + AL)	III	P	120	
	Total			293	

Existing / Sanctioned Facility

	Facility	District	Status	Remarks
24	Jajmau STP (UASB)	I	E	for industrial wastewater
25	Rakhimandi SPS	III	S	
26	Munshi Purwa SPS	III	S	
27	Ganda Nala SPS	III	S	
28	Bingawan STP (UASB)	III	S	in process of sanction

E: Existing R: Rehabilitation
S: Sanctioned A: Augmentation
P: Proposed Rp: Replacement

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PROJECT	LOCATION	Figure 4.5
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	Kanpur City	Proposed Sewerage Facilities for Feasibility Study (Kanpur)

(2) Design Data and Parameters

Project Design Horizon

The design period considered for sewers is 30 years (single phase). Civil works for pumping station facilities are designed also for 30 years, Electrical and Mechanical (E&M) works are designed for two-staged implementation, first stage up to 2015 and second stage up to 2030. Treatment facilities will be implemented in two stages as well. First stage would be up to 2015 and wherever flow increases / raw wastewater quality changes after 2015, the treatment facility would be augmented for the requirement of 2030.

Sewerage Districts Planning

The Master Plan has divided Kanpur into four sewerage Districts I to IV. All the priority projects identified in the Master Plan fall into three districts viz. District I, II and III.

Design Population

The population of Kanpur as per 2001 census is 2,721,145. Growth rates for each district have been calculated based on the growth potential of the district. With these growth rates and with 2001 census figure as the base, the Master Plan has calculated population figures for each sewerage district; these are presented in the table below.

Table 4.19 Population Projection for Urban Area (Kanpur)

Sewer Service Areas	Population within Municipal Area		
	2003	2015	2030
District I	1,005,000	1,264,000	1,455,000
District II	1,391,000	2,007,000	2,345,000
District III	336,000	802,000	1,284,000
District IV	88,000	269,000	545,000
Total	2,820,000	4,342,000	5,629,000

Water Supply Status

The main water sources for municipal supply are the Ganga river (near Bhairon Ghat upstream of Sisamau nala) and groundwater. In 2002, intake from the river was about 350 mld and from groundwater was 152 mld. Hence, total estimated water production from municipal supplies in 2002 was 502 mld.

The per capita water consumption of municipal water calculates to 140 litres per capita per day (lpcd). This has been modified in the Master Plan, to account for water consumed from private supplies, unaccounted-for water (UFW) and industrial consumption. The final figures work out to 182 lpcd for 2003, 174 lpcd for 2015 and 172.5 lpcd for 2030.

Waste Water Quantity Generated

Per capita wastewater discharge has been arrived at in the Master Plan by applying a return factor of 0.7 to 0.8 on the per capita water consumption (lpcd). The final figures for wastewater generated in the four districts area:

Table 4.20 Wastewater Generated

Sewer Service Areas	Wastewater Generated in mld		
	2003	2015	2030
District I	140.6	183.2	225.5
District II	194.8	291.1	363.6
District III	47.0	116.2	198.9
District IV	12.3	39.0	84.5
Total	394.7	629.5	872.5

Design Flow for Sewers

The design flows for all trunk sewers have been calculated and specified in the Master Plan based on the population of the catchment area and connection ratios. These flows have been considered for preliminary design.

Pumping Capacity and Configuration

For large capacity plants (or critical facilities) equal capacity pumps (6 to 8) have been proposed, with 50% or more stand-by on peak flow, and 100% or more standby for non-peak flow.

Design Capacities for STPs

As per the final sewerage system configuration adopted in the Master Plan, one new STP is to be constructed and the existing ASP plant of Jajmau STP will be augmented to 173 mld.

Table 4.21 Design Capacities for STPs

Location	Catchment Area	Capacity (mld)	
		Year 2015	Year 2030
Jajmau (ASP)	District I	173	183
Panka	District III	120	200

Raw Sewage Characteristics

The raw sewage characteristics for the STPs have been decided based on the ratio of flow tapped via nalas to the flow reaching the STP via piped sewers.

Table 4.22 Raw Sewage Characteristics

Sr.	Parameter	Jajmau and Panka STP	
		2015	2030
1	Minimum Temperature, ^{o}C	20	20
2	pH	6-8.5	6-8.5
3	Biochemical Oxygen Demand (BOD5), mg/l	230	230
4	Total Suspended Solids, mg/l	500	500
5	Faecal Coliform Count, MPN/100ml	$2x10^{7}$	$2x10^{7}$

Treated Effluent Characteristics

The effluent standards considered in the design of STPs, as specified in the Master Plan and in accordance with NRCD guidelines, are listed in the table below.

Table 4.23 Treated Wastewater Quality

Parameter	Value
pH	5.5 – 9.0
Biochemical Oxygen Demand, mg/l	< 30
Total Suspended Solids, mg/l	< 50
Faecal Coliform Count, MPN/100ml	<10,000

Wastewater Treatment Technologies

Treatment technologies with a proven track record in the country have been compared. The comparison is considered in view of the following constraints, to recommend the final treatment technology to be adopted:

- Land availability within the urbanised area is limited
- The city faces long power cuts almost everyday

Hence, treatment technologies preferred are those, which have less land area and power requirements and have a high reliability in face of long and frequent power cuts. In general, either Waste Stabilisation Ponds or Upflow Anaerobic Sludge Blanket (UASB) with a suitable post treatment has been chosen, based on the requirement of the specific site. Besides, if augmentation is proposed and land has been procured for that purpose in existing STP sites, same technology as existing one shall be adopted considering coherence of the facility and operation and maintenance.

(3) Summary of Proposed Sewerage Facilities Under Feasibility Study

1) Sewerage District I

i) Existing Sewerage Pattern

Sewerage District I is bounded by the river Ganga in the North, H.B.T.I and roadways workshop in the west, Armapur Estate, Dada Nagar, Kidwai Nagar and COD in the south. This area includes the old city core with the old sewerage network dating back to as early as 1910.

- Trunk sewers
- Guptarghat SPS, Muirmill SPS, Parmat SPS, Nawabganj SPS, Jajmau SPS
- Jajmau STP; capacity 130 mld (ASP), 36 mld (UASB) and 5 mld (UASB)

The trunk sewers of District I drain into the existing Jajmau SPS, which is located near Jajmau STP in tannery area. It pumps wastewater to the Jajmau STP. The sewage flowing into Jajmau STP is much more than the effective treatment capacity 60 mld of the STP (although its installed capacity is 130 mld). The excess sewage mixes with effluent of the STP without any treatment, and then flows into irrigation channel. Furthermore, almost all flow of Sisamau nala is discharging into Ganga river despite some tapping facilities located on the nala.

ii) Proposed Sewerage Pattern

In the proposed system, the sewage from southwestern part of District I will be diverted to Bingawan STP of District II. Hence, Jajmau STP will receive flow only from the catchment consisting of the remaining area of District I. This is expected to be 183 mld in 2015. In this

manner, overflows from Jajmau STP and Sisamau nala are proposed to be eliminated.

iii) Recommendations for Existing Sewers

Based on the manhole survey the following rehabilitation works have been recommended.

- Desilting and continued use of existing trunk sewers: 700 - 2200 mm dia, 9.2 km
- Rehabilitation: 700 - 2200 mm dia, 5.8 km
- Replacement of existing trunk sewers: 700 - 2200 mm dia, 9.9 km

iv) Recommendations for Existing Pumping Stations

Based on the inspection, the following are recommendations to improve the pumping stations.

Guptarghat SPS

- Existing capacity: 4 mld (average)
- Planned flow: 4 mld (average) in 2015
- Minor repairs in civil structure, painting
- New panels
- New lighting facility
- New earthing facility

Muirmill SPS

- Existing capacity: 5 mld (average)
- Planned capacity: 5 mld (average) in 2015
- Mechanised screen
- New panels
- New cables
- New lighting facility
- New earthing facility

Parmat SPS

- Existing capacity: 54 mld (average)
- Planned flow: 104 mld (average) in 2015
- Additional SPS: 50 mld (average) in 2015
- Minor repairs in civil structure, painting
- Mechanized screen
- New panels and new cables
- New lighting and earthing facility
- Rising main: 1000 mm dia, 1.6 km

Nawabganj SPS

- Existing capacity: 8 mld (average)
- Planned flow: 6 mld (average) in 2015
- Minor repairs in civil structure, painting
- Mechanized screen
- New panels and new cables
- New lighting facility
- New earthing facility
- Rising main: 450 mm dia, 1.5 km

Jajmau SPS
• Existing capacity: 202 mld (average) and 24 mld (average) • Planned flow: 202 mld (average) and 24 mld (average) in 2015 • 2 nos. mechanized screens • New rising main • New panels • New cables • New lighting facility • New earthing facility

v) Recommendations for Existing Jajmau STP

Existing Status

Sewage from District I is conveyed to Jajmau STP. At Jajmau, domestic wastewater is pumped to the existing 130 mld STP, which is based on activated sludge process (ASP) and also to a 5 mld pilot STP based on UASB. In addition, a separate network of open drains and pumping stations collects about 13 mld of tannery wastewater in Jajmau area and pumps it to the 36 mld UASB based STP. 130 mld STP was commissioned in January 1999. The plant was designed with three parallel streams for a total capacity of 130 mld. Also, a provision was made for adding another 43 mld stream.

Performance of Existing Treatment Process

Actual strength of incoming wastewater exceeds the design parameters, which is mainly due to mixing of industrial wastewater. Treated wastewater does not meet the NRCD standards for discharge into river or for irrigation. It has shown lower BOD removal efficiency as considered for activated sludge process. Therefore, complete segregation of industrial wastewater becomes necessary in order to get the desired plant performance. The centrifuge system provided for dewatering of sludge has become defunct due to presence of leather flushing, hair, chromium etc. UP Jal Nigam has added 18 nos. of sludge drying beds subsequently which caters to only one-third plant capacity. Also, the plant does not meet the criteria for faecal coliform content in treated wastewater.

Rehabilitation Proposed

The capacity of 130 mld STP needs to be augmented with additional treatment capacity of 43 mld. It is proposed to adopt the same technology (Activated Sludge Process) for the reason that the operators of the 130 mld plant can also look after the augmented capacity of 43 mld, ease of operation and the plant can be fitted in the available space on the site.

In the existing 130 mld STP, mechanical dewatering of the digested sludge was provided and these equipments are not working satisfactorily. It is proposed to provide sludge drying beds and decommission the existing mechanical units. In addition, upgradation and repairs, etc. of the worn out units also has been proposed.

Existing plant does not meet the discharge guidelines for faecal coliforms, so disinfection facility of chlorination has been proposed for total capacity of (130+43) mld of plant.

- Upgradation and repairs of the existing facility
- 43 mld domestic STP (AS) capacity augmentation
- Total 173 mld of chlorination facility
- Sludge drying beds for existing and augmented STP

vi) New Sewer Proposed in Jajmau Tannery Area

During implementation of Indo-Dutch schemes to convey tannery wastes up to 36 mld industrial waste treatment plant, surface channels were laid keeping in view that all the tannery wastes from different tanneries will be connected to the surface channels only. But as per the ground reality there are quite a few tanneries whose connections are directly to the 90" domestic trunk sewer. This very fact is causing problems at 130 mld treatment plant, which is meant for only domestic sewage. Therefore the need for separation of tannery waste from the domestic wastewater collection and treatment facilities is felt. The new facilities proposed for this district are:

- Construction of new trunk sewer and lateral sewers in Jajmau tannery area: 300-1600mm dia, 8.4 km.
- Replacement of existing sewer in Jajmau tannery area: 1600 mm dia, 1.0 km

vii) New Sewers from Sisamau Nala to Parmat SPS

Sisamau nala is the largest nala of Kanpur city whose measured flow is 138 mld. It has been proposed that under GAP II 100 mld of flow shall be tapped at the upstream side and diverted to proposed Bingawan STP. The remaining 30 to 50 mld has been tapped at down stream side and provision to convey it through 36 inch line up to Parmat Pumping Station has been made but this system has not been successful because the carrying capacity of the existing sewer is less than the actual flow. Also the sewer line is non functional at places because of silting and damages. The new facilities proposed for this district are:

- Construction of new trunk sewer from Sisamau nala to Parmat PS: 1600mm dia, 1.5 km.

viii) New Pumping Station Proposed at Bhagwatdas ghat nala

Near the Guptarghat nala one untapped nala called Bhagwatdas ghat nala exists. The flow of this nala is directly going to the Ganga river behind the ordnance factory. To control the pollution of Ganga river from this nala, interception/diversion works and a sewage pumping station is proposed at the out fall of Bhagwatdas ghat nala behind the ordinance factory. Flow of this nala shall be pumped to existing 60" sewer near Bal Bhavan.

Total design flow:

- 2015: 8.1 mld (average)
- 2030: 9.1 mld (average)

Major works proposed:

- 3 pumps of 9.1 mld, 33 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Construction of rising main: 400 mm dia, 1.2 km

2) Sewerage District II

Sewerage District II is bounded by the city district in the north, Kanpur Jhansi railway line in the west, and Pandu river in the south. The eastern boundary is formed by Hamirpur road.

In existing sewerage pattern, like the District I, the trunk sewers of District II also drain into the existing Jajmau SPS.

In the proposed system, the sewage from District II will be discharged to Bingawan STP, which is in the process of sanction under the GAP-II.

i) Recommendations for existing sewers

Based on manhole survey during the feasibility study period, duplication and replacement of existing sewer from Kidwai Nagar to Munshi Purwa Pumping station is recommended.

- Desilting and continued use of existing trunk sewer: 700 - 2000 mm dia, 2.4 km
- Rehabilitation: 838 mm dia, 1.6 km
- Replacement of existing trunk sewer: 700 - 2000 mm dia, 3.8 km

3) Sewerage District III

District III is bounded by the Pandu river in the south, development master plan boundaries in the west and north and the Kanpur Jhansi railway line in the east. At present, there are only a few sewer lines in newly developed colonies of this district and in the absence of any trunk facilities, these branch sewers and laterals discharge into the open drains, which ultimately go to river Ganga or Pandu.

i) Proposed Sewerage Pattern

The untapped Makrikhera nala, covering the area of Lakhanpur is directly going to the river Ganga. There is no integrated sewerage system in this area. In order to arrest this nala directly joining the river Ganga a trunk sewer is proposed from Lakhanpur area, covering the Kanpur Development Authority area near Lakhanpur, Kalyanpur Bithoor road, Kalyanpur Panki Road, Armapur Estate and Panki Power Generating Station.

ii) New Trunk Sewer

The new facilities proposed for this district are:

- Construction of new trunk sewer: 14.2 km
  - a) From Makrikhera Nala to Lakhanpur SPS: 600-900mm dia, 2.4 km
  - b) From Lakhanpur SPS to Panki SPS: 1200-2000mm dia, 4.9 km
  - c) Panki SPS to Panka STP: 1800-2000mm dia, 6.9 km

iii) New Pumping Stations Proposed

A pumping station is proposed at Lakhanpur within the existing premises and intermediate pumping station at Panki near Upper Ganga Canal, which will receive the sewage from the proposed trunk sewer and convey the same to proposed MPS at Panka. This pumping station is proposed near Panka STP site to maintain the hydraulics of the treatment plant. This pumping station will receive sewage from proposed trunk sewer and convey the same to the inlet of STP at the required elevation.

<u>Reconstruction of Lakhanpur SPS</u>

Total design flow (average)
- 2015: 22.5 mld
- 2030: 45 mld

Major works proposed:

- 3 pumps of 15 mld, 17 m head
- 2 pumps of 10 mld, 17 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Rising main: 600 mm dia, 0.65 km

Panki SPS

Total design flow (average)
2015: 80 mld
2030: 126 mld

Major works proposed:

- 6 pumps of 42 mld, 13 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Rising main: 1200 mm dia, 0.26 km

Main PS at Panka

Total design flow (average)
2015: 120 mld
2030: 200 mld

Major works proposed:

- 9 pumps of 40 mld, 22 m head
- Wet sump
- Mechanical and manual bar screen
- Necessary electrical system
- Rising main: 1400 mm dia, 1.5 km

iv) New Sewage Treatment Plant Proposed – Panka STP

This STP will treat the sewage to the desired standards and the treated effluent shall be discharged into Pandu river. Treated effluent may also be used for irrigation purposes in the close vicinity to the STP site. This will also reduce, to a minor extent, further exploitation of the ground water in the vicinity.

The wastewater of District III will reach Panka STP from Main PS. The capacity of the STP will be 120 mld in year 2015 and 200 mld in year 2030.

The technology for this site should:

- Require minimum land area
- Should have low power requirement
- Have low dependency on power for effective and reliable treatment of wastewater

A detailed techno-economic comparison of the treatment technologies was carried out for choosing an appropriate technology. Finally, life cycle costs were calculated for all the above options and UASB followed by Aerated Lagoons was found to have the least life cycle cost and is hence, recommended for Panka STP.

- UASB followed by Aerated Lagoons and chlorination
- Capacity 120 mld for 2015
- Sludge drying beds

(4) Project Cost Estimation and Implementation Schedule

1) Capital Cost Estimation of the Priority Projects

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated using Kanpur rates on the basis of Delhi Schedule of Rates taking localities and deflator into account. Furthermore, prices of items such as sewer pipes, reinforcing steel bars, manhole covers and so on that are not found in UPJN Schedule or DSR are obtained by quotation. The following are cost estimation conditions for physical contingencies, engineering and project administration. The abstract of the capital cost is shown in Table 4.25.

- Physical contingencies: 5% of capital cost
- Engineering costs (detailed design (6%) and project management (5%)): 11 % of capital cost
- Project administration: 5 %

2) Implementation Programme

The implementation programme for the priority projects has been prepared assuming following conditions.

- Preparation of detailed project reports and tender documents for project component shall be completed within 2006 and 2007.
- Actual execution of various priority project components shall start from 2008.
- During execution, various project components shall be executed in parallel.
- UPJN, Kanpur, will acquire 100 % of the land required for construction of proposed sewage treatment plants and pumping stations before the commencement of tendering.

The implementation schedule of the total project works and the year-wise fund flow requirement is presented in Table 4.26.

3) Operation & Maintenance Cost Estimation

The O&M costs for sewers, pumping stations and sewage treatment plants including existing, sanctioned and proposed facilities for 2015 are estimated based on following two cases in terms of power supply conditions.

- Operation by power from grid (24 hours a day)
- Operation by power from grid (20 hours a day) and diesel (4 hours)

The estimated annual O&M costs for all major facilities for 2015 is summarised in the following table.

Table 4.24 Summary of Annual O&M Costs for 2015
(1,000 Rs./year)

Facility	Case-1 Grid Power Supply	Case-2 Grid Power Supply Supplemented by Diesel
(1) Sewers and Rising Mains	30,798	30,798
(2) Pumping Stations	99,654	135,084
(3) Sewage Treatment Plants	130,064	130,064
Total	**260,516**	**295,946**

Table 4.25 Summary of Preliminary Project Costs (Kanpur)

	Sewerage District	Capital Cost (Rs.)	Contingencies	Detailed Design	Supervision	Project Adminisrtation	Total Cost (Rs.)	Land Acquisition	Total Project Cost (Rs.)
			5%	6%	5%	5%			
SEWERAGE SCHEMES									
Installation / Replacement of Trunk Sewer									
From Sisamau Nala to Parmat SPS	I	32,186,000	1,609,000	1,931,000	1,609,000	1,609,000	38,944,000		38,944,000
From Rawatpur to Hudson School Crossing then to Cantonment	I	575,871,000	28,794,000	34,552,000	28,794,000	28,794,000	696,805,000		696,805,000
Tannery Area Trunk Sewer	I(CE)	137,929,000	6,896,000	8,276,000	6,896,000	6,896,000	166,893,000		166,893,000
From Kiwad Nagar to Munshipruwa SPS	II	68,613,000	3,431,000	4,117,000	3,431,000	3,431,000	83,023,000		83,023,000
Trunk Sewer in District III	III	431,192,000	21,560,000	25,872,000	21,560,000	21,560,000	521,744,000		521,744,000
Construction of Sewerage Pumping Station					0				
Bhagwandas Ghat SPS	I	35,458,000	1,773,000	2,127,000	1,773,000	1,773,000	42,904,000	0	42,904,000
Lakhanpur SPS	III	43,407,000	2,170,000	2,604,000	2,170,000	2,170,000	52,521,000	0	52,521,000
Panki SPS	III	85,376,000	4,269,000	5,123,000	4,269,000	4,269,000	103,306,000	0	103,306,000
MPS at Panka STP	III	144,592,000	7,230,000	8,676,000	7,230,000	7,230,000	174,958,000	0	174,958,000
Construction of Sewerage Treatment Plant					0				
Panka STP (UASB)	III	380,721,000	19,036,000	22,843,000	19,036,000	19,036,000	460,672,000	65,745,000	526,417,000
Augmentation of Sewerage Treatment Plant					0				
Jajmau STP (ASP)	I(CE)	114,073,000	5,704,000	6,844,000	5,704,000	5,704,000	138,029,000		138,029,000
Rehabiltation of Existing Trunk Sewer					0				
Desilting, Detailed Investigation	I	185,064,000	9,253,000	11,104,000	9,253,000	9,253,000	223,927,000		223,927,000
Rehabilitation	I	676,271,000	33,814,000	40,576,000	33,814,000	33,814,000	818,289,000		818,289,000
Desilting, Detailed Investigation	II	19,396,000	970,000	1,164,000	970,000	970,000	23,470,000		23,470,000
Rehabilitation	II	83,824,000	4,191,000	5,029,000	4,191,000	4,191,000	101,426,000		101,426,000
Rehabiltation/Upgrading of Existing Pumping Station					0				
Guptarghat SPS	I	292,000	15,000	18,000	15,000	15,000	355,000		355,000
Muirmill SPS	I	479,000	24,000	29,000	24,000	24,000	580,000		580,000
Parmat SPS	I	66,864,000	3,343,000	4,012,000	3,343,000	3,343,000	80,905,000		80,905,000
Nawabganj SPS	I	7,604,000	380,000	456,000	380,000	380,000	9,200,000		9,200,000
Jajmau SPS (ASP)	I(CE)	9,750,000	488,000	585,000	488,000	488,000	11,799,000		11,799,000
Rehabilitation of Existing STP					0				
Jajmau STP (UASB, Pilot, 5 mld)	I(CE)	8,739,000	437,000	524,000	437,000	437,000	10,574,000		10,574,000
Jajmau STP (ASP, 130 mld)	I(CE)	64,800,000	3,240,000	3,888,000	3,240,000	3,240,000	78,408,000		78,408,000
Total		3,172,501,000	158,627,000	190,350,000	158,627,000	158,627,000	3,838,732,000	65,745,000	3,904,477,000

Table 4.26 Preliminary Implementation Schedule (Kanpur)

(Unit: Rs.)

	Capital Cost	Detailed Design Cost	Total Project Cost	2007	2008	2009	2010	2011	2012
				Capital and Detailed Design Cost Schedule					
Construction of Trunk Sewer									
From Sisam Nala to Parmat SPS	32,186,000	1,931,000	38,944,000	1,931,000	6,437,000	6,437,000	6,437,000	9,656,000	3,219,000
From Rawatpur to Hudson School Crossing then to Cantonment	575,871,000	34,552,000	696,805,000	34,552,000	115,174,000	115,174,000	115,174,000	172,761,000	57,588,000
Tannery Area Trunk Sewer	137,929,000	8,276,000	166,893,000	8,276,000	27,586,000	27,586,000	27,586,000	41,379,000	13,792,000
From Kiwad Nagar to Munshipruwa SPS	68,613,000	4,117,000	83,023,000	4,117,000	13,723,000	13,723,000	13,723,000	20,584,000	6,860,000
Trunk Sewer in District III	431,192,000	25,872,000	521,744,000	25,872,000	86,238,000	86,238,000	86,238,000	129,358,000	43,120,000
Construction of Sewerage Pumping Station									
Bhagwandas Ghat SPS	35,458,000	2,127,000	42,904,000	2,127,000	7,092,000	7,092,000	7,092,000	10,637,000	3,545,000
Lakhanpur SPS	43,407,000	2,604,000	52,521,000	2,604,000	8,681,000	8,681,000	8,681,000	13,022,000	4,342,000
Panki SPS	85,376,000	5,123,000	103,306,000	5,123,000	17,075,000	17,075,000	17,075,000	25,613,000	8,538,000
MPS at Panka STP	144,592,000	8,676,000	174,958,000	8,676,000	28,918,000	28,918,000	28,918,000	43,378,000	14,460,000
Construction of Sewerage Treatment Plant									
Panka STP	380,721,000	22,843,000	526,417,000	22,843,000	76,144,000	76,144,000	76,144,000	114,216,000	38,073,000
Augmentation of Sewerage Treatment Plant									
Jajmau STP (ASP)	114,073,000	6,844,000	138,029,000	6,844,000	22,815,000	22,815,000	22,815,000	34,222,000	11,406,000
Rehabiltation of Existing Trunk Sewer									
District I									
Detailed Investigation	185,064,000	11,104,000	223,927,000	11,104,000	185,064,000				
Sewer desilting, flow diversion and rehabilitation	676,271,000	40,576,000	818,289,000			40,576,000	225,424,000	225,424,000	225,423,000
District II			0						
Detailed Investigation	19,396,000	1,164,000	23,470,000	1,164,000	19,396,000				
Sewer desilting, flow diversion and rehabilitation	83,824,000	5,029,000	101,426,000			5,029,000	27,941,000	27,941,000	27,942,000
Rehabiltation of Existing Pumping Station			0						
Guptarghat SPS	292,000	18,000	355,000	18,000	146,000	146,000			
Muirmill SPS	479,000	29,000	580,000	29,000	240,000	239,000			
Parmat SPS	66,864,000	4,012,000	80,905,000	4,012,000	33,432,000	33,432,000			
Nawabganj SPS	7,604,000	456,000	9,200,000	456,000	3,802,000	3,802,000			
Jajmau SPS (ASP)	9,750,000	585,000	11,799,000	585,000	4,875,000	4,875,000			
Rehabilitation of Existing STP									
Jajmau STP (UASB, Pilot)	8,739,000	524,000	10,574,000	524,000	4,370,000	4,369,000			
Jajmau STP (ASP)	64,800,000	3,888,000	78,408,000	3,888,000	32,400,000	32,400,000			
Total	3,172,501,000	190,350,000	3,904,477,000	144,745,000	693,608,000	534,751,000	663,248,000	868,191,000	458,308,000

(Unit:million Rs.)

Items		Total	2007	2008	2008	2009	2009	2010
Capital Cost		3,172.51	0.00	693.61	489.15	663.25	868.19	458.31
Detailed Design Cost		190.36	144.75	0.00	45.61	0.00	0.00	0.00
Contingencies		158.63	0.00	34.68	24.46	33.16	43.41	22.92
Supervision		158.63	0.00	34.68	24.46	33.16	43.41	22.92
ProjectAdmin		158.63	0.00	34.68	24.46	33.16	43.41	22.92
Total Cost		3,838.76	144.75	797.65	608.14	762.73	998.42	527.07
Land Acquisition		65.75	65.75	0.00	0.00	0.00	0.00	0.00
Total		3,904.51	210.50	797.65	608.14	762.73	998.42	527.07

Detaied Design
Construction Cost

4.3.2 Environmental Impact Assessment

(1) Justification of the Project

Kanpur city's population is projected to double from 2.8 million in 2003 to 5.6 million by 2030. At present the total domestic wastewater load is about 395 mld vs. an installed treatment capacity of 171 mld. Remaining wastewater is discharged to Ganga and Pandu rivers through open drains. The Pandu river is a tributary to the Ganga with its confluence at approximately 25 km downstream of Kanpur.

Sanitation services are inadequate for city's present population. The sewer infrastructure is old, and poorly maintained. Many of the existing trunk sewers do not have sufficient hydraulic capacity for projected wastewater loads. New colonies are coming up from where wastewater goes either to old trunk sewer or directly to river through natural drains. In fact, the regular sewer system is lacking. Keeping in view the growth, a sound master plan for disposal and treatment of wastewater and its implementation is urgently required.

(2) Positive Benefits

Project benefits of the sewerage and pollution control projects is to ameliorate overall development and betterment of public health and hygiene coupled with upgradation of environmental management in the target project area through abatement of pollution; improvement of public health and aesthetics leading to improvement in quality of living and inducing economic growth.

(3) Key Impacts Identified and Mitigation

The overall identification of the negative impacts has been done by using a matrix table (Master Plan). As identified in the table, all the possible key negative impacts are associated with construction and operation of STP. The following key impacts are identified.

- Resettlement and economic activities due to the land acquisition
- Landscape change due to construction of STP
- Groundwater, surface water and soil contamination due to discharge of treated sewage that is not properly treated in STP and usage of dried sludge
- Odour problems due to operation

In addition to negative impacts in construction and operation phase, contingent impact or risk has been analysed. The identified risk of the project is disruption of power supply. In the city, frequent power supply cuts have been occurring, which causes breaking down of operation of STP and PSs.

1) Sewage Treatment Plant (Construction Phase)

The key potential impacts of construction phase of STP are loss of village houses, agricultural land and few trees and such impacts are long term. The other impacts of construction phase will be small in magnitude because of temporary nature and are expected to decrease gradually once the construction activity is completed.

a) Landscape Change (Visual Impacts)

Impacts

The construction of STP will alter landscape and change the land use of the area. The visual impacts at the construction site would be unaesthetic for the villagers.

Mitigation Measures

To minimise visual impacts and landscape change, provision of open space and plantation of trees in the surrounding area of the STP site is recommended. Plantation of trees in the open spaces would provide a visual comfort.

b) Land Acquisition

Impacts

The technology adopted for proposed Panka STP requires 45 ha land. The resettlement is avoided by selecting appropriate site without displacement of villages, and 45 ha will be acquired in agricultural land. The STP site is located in Panka Bahadur village and the information of landowners has been collected during the field visit as shown in table below.

STP	Land use	Name of village	No. of land owners affected
Panka STP (45 ha)	Agricultural land	Panka Bahadur	68

Mitigation Measures

- Minimisation or avoidance of village displacement

As stated in the impacts, the site for STP has been properly selected and no village displacement will occur.

- Appropriate Compensation

Land is normally acquired under the provisions of the Land Acquisition Act, 1894 which is general and basic law in the country for the acquisition of land for public purposes and companies. This Act was comprehensively amended in the year 1984, taking into consideration the recommendations of the Law Commission, the Land Acquisition Review Committee.

There are two types of compensation. Monetary compensation has to be provided to direct Project Affected Persons (PAPs) if their houses have to be acquired and demolished. It has to be provided also to indirect PAPs for their agricultural land to be acquired. Alternate land has to be provided to displaced persons for their resettlement. If land for resettlement can not be provided or PAPs are not willing to resettle in the new resettlement site, then monetary compensation has to be provided to direct PAPs for their homestead (i.e. residential) land to be acquired.

c) Socio-cultural Environment

Impacts

The proposed site does not have any national monuments / national parks / reserve forests.

Mitigation Measures

Looking to the nature of the site, no specific mitigation measure in respect of socio-cultural environment is considered necessary.

2) Sewage Treatment Plant (Operational Phase)

Overall, the predicted adverse impacts during the operational phase will be minor as compared to the construction phase. During the operation phase all the beneficial impacts of the project will be realised.

However, treatment works will not perform satisfactorily unless they are operated and maintained properly. Malfunctioning of the system would pose risks of health hazards. Hence, this system should be operated and maintained properly by trained technicians. Following preventive measures should be adopted:

- Provision of two power supply lines
- Provision of generator sets at sewage treatment site
- Provision of diesel for the generator sets
- All spare parts should be readily available in case of emergency
- Provision of adequate maintenance staff with accessories
- Regular training of system staff, skilled technicians and craftsmen
- Proper operating budgets and attractive salaries

a) Ground Water Quality

Impacts

The potential source of ground water contamination would be of three kinds; percolation of wastewater from the bed of the STP, percolation from the canal where treated effluent will be discharged and percolation from the agricultural land where wastewater is applied.

Wastewater in the aerated lagoon, which will be basically water-tight, may percolate through the underlain soil layer by seepage and pollute the ground water table of the nearest unconfined upper aquifer. These aquifers are connected with a number of open wells from which nearby villagers draw water for drinking and other purposes. There is some possibility that the aquifer is contaminated by partly treated wastewater.

Mitigation Measures

First and foremost, care should be taken to ensure adequate treatment to meet the discharge standards.

It has been planned that the aerated lagoon and treated water channel is lined with waterproof material to avoid seepage of wastewater in the lagoon into the soil and thus contamination of ground water.

It has also been planned that chlorination facility will be installed in proposed STP and therefore any bacterial contamination will not occur in the irrigation canal and through land application of treated effluent. If the STP is well functioned and wastewater is appropriately treated, the groundwater in the aquifer is remote from any contamination. Removal of pathogens is the prime objective in treating wastewater for re-use.

b) Treated Effluent Use

Impacts

The treated effluent from the proposed STP will be discharged into the river and/or irrigation canal. This effluent would be rich in phosphate and nitrate and therefore contribute increased

fertility of the agricultural land and increased area of irrigated land. This would be a positive impact to the nearby villagers.

The effluent quality of the proposed STP will comply with the national standards and thus no negative impact is foreseen on the river Pandu or the proposed canal. However, the project has to be aware of following impacts as well.

If a large concentration of inorganic salts or the metals are contained in the treated effluent, it will eventually influence the growth of the crops.

Toxic substances such as heavy metals that might be present in the irrigation water stay as alimentation in the soil and then absorbed into vegetation. Taking in such vegetables might harm human health.

Quality of soil governs the pattern and quality of the vegetation. The different heavy metals in the treated effluent will be adsorbed by the soil grains, which may affect the vegetation and crop quality. This may lead to a negative impact to the soil.

Insoluble inorganics make soil tough, and obstruct absorption of water. And excess organics in irrigation water may give direct effect to the cultivated land, and indirect effect as abnormal growth due to lack of oxygen in the water. This eventually gives negative influences to vegetation.

Mitigation Measures

As it is proposed that the treated wastewater of proposed STP may be reused for irrigation purposes, treated wastewater should meet the required standards for irrigation re-use. Also treated water quality should be monitored carefully so as to meet the discharge standards effectively.

With regard to application of sewage for land farming the 'Manual on Sewerage and Sewage Treatment', CPHEEO, Ministry of Urban Development, Govt. of India, provides guidelines on characteristics of irrigation waters. These include conductivity, salinity, sodium absorption ratio, chlorides, boron, etc. In addition, the manual provides maximum permissible concentrations of toxic heavy metal, etc.

c) Sludge production and disposal

Impacts

The sludge production will be to the tune of several tens ton/day from the STP. It will be dried on the sludge drying beds. During the drying process, there will be nuisance of insects and odour around the sludge drying beds.

The dried sludge may be given or sold to farmers as manure if it could be handled properly by them. The value of sludge as an organic fertilizer has long been recognized and this offers reduced fertilizer costs to the farmer. Besides, the dry sludge can be disposed of in specified landfill sites.

Mitigation Measures

The sludge from the STP should be disposed of in an environmentally acceptable manner. The sludge should be dewatered in sludge drying beds and the dried sludge is proposed to be

used as fertilizer in the nearby agricultural lands since it is biological in nature and has soil quality enhancing properties.

Nuisance of insects can be minimised by spraying insecticides on sludge drying beds, also by proper maintenance of sludge drying beds and proper drainage. The precautions should be taken in handling and disposal of the sludge.

Monitoring of the quality of the sludge is required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials.

The effectiveness of the sludge production for agricultural/vegetation use is not constant to any crops. Use of the sludge production at the region must be done with soil observation of its effect to avoid negative effects to crops. After the observation period, recommended method of the use should be established and educated to the local farmers. Parameters of soil observation monitored are Zinc, Copper, Total Carbon, Total Nitrogen, Phosphate and pH.

Use of the sludge product must be done strictly under the continuous monitoring of sludge product's contents especially the toxic substances.

d) Odour Production

Impacts

There is a possibility of bad odour in the case of UASB reactors and sludge drying beds proposed at the site of Panka, if the STP is not properly operated / maintained.

Mitigation Measures

To mitigate this, the width of peripheral green belt at Panka STP site has been increased. All required pollution prevention measures should be considered and implemented. Besides, the normal mitigation measures about dried sludge shall be taken to minimise odour problems although the impact is minimal in the STP that is located in remote area.

(4) Analysis of Alternatives

Different treatment processes are available for biodegradation of organic material present in domestic wastewater. Individual treatment process has its own limitation and advantage in terms of land requirement, environmental impacts, power consumption and operation and maintenance.

Several treatment processes have been selected for detailed evaluation before finalising the suitable one that would be environmentally, technically and financially viable option. A treatment technology of UASB followed by Aerated Lagoon (AL) and Chlorination has been selected for the Panka STP. The major constraints in comparison are land availability and operation and maintenance cost.

(5) Contingency Impacts and Mitigation

1) Contingency and Risk

The major risks that can result in breakdowns and disruptions are described below.

Power Supply

One of the main reasons for disruption during the operation phase of the treatment works is power cuts, which are routine in the city.

It is recommended that the new treatment plant and pumping stations receive their power supply through dedicated feeders from two different power sources. It is also suggested that standby power generators are provided to ensure at least minimum services in case of prolonged power cuts, and also that cost of diesel be built into the O&M costs.

Also the sewage treatment technology chosen should be able to survive short spells of power cuts.

Electric & Mechanical Equipment Disruptions

Operational disruption due to E&M equipment can be avoided by proper preventive maintenance activities and provision of adequate spare parts and stand-by equipment.

O&M manuals should be available in the treatment plant with training of the operation staff for the new plant.

2) Contingency Measures Plan

Contingency measures plans have been prepared for:

i) sewage treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (i.e. maintenance, etc. or breakdown);
ii) discharge of sub-standard wastewater into the environment from treatment plant which could cause a significant public health impact, and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.
iii) accidents which may occur while laying sewers or during construction of the treatment works;

(6) Environmental Management Plan

The success of the Environmental Mitigation Plan depends on the efficiency of the organisational set up responsible for the implementation of the programme.

For a sanitation project of this magnitude, the Environmental Management Plan needs to be entrusted, in both the construction and the operation phases, to an Environmental Management Cell (EMC), and regular monitoring of various environmental parameters is also necessary to evaluate the effectiveness of the management programme so that necessary corrective measures could be taken in case there are some drawbacks in the proposed programme. Thus, the Environmental Management Plan will consist of:

- Setting up an EMC to implement the mitigation measures in operation phase,
- Ensuring proper operation and maintenance of the treatment works,
- Ensuring proper maintenance of the sludge drying beds and the disposal of dry chemical sludge in a proper landfill site,
- Monitoring the waste and treated water quality,
- Monitoring the built in pollution control equipment, for vehicles and equipment, and
- Maintaining tree plantations around the pumping stations and the periphery of the sewage treatment plant.

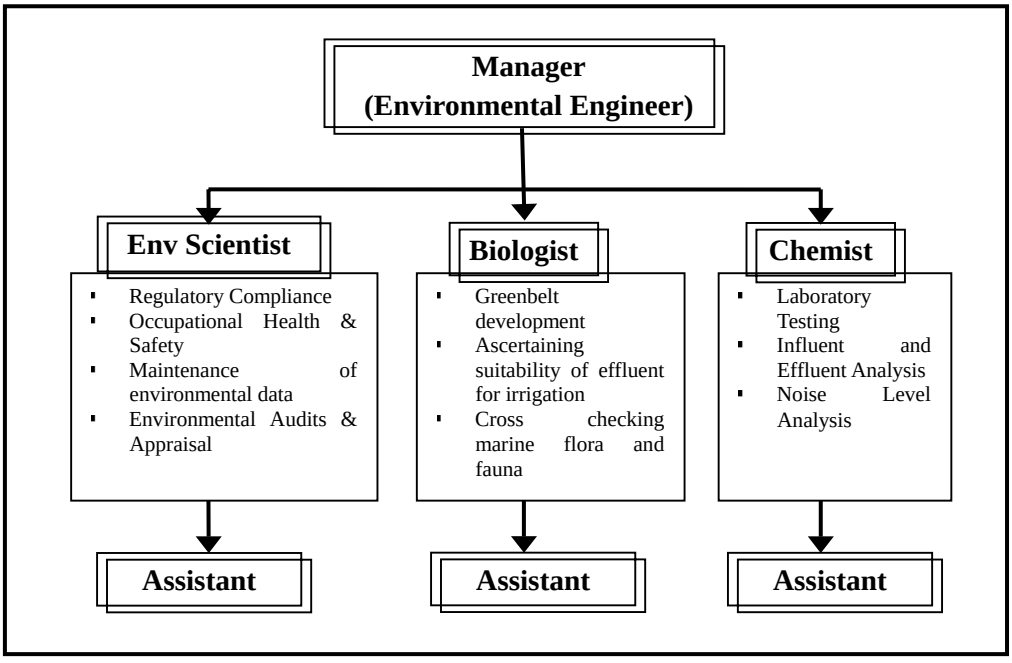
(7) Environmental Management Cell (EMC)

The Environmental Management Cell will be part of the staff in charge of the operation and

maintenance of the sewerage works, since the laboratory will be housed at the treatment plant site. But this staff will be in charge of the overall management of the environmental aspects of the Sanitation Project.

Under the supervision of an Environmental Engineer, the EMC will comprise an Environmental Scientist, a Chemist and a Biologist, plus three assistants, as shown in the following organisation chart. The main functions of the EMC will be:

- Collecting water, air, soil and sludge samples,
- Analysing the samples collected or getting analysis done from outside sources,
- Preparing and updating a database of environmental parameters,
- Implementing the environmental control and protective measures,
- Controlling the sludge treatment, disposal and re-use,
- Collecting statistics of health of workers and the population of surrounding areas,
- Ensuring the development and maintenance of the green belts,
- Monitoring the progress of implementation of Environmental Management Programme,
- Co-coordinating the environment related activities within the project as well as with outside agencies.



(8) Monitoring Plan

To evaluate the effectiveness of the Environmental Management Plan, regular monitoring of the important environmental parameters as follows will be taken up by UPJN/JS in environmental testing laboratory.

1) Water quality
2) Air quality and odour
3) Noise
4) Green belt and compensatory plantation

(9) Environmental Training

The environmental monitoring plan will be successful only if trained and skilled staff implements it.

The training of the qualified staff should be necessary not only in day-to-day operation and maintenance of the treatment plant, but also in environmental aspects.

It will be essential to involve the staff that will be responsible for the execution of the Environmental Management Plan, in the construction phase, as well as to train the staff in practicing the mitigation actions and the day to day monitoring programmed during the operation phase of the water supply units. The training should include:

- Basic concepts of pollution control techniques in the various methods of sewage treatment,
- Operation and maintenance of the sewage treatment plant,
- Emergency preparedness to handle adverse situations,
- Principles of wastewater analysis,
- Other environmental monitoring techniques,
- Development of green belt and its maintenance,
- Sewage farming, and
- Communication with farmers and general public.

This training is different from the mandatory training required for operation and maintenance of the sewage treatment plant.

4.3.3 Non-Sewerage Scheme (CTC Programme and Constructed Dhobighat Programme)

The objectives of this study are to formulate programmes of development/ management of Community Toilet Complexes (CTCs) and Constructed Dhobighats (DG); to assess the technical, institutional, financial and economic viability; and to assess the environmental and social soundness of the proposed programmes.

The objective of the proposed programmes is to improve slums and DGs' sanitary conditions, thus improving water quality of rivers.

The shortcomings in the operation and maintenance (O&M) of existing CTCs in slum areas and DGs are causing serious problems in proper functioning and general sanitation in the surrounding areas. O&M aspect is one of the main factors to be considered in formulating sustainable programmes of CTC and Constructed DG. Keeping this in mind and on the basis of the assessment of existing conditions of the target areas and facilities as well as the needs and demand of slum dwellers / Dhobis, the proposed programmes are formulated.

The proposed programmes adopt a needs-driven and community-driven approach in planning, implementing, operating and maintaining the facilities and suggest that the O&M is facilitated through local CBOs/SHGs or local Dhobi Associations. Implementation by this approach will make the programmes technically, financially, socially and culturally viable.

For successful implementation of the programmes, the following are required:

- Involvement and assistance of NGOs/Consultants for training and monitoring
- Regular monitoring, evaluation and feedback on the functioning of CTCs and Constructed DGs by Nagar Nigam in coordination with SUDA, DUDA and representatives of CBO/SHG.
- Appropriate implementation steps as follows to ensure involvement and training of CBOs/SHGs or Dhobi Associations:

Step 1: Needs survey of slum / Constructed DG
Step 2: Creation of CBOs/SHGs/ Dhobi Association
Step 3: Planning and designing
Step 4: Selection of location of CTC/Constructed DG including land acquisition clearance
Step 5: Construction
Step 6: Training of CBOs/SHGs/ Dhobi Association during construction
Step 7: Operation and maintenance
Step 8: Monitoring, evaluation and learning
Step 9: Feed back

Creation of a CBO/SHG for O&M of CTCs has not been attempted earlier. Therefore, it is proposed that a pilot project to manage CTC through CBO be implemented and a good model for O&M of CTC be created before implementing full-scale project. Similarly, to manage the improved or new facilities of Constructed DGs in an appropriate manner, the functioning of the existing Dhobi Associations will require improvements through a process of capacity building. This capacity building will be also tested through a pilot project. This model project can then be extended to other proposed facilities.

One of the important constraints relating to O&M is the lack of funds. To make the project financially feasible, a minimum monthly charge of Rs. 70 per household, is required to be levied along with subsidy for electricity and sludge disposal costs (where applicable) by the local bodies and part of manpower costs being provided by the community through voluntary activities. This level of user charge was assessed affordable and acceptable even for low-income communities as their willingness to participate in the project is very high. Besides, if the facilities are well maintained and kept clean the willingness to pay will improve and the project will become financially more viable.

The estimated monthly user charge per member for O&M of a Constructed DG is Rs. 35 to Rs. 92. Based on the results of the primary survey, which indicated a willingness to pay user charges up to Rs. 100 per month, the project is expected to be financially feasible.

If following factors are considered in the proposed facilities, the projects are expected to be technically feasible and would also ensure adequate O&M of the facilities.

CTCs
- Constant water supply for flushing and cleaning of water closets (seats)
- Sufficient capacity of storage tank for constant water supply
- Regular electricity for tube well and lighting

Constructed DGs
- Appropriate design and quality of construction to ensure no leakage
- Constant water supply
- Amenities (toilet, rest room, safety measure, shed, etc.)

Land availability for both CTC and Constructed DG facilities is the most critical aspect for the feasibility study. The result of a rapid survey to assess the land availability in ten of slums indicated that the land for CTC could be made available in many of the slums. These lands are mostly owned by the various Government bodies and efforts have been made to select lands without any disputes or encumbrance. However, more detailed surveys are required to decide the best location by matching the demand for CTC and the availability of land. A detailed study should be done at the detailed design stage with the help of hired NGO/Consultants and communities.

The project shall generate tangible and intangible benefits as follows:

- Environmental benefits are expressed through reduction of pollution load caused by open

defecation

- Health-related benefits include reduction of the incidence of water-borne diseases resulting from poor sanitation
- Economic benefits include productive gains, secondary economic benefits and developmental impact due to improved health and reduced health costs
- Social or equity benefits include gender, regional and income-related equity through appropriate sanitation for women and girls who are most affected by poor sanitation
- Institutional benefits are expressed to strengthen the CBO/SHGs through capacity-building

The proposed facilities and total capital costs in these programmes are summarised in the following table.

Table 4.27 Cost Estimation for Non-Sewerage Scheme (Kanpur)

Kanpur	No of Proposed Facilities	Total Cost(Rs.)
CTCs		
10 Seater	92	65,182,000
20 Seater	3	3,708,000
Sub-total	95	68,890,000
Constructed DGs		
New CDG	0	0
Improvement works	4	1,400,000
Sub-total	4	1,400,000
Total		70,290,000

Study Summary for Proposed Programmes (Kanpur)

Community Toilet Complex (CTC) Programme in Slums	
Existing situation	• The total slum population is estimated as 0.4 million; there are 390 slums in Kanpur. • Lack of adequate sanitation facilities has led to a high incidence of water-borne diseases. • There are 366 existing CTC out of which 13 are not operational; 215 are connected to sewer lines; 84 have septic tanks; 45 have biogas plants. • CTCs are operated and maintained by NGOs, DUDA (both through contractors) and other private contractors. • Main problems of existing CTCs – lack of cleanliness and adequate maintenance. • 24.8 per cent of the slum population, based on the sample survey, practice open defecation. • 41 per cent of the slum dwellers, who do not have any toilet facilities, are willing to pay Re. 1 per usage; 24 per cent are willing to pay Re. 0.50 (sample survey). • 63.2 per cent of the slum dwellers expressed willingness to participate in O&M of CTCs (sample survey).
Proposed Design Options	• A seat (water closet) is designed to be used by 30 users per day. • The maximum travel distance for a user from his or her place of residence to the CTC should be less than 500 m. • 10-seater or 20-seater CTC with required amenities are recommended. • The preferred wastewater disposal option is connecting the CTC to a sewer line; in its absence, a septic tank and soak pit is recommended.
CTCs Needs	• The total number of new CTCs was estimated on the basis of need assessment (number of persons practicing open defecation) and the percentage thereof willing to pay user charges obtained through sample survey. • Total number of new CTCs is estimated as 95; 92 nos. of 10-seater and 3 nos. of 20-seater.
Capital Costs	• Total capital cost of 95 CTCs is Rs. 68.89 million spread over 5 years.
Benefits	• Reduction in river pollution • Health and environmental benefits • Improved sanitation in slums decreases the incidence of water-borne diseases and thereby improving productivity • Women and children are the biggest beneficiaries
Recommendation	• O&M by Community-Based Organisation (CBO) or Self-Help Group (SHG) • Voluntary participation of project beneficiaries in O&M to reduce O&M costs especially the wages payable to a caretaker • Electricity costs and de-sludging (where applicable) to be covered by Nagar Nigam • Monthly user charge of Rs. 60 to 90, or a per day charge of Rs. 2 to 3 per family • Implementation of a pilot project first to create model O&M through CBO/SHG • Training centre for O&M to provide hand-on training to the members of the CBO, and facilitate extension of the model project to full-scale • Need assessment for CTCs to be conducted for each location at the time of commencement of the project
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, CBOs/SHGs • Participation of member(s) of CBO/SHG in construction supervision • Day to day O&M by CBOs/SHGs comprising members of the community benefiting from the project

Constructed Dhobighats (CDG) Programme	
Existing situation	• No major traditional riverside Dhobighats and 4 Constructed Dhobighats • About 60-80 Dhobis use traditional river-side ghats • Dhobis unsatisfied with existing CDG, and want improvement in amenities • Chemicals used by Dhobis include detergents, solvents, bleaching agents, dyes etc.; high incidence of skin diseases • The only one existing CDG are being managed by respective Dhobi Association • Current O&M not satisfactory; problems related to leakages, broken pumps, poor sanitation conditions, lack of shelter and space for drying clothes etc.
Proposed Design Options	• One cubicle is required for 6 washer-men; 3 shifts in a day and each washer-man use the ghat once in 2 days. • It is desirable that a washer-man is not required to travel more than 2 km from his residence • As for wastewater disposal, sewer connection is preferred but if unavailable open drain connection is selected and the latter is being tapped for diverting the wastewater to treatment plant. • No on-site treatment is recommended since high capital and operation & maintenance costs and the complicated process of treatment and considering current power supply situation in the city.
Needs of Constructed Dhobighat	• 5 new Dhobighats are planned and sanctioned by the State Government and are under implementation/planned to be implemented by local body. These facilities are expected to meet the existing demand. • No new Dhobighat proposed • Improvements/rehabilitation of existing 4 Dhobighats proposed • Improvement works include new pump, generator, roof, rest room, electrical work etc.
Project Costs	• The total capital cost for improvement works is estimated as Rs. 1.40 million
Benefits	• Reduction in river pollution • Health and environmental benefits • This project shall ensure access of quality services to the affected communities • Properly designed facility will reduce the incidence of diseases among the Dhobis thus enabling them to work for greater number of days (improved productivity) • Capacity building and training to Dhobi Associations
Recommendation	• O&M by Dhobi Associations; capacity building necessary in existing ones • Monthly user charge of Rs. 35 to 90 per member, depending on percentage of usage and number of cubicles in the CDG, to provide coverage for O&M costs be collected for adequate O&M of facilities. • Implementation of a pilot project first to create model O&M through CBO/SHG
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, Dhobi Associations • Participation of member(s) of Dhobi Association in construction supervision • Day to day O&M by Dhobi Association

4.3.4 Public Participation and Awareness

(1) General

For the sound operation and maintenance of sanitation facilities at city scale, generally, 'Public Participation' is indispensable. The construction and operation of such systems alone will not attain desired improvement in environmental sanitation, public health, surrounding environment and abatement of pollution of river water bodies. Therefore, greater public awareness on the health and environmental impacts, importance of those systems and facilities among communities, and the encouragement of their positive participation in the share of the obligation is essential. This would help work out problems related to operation and maintenance and long-term sustenance of these systems and facilities.

Therefore, in this study, the JICA Study Team has:

1. Proposed the elaborated programmes on related activities and campaigns to promote public participation and heighten public awareness (PP/PA).
2. Analysed the existing formal and informal institutions in these cities that participate/had been participating in PP/PA programmes and suggested an institutional framework for successful implementation.

This is based on participatory techniques and the concept of the 'hygiene education', which has been prepared in the Master Plan and specifically responds to each event proposed in the Feasibility Studies in the four cities. Within this framework the programmes have been designed into two sets. Set I addresses the proposed priority projects and set II comprises regular activities to follow the hygiene education concept. The end achievable of these sets is to generate willingness to pay for the facilities and create awareness to a level that people participate for a cleaner river.

Whereas Varanasi and Allahabad are very religious and have emotional linking to the river, Kanpur and Lucknow are more urbanised. These and other distinctive characters and target groups for the four cities have been analysed and their flavour adequately addressed in the programmes.

(2) Programmes

Set I describes the necessary programmes that have to be undertaken in accordance to the timings of the projects (sewerage and non-sewerage). These include:

Committee (SPC) Meetings	To monitor the progress of work on PP/PA (once in every month)
Necessary Publicity Programmes	To advertise widely the information on the projects through the mass media and printed materials to general public
Necessary Explanatory Meetings	To discuss with communities and stakeholders about PP/PA activities
Demonstration Programmes	In accordance with the priority projects of sewerage and non-sewerage works, demonstration programmes shall be launched

Set II includes programmes that run parallel to the first set and shall communicate the ideas on health, sanitation and better living environment in accordance with the hygiene education concept in the M/P. The programmes shall broadly constitute:

Entry point Activities	To build a platform for initiating the programmes
Regular Publicity	To keep the message fresh in the minds of the people
Yearly Campaign	A yearly campaign should be implemented in accordance with public participatory approach and the stepwise planning as discussed in Master Plan
Clean River Day and Clean River Week	To raise the awareness on river cleaning
Regular activities in slums and Dhobighats	To formulate the community-based organisation for O&M of the facilities created.

Further for ground implementation communication tools and communication activities have been detailed. A mix of all the activities and tools shall constitute a programme and the appropriate mix shall be selected by the implementing agency as per the guidelines given in the TOR and budgetary allocations that have been made.

Communication Tools

1) Media	**Contents**
Press	Press Conferences, Press Releases, Articles, Advertisements
Television	Talk Shows, Advertisements, News
Other Publicity Materials	Hoardings, Banners, Posters, Pamphlets, Hot Air Balloons
2) Other Means	
Theme Plays, School Programmes, Information Kiosks, Power Point Presentations, Documentary Films, Information Van, Site Visits, Shram Dan	

Summary of Activities for Communication

Communication Activities	**Intended Target population**
Focus Group Discussions (FGDs)	Lawyers, Doctors, Professors, Religious Leaders, Political Personalities, Municipal Officers, RA's and other Professionals
Transect walks/Padyatras	Women and Youth
Workshops	Beneficiaries and future beneficiaries of priority projects
Swasthya Mela in city	General Public encouraging women in particular.
Health Camp for slums	Slum community
School Programmes	School Children
Programmes for women	Women
Information Mela	Beneficiaries and future beneficiaries of priority projects
Competitive Programmes	Clubs, industry houses, hotels, private hospitals

(3) Implementation Structure

In the institutional front after analysing the institutional structures it is felt that there is no structure at present that takes care of the PP/PA activities in the state or the city. Therefore, for implementing the works Health Officer in the Nagar Nigam will be the main authority answerable to the Municipal Commissioner and provided with additional technical staff to support on the programme. This addition of technical staff is very important because at present the Nagar Nigam does not have a qualified person to deal with the PP/PA issues and monitor its progress.

The hierarchy of the implementation structure is as explained in Figure 4.6. The emphasis at the implementation level shall be on the Nagar Nigams of the four cities.

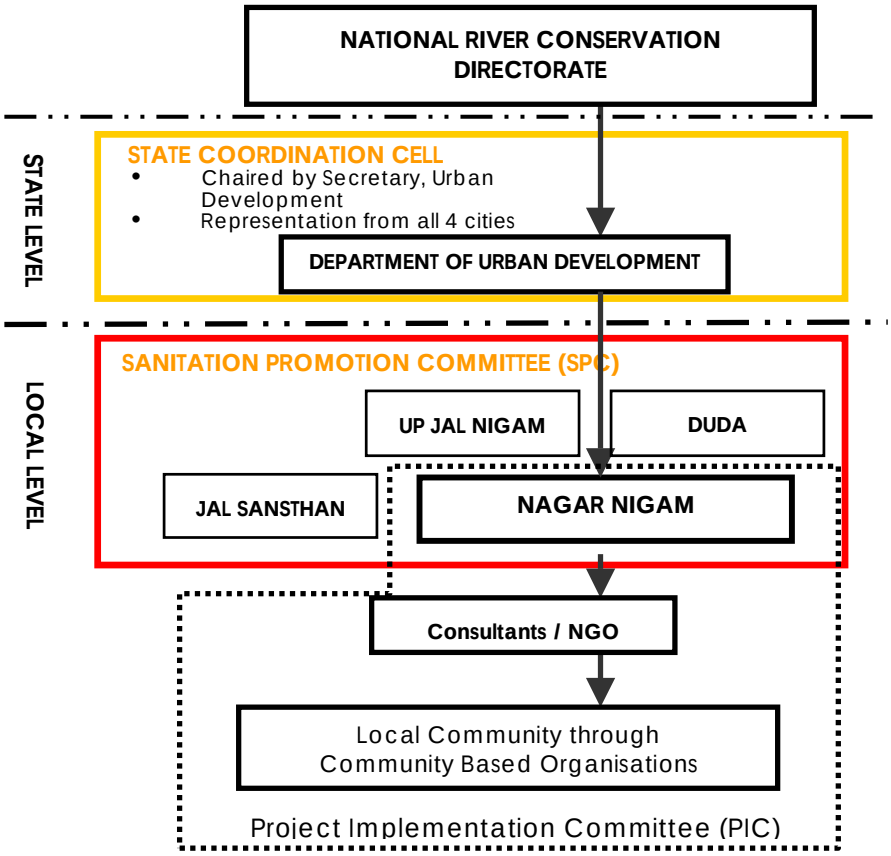


Figure 4.6 Proposed Organisational Structure of the Implementing Agency

(4) Monitoring and Evaluation

There will be two parallel monitoring and evaluation structure for the entire PP/PA programme:

i) Implementing Agency - Prepare reports on the progress of work based on monthly reports from the local consultant and send to NRCD PP/PA Cell (NPPAC).

ii) Community - On the people's side the groups of communities (ward committees and the citizens committee in each city) will report to Project Implementation Committee (PIC) and PIC will report to State Co-ordination Cell. These reports will be sent on quarterly basis.

Such a system will ensure that a check is maintained on the works that are being undertaken and the budgets allocated are utilised properly. Evaluation of Programme will be done in the regular State Co-ordination Cell meetings and once a year evaluation reports are a must.

For the purpose of evaluation, a set of Impact Indicators shall be developed by the local consultant that henceforth shall be circulated to the PIC, NN and the local groups who all shall rate the programmes. The essential function of the impact indicators is to evaluate the effectiveness of PP/PA programmes.

- Operational – Measure information provision, feasibility, and duplicity of each
- Effect – Direct and indirect influences

On the basis of reports and evaluation of the PP/PA Programme, necessary changes in the content and direction of the programme will be made, if required, to make it more effective.

(5) Project Costs

Table 4.28 Cost Estimation for PP/PA (Kanpur)

(Rs.)

Items	Kanpur
Activities SET I	1,364,000
Activities SET II	27,927,000
Fixed Costs (Equipments for NN)	3,810,000
Administrative Activity	14,335,000
Total	**47,436,000**

4.3.5 Operation & Maintenance and Institutional Development Programme

(1) Management Responsibility for Environmental Public Services

The major administrative units that are closely related to water quality management under GAP present hierarchic tiers of the national, the state (Uttar Pradesh State Government) and the municipal levels of organisations. There are two major groups of organisations: One group including Development Authority and Nagar Nigam is associated with urban development and the second group including UP Jal Nigam and UP Pollution Control Board is associated with environmental conservation and pollution control. Both groups are administratively separate entities but coordination amongst these organisations is vital for implementation of NRCP activities.

The division of responsibilities amongst local and state organisations, for development and maintenance of sewerage collection and treatment systems is summarised as follows:

Table 4.29 Management Responsibilities for Environmental Public Services

Management Responsibility	Organisation	Functions
• Master planning	UPJN	• Physical infrastructure (water supply, sewerage and pollution control) • Capacity and location of facilities
	DA	• Spatial arrangement • Land use • Population projections
	UPJS	• Physical infrastructure for water supply facilities • Capacity and location of facilities (water supply)
• Design and construction	UPJN	• Sewerage infrastructure for river pollution abatement Action Plans. • Water supply and sewerage infrastructure for urban development
	DA	• Infrastructure for new development areas
	HDB	• Infrastructure for state housing developments
• Operation and maintenance	UPJN	• Trunks sewers • Interception and treatment works • Storm water pumping stations • Compliance with environmental regulations
	NN	• Storm water drains • Solid waste disposal
	JS	• Sewers and pumping stations • Water supply treatment and distribution works
• Pollution control and monitoring	UPPCB	• Monitoring and preventing entry of polluted wastewater (if they do not meet discharge standards) into nalas and rivers. • Regulating industries

Currently, sewerage facilities are planned, constructed and maintained by many parties without effective coordination. UP Jal Nigam is constructing interception and diversion facilities and sewage treatment plants (downstream facilities) to improve river water quality and Urban Development Agency, Housing and Development Board and Development Authorities is constructing branch sewers (upstream facilities) as and while they develop new urban areas and housing complexes.

Jal Sansthans as well as Nagar Nigams are legally responsible for the sewerage service but they are, in practice, doing only maintenance of the upstream facilities as long as the funds are available. The downstream facilities are operated and maintained by UP Jal Nigam.

Various parts of the sewerage system are constructed, operated and maintained by various organisations for various purposes different from each other. The existing sewerage system has neither been planned, envisaged nor conceived as an integrated one. As a result, inefficient facilities have been constructed and maintained insufficiently without a definite ownership.

(2) Key Issues

There are several institutional and financial weaknesses that adversely affect the quality and extent of sewer coverage as well as ability to provide adequate operation and maintenance. The key issues are summarised as follows:

1) No master plans for urban infrastructure

There is no master planning for physical infrastructure. The absence of a master plan leads to the fragmented and uncoordinated implementation of infrastructure by several implementing agencies, each fulfilling their immediate short-term objectives. As a result several schemes cannot be integrated into the main trunk sewer network.

2) Lack of single point responsibility

Several implementing agencies at state and local levels are developing land and infrastructure in the city. Their efforts are not well coordinated, especially in the absence of a master plan. Although taxes and water charges are collected at the local level, accountability to the citizens for sewerage and drainage problems is obscured by the lack of single point responsibility. Similarly, accountability for achieving water quality objectives is unclear.

3) Insufficient revenue for O&M

Municipal Corporations have the power to implement a tax for water, and a separate sewer/drainage tax. These taxes are based on the annual rental value of the property, which does not reflect the real value of the property. Municipal Corporations also collect revenue from the sale of water through their Jal Sansthans; however the State Government controls the water tariff. Municipal Corporations are allowed to pool all sources of revenue to finance maintenance and development of municipal infrastructure. The revenues are at present insufficient to cover O&M costs.

UPJN has no such source of revenue. It depends on state funding to operate and maintain facilities. At present, local Jal Sansthans are expected to operate all new assets created by other implementing agencies however they do not in general have the required financial or human resources. As a result most Jal Sansthans have refused to accept responsibility for O&M of assets created by UP Jal Nigam.

(3) Improvement of Operation and Maintenance

1) Current O&M Status

The current maintenance practices are reactive rather than preventive and routine as per manual. Most of the maintenance is carried out in response to customer complaints related to overflows etc. These problems are normally resolved by clearance of blockages in the sewer. There is no evidence of a planned regime of cleaning or inspection of the system. Any repairs to the system arise from problems noted during blockage clearance or from customer complaints. Besides this, record keeping is highly limited and in some cases even inaccurate.

From discussions and site visits, it could be stated that maintenance management (for sewerage as well as for water supply) is undertaken on an ad hoc basis. Site work is not always carried out in an organised way. Indeed, at some of the sites, it was not very clear, who was the in-charge official(s). Working practices observed were not in accordance with The Manual on Sewerage and Sewage Treatment (i.e. The Manual on Sewerage and Sewage Treatment, Second Edition prepared by the Expert Committee constituted by the Ministry of Urban Development, Government of India, and published in 1995). During maintenance works, the safety was either non-existent or of very poor quality.

2) Collection System O&M improvements required

Ideally all elements of a sewerage system should receive the highest levels of maintenance to ensure its performance. However, this is an unrealistic aspiration for any sewerage authority to contemplate.

There are three broad policy options:
- Purely reactive
- Totally planned
- Selective planned/reactive

A more appropriate and cost-effective approach is to achieve a balance between planned and reactive maintenance in providing an acceptable and reasonable level of service.

Many parts of a sewer system operate quite satisfactorily with minimum maintenance. The key to a cost effective maintenance strategy is the recognition that maintenance and rehabilitation programmes should retain as much as is practicable of the existing network by a combination of optimising hydraulic performance and the use of renovation. Therefore regular inspection and assessment is required to identify those elements of the sewer system that will require attention on a regular and planned basis. Elsewhere the sewers only need to be dealt with on a reactive basis.

<u>Immediate priorities</u>

- Establish System Records and Maps

  There is an immediate need to collect and to store centrally all existing records of the sewerage network by setting up a comprehensive computerised database at the local level. This database is typically referred to as a sewer inventory.

- Inspect Critical Sewers and Assess Conditions

  A comprehensive survey of critical sewers is required in order to:
  - Develop the sewer inventory data
  - Assess the physical condition of sewers
  - Identify critical sewers and priorities
  - Identify maintenance, rehabilitation or replacement needs

- Upgrade Pumping Stations O&M Procedures

The primary objective of operating and maintaining a pump station is to keep the station in continuous operation in order to prevent sewage overflows to the environment and flooding in upstream reaches of the incoming sewers. The following activities are critical to the successful operation of pumping stations:

- Developing equipment operation and maintenance manuals
- Developing procedures for normal, abnormal, and emergency conditions
- Developing systems for recording daily operating conditions
- Establishing systems for recording equipment maintenance and breakdown history

Long term needs

Long-term measures in line with standard international practices are given in the main report and need to be integrated into a long-term maintenance programme, summarised in the table below:

Table 4.30 Outline of Sewerage Maintenance Programme

Type of activity	Description
Sewer inventory	GIS base maps, data collection, updating
Sewer survey and inspection	Cleaning, CCTV inspection, assess condition, identify critical sewers
Routine inspection & cleaning	Follow-up routine cleaning, CCTV survey
Emergency blockage clearance	Sewer clearance
Sewer & manhole repairs	Emergency repair
Planned maintenance & rehabilitation	Sewer replacement or other rehabilitation technologies
Service connections	Check and repair of existing connections, Installation of new connections
Control of storm water discharge into sewers	Identification of connections, remove connections

3) Treatment facilities O&M improvements required

Operation and maintenance improvements should initially be carried out at the existing sewage treatment works, but this work will effectively be a training ground for establishing procedures and an organisation capable of running the proposed future sewage treatment works.

Accurate records should be maintained which give full details of the design criteria and sizes of treatment units, etc. and comprise a diary of every significant event at the works. These records should be checked on each routine supervisory site visit. The records should include comprehensive details, with drawings and service manuals, for all electrical and mechanical components indicating their dates of manufacture and installation, and a detailed service/maintenance history for each unit. Detected faults should be recorded and reported to ensure that remedial action will be taken as soon as possible to have the faults rectified. Other routine O&M requirements are listed in the main report.

4) Contracting Out

Strengthening the capacity of local Jal Sansthan for O&M of sewerage system is recommended, however, ‘contracting out’ can make good sense economically in the alternatives given below. A decision regarding what tasks/components will be ‘contracted out’ and for what total periods needs to be treated as an urgent matter, as it will greatly influence the staffing requirements of the new sewerage division to be created within JS.

- Contracting out sewer inspection surveys to establish the sewer inventory
- Contracting out design, tender document

- Contracting out sewerage construction supervision
- Contracting out sewage treatment construction supervision
- Contracting out sewerage operation and maintenance
- Contracting out sewage treatment operation and maintenance

The operation and maintenance of the proposed new sewage treatment works for a fixed period could be included as part of a 'turn-key' design and construction contract. Even if it is decided to let some tasks out to another public agency (e.g. UPJN) or to private sector contractors, the Sewerage Authority (NN/JS) should always retain overall responsibility for and should closely control and supervise the work carried out by others, and so it will still require competent managers and supervisors.

(4) Institutional Development and Capacity Building

1) Institutional Development Programme

A single agency should cover the entire sewerage system; from planning to operation and maintenance; from house connection to sewage treatment plant. By this way, comprehensive and organised sewerage will be attained. To achieve this objective, Institutional Development Programme (IDP) was proposed in the Master Plan. The contents of IDP, which have been identified in the Feasibility Study, are as follows:

Framework	Contents
Organisational strengthen	Create and organise sewerage division on basis of objective, principles and guidelines
Operational resource development	Stocktaking of sewerage facilities (asset list), current status of them
Human resource development	Recruitment and training of engineers, operators and business handlers
Financial resource development	Identify or create financial source or revenue source

2) Future Management Structure

The responsibility for O&M should rest with a single sewerage authority that should be integrated with the existing Jal Sansthan. However, in the context of this Report, the proposals made are, for clarity, for the management of sewerage functions only. Several of the technical services, administration and financial functions can be provided by the existing water supply departments. The recommended organisational structure is represented here:

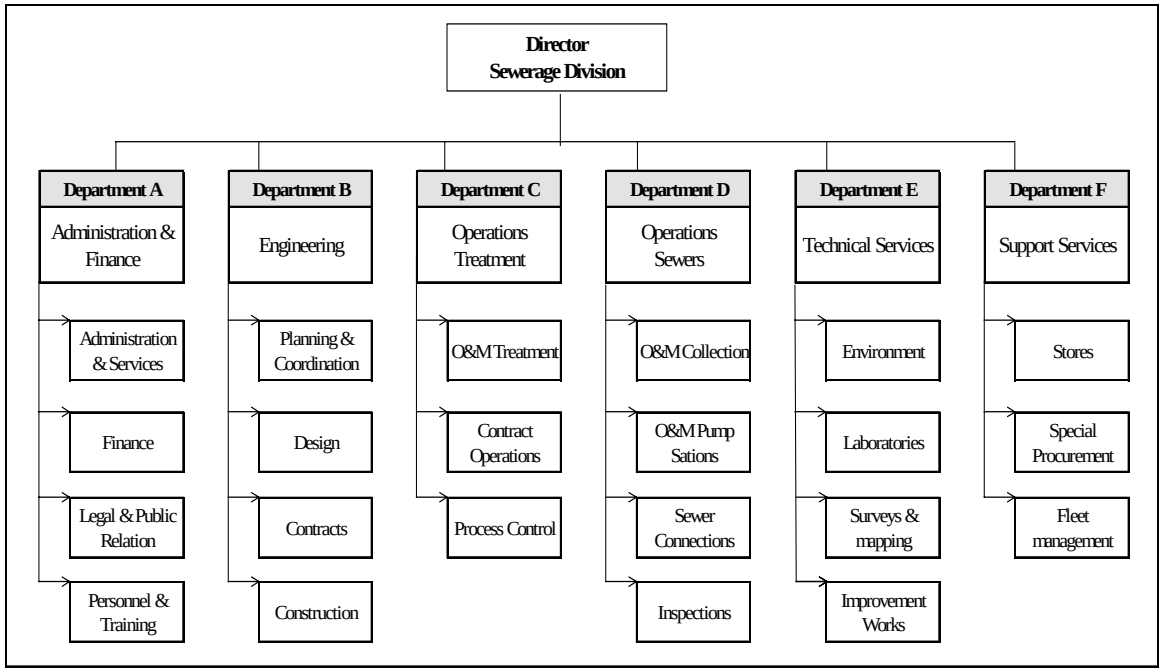


Figure 4.7 Future Management Structure

3) Methodology for setting up proposed new organisation

The following are a methodology for setting up the proposed new organisation.

STEP 1: Decide responsibilities of the Sewerage Division

STEP 2: Decide personnel requirements for Managerial level

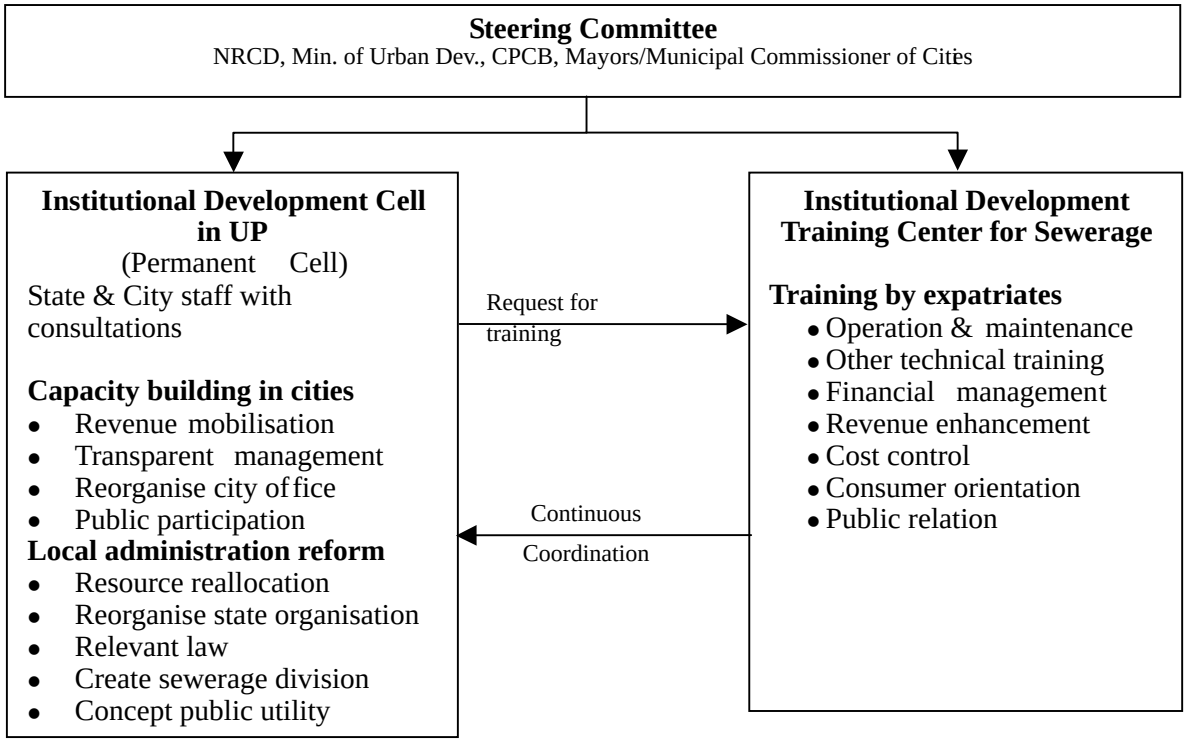
STEP 3: Locate office space and other practical details for management structure

STEP 4: Decide personnel requirements for Worker level

STEP 5: Chalk out policy framework

4) Institutional Development Programme

To implement IDP, Institutional Development Cell (IDC) should be created in the UP State Department of Urban Development. It is also suggested that an "ID Training Centre for Sewerage" should be established at the national or state level to satisfy the training needs for the personnel. Staff shall be selected from the State Government (UP Jal Nigam) and city offices (Nagar Nigams and Jal Sansthans). The implementation structure is presented in the following figures.



5) Institutional Development and Capacity Building (IDCB)

The strategic action plan for Institutional Development and Capacity Building (IDCB) is primarily identified and summarised as presented in Table 4.32.

(5) Cost Estimation of IDCB

Table 4.31 Cost Estimation for IDCB (Kanpur)

(1,000 Rs.)

Sr.	Description	Cost
1	IDP Consultancy Services	70,700
2	Training	84,000
3	Infrastructure Enhancement	28,300
Total		**183,000**

Table 4.32 Action Plan for Institutional Development and Capacity Building (IDCB)

Sr.	Objective	Action	Agency
A. Financial Sustainability			
1	1. Reduce Costs	Measures to reduce power consumption have to be implemented.	Organisation
2		Reduce number of non-technical staff.	Organisation
3		An "on the job" training should be implemented to increase the productivity of the personnel.	Consultant
4		The expenditure - "Interest/dividends" on Government capital – has to be reduced/eliminated, if possible.	Organisation
5	2. Increase Revenue	• Carry out property survey along with the size and type of water connection and broaden the tax net in the short term. • As a long term planning strategy, create a GIS database of the existing properties, water and sewerage system and integrate this database with the property permission applications.	Consultant Consultant
6		Along with the property survey, a re-assessment of the property values should be carried out to have realistic basis for property tax.	Consultant
7		• Start the process of water and sewerage charges based on dual criteria of property tax and size of water connection. • Initiate, a study to evaluate the implementation of metering over the entire city.	Consultant Consultant
8		The whole billing system has to be computerized and the staff to be trained to undertake this assignment.	Consultant
9		Formulation of the incentive scheme, based on the amount collected and the number of bills collected	Organisation
10		Carry out a detail study to assess the market for selling the by products generated from the STP	Consultant
11		As a long term strategy, the JS should pursue the UP Government to link the tariff with the cost of production, specifically the cost of electricity charges.	Organisation/ Consultant
B. Institutional Capacity Building			
12	Human Resource Development	Determine the requirement of technical manpower and recruit/ contract requisite manpower	Consultant
13		Identification of the training needs, development of training programs and selection of the training institute.	Consultant
14		Conduct a detail study to identify the opportunities for public private partnership programs	Consultant
15	Infrastructure Development	Procure hardware and software for creating a sewerage system inventory and develop a GIS based sewer application for visual interpretation.	Consultant
16		Procure engineering equipment for proper maintenance of the sewerage system.	Consultant
C. Communication			
17	Communication	Establish a comprehensive and reliable communication system between the organisations involved and PMC.	Consultant
D. Institutional Development			
18	Institutional setting up	Establishment of Sewerage Division in Jal Sansthan and Nagar Nigam	Organisation/ Consultant
19		Capacity Building of City Office (Nagar Nigam)	Organisation/ Consultant

4.3.6 Summary of Total Project Costs and Implementation Schedule

The project costs of Sewerage, Non-sewerage, Public Participation and Awareness and Institutional Development Programme for Kanpur are summarised in the table below.

Table 4.33 Summary of Project Cost by Components (Kanpur)

(Million Rs.)

Item	Capital Cost	Physical contingencies, Engineering, Project administration	Land Acquisition	Total Project Cost
Sewerage Scheme	3,172.5	666.3	65.7	3,904.5
Non-Sewerage Scheme	70.3	17.6	0.0	87.9
Public Participation and Awareness	-	-	-	47.4
Institutional Development Programme	-	-	-	183.0
Total	**3,242.8**	**683.9**	**65.7**	**4,222.8**

The implementation of the total project and year wise fund flow requirement is presented in the table below.

Table 4.34 Summary of Project Implementation (Kanpur)

(Million Rs.)

Item	Total Project Cost	2007	2008	2009	2010	2011	2012
Sewerage Scheme	3,904.5	210.5	797.7	608.1	762.7	998.4	527.1
Non-Sewerage Scheme	87.9	2.9	23.2	21.9	20.4	19.5	0.0
Public Participation and Awareness	47.4	9.7	7.6	7.4	7.6	7.4	7.7
Institutional Development Programme	183.0	36.5	54.9	54.9	18.3	9.2	9.2
Total	**4,222.8**	**259.6**	**883.4**	**692.3**	**809.0**	**1,034.5**	**544.0**

4.3.7 Water Quality Estimation With Project

Estimated water quality with project and without project scenarios for 2015 is compared in the table below. The without scenario includes the projects sanctioned and in process of sanction. The future water quality is estimated for the Ganga river at the downstream of the city.

Table 4.35 Comparison of With and Without Project in year 2015

Item	Without Project	With Project
Estimated wastewater discharged in 2015	396.9 mld	396.9 mld
Treatment capacity in 2015	160 mld	203 mld
Diversion to Pandu river basin in 2015	135.8 mld	193.9 mld
Untreated wastewater in 2015	101.1 mld	0 mld
Percentage of untreated wastewater in 2015	25 %	0 %
Estimated BOD discharge (untreated + treated)	35.13 ton-BOD/day	6.09 ton-BOD/day
BOD concentration at upstream (u/s) of city (assumption)	2.5 mg/l	2.5 mg/l
BOD contribution to the river (if treated water is used for irrigation)	+3.8 mg/l (+3.2 mg/l)	+0.6 mg/l (+0.0 mg/l)
BOD concentration at downstream (d/s) of city (if treated water is used for irrigation)	6.3 mg/l (5.7 mg/l)	3.1 mg/l (2.5 mg/l)
Environment for bathing	Large volume of wastewater will be discharged in the Ganga, by which unhygienic condition for bathing will be further degraded.	All wastewater except in District IV will be intercepted and treated before entering the Ganga. Bathing environment will improve.
Protection of water source of drinking water	Discharge of wastewater upstream of the municipal water intake will be kept continued and thus the water quality of water supply source will be further degraded.	The wastewater discharged upstream of the municipal intake will be intercepted and treated and thus the source will be protected.
Water quality of effluent of existing and proposed STP	Bacterial pollution will increase because of no disinfection facility	Chlorination or maturation pond will be applied to both existing and proposed STPs. Bacterial pollution will be reduced.

Note:
1) The dry flow of the Ganga river is used for analysis.
2) BOD concentrations of untreated and treated wastewater of 300 mg/l and 30 mg/l are used for analysis.
3) The sanctioned project includes 200 mld STP at Bingawan and is assumed to be implemented.

If the project is implemented (with the project scenario), 100 % of the wastewater discharged to the Ganga river will be intercepted and treated in 2015. While if the project is not implemented (without the project scenario) 75 % is treated and the rest of wastewater discharged will find its way to the Ganga degrading its water quality and river environment and also affect the downstream cities such as Allahabad and Varanasi. The preliminary estimation shows that the BOD concentration in downstream of Kanpur will be 6.3 mg/l without the project and 3.1 mg/l with the project assuming 2.5 mg/l at upstream of the city. If treated effluent is used for irrigation, the BOD concentration in 2015 with the project will be 2.5 mg/l.

4.3.8 Economic and Financial Evaluation

(1) Financial Evaluation

Economic benefits of the proposed project are identified as follows:

1) Increment of willingness to pay (WTP) for improvement of water quality of the river Gomti estimated by Contingency Valuation Method (CVM)

2) Increment of WTP for improvement of sewage treatment systems estimated by CVM
3) Saving of medical expenditure due to decrease of suffering rate of water borne diseases derived from the improvement of water environment
4) Increase in saving due to decrease of suffering rate of water borne diseases also derived from the improvement of water environment
5) Contribution to regional economy derived from incremental increase of bathing population at the ghats along the river Gomti, and
6) Agricultural benefit from utilisation of treated effluent for irrigation.

Following table shows their estimated unit values.

As of 2004 Price Level

WTP for Improvement of Water Quality of the river Gomti	WTP for Sewage Treatment Services	Incremental Saving of Medical Expenses due to Decrease of Suffering Rate of Water Borne Diseases		Incremental Saving of Salaries/Wages due to Decrease of Suffering Rate of Water Borne Diseases		Contribution to Local Economy Derived from Bathing Population From Regular Users	Agricultural Benefit (Paddy + Wheat)
		Outpatient	Inpatient	Outpatient	Inpatient		
(Unit: Rs./Annum per House Hold)						(Unit: Rs./Annum per person)	(Unit: Rs./Annum per hectare)
354	1,250	10.7	141.2	2.6	7.6	17,852	6,932

Annual economic benefits for (1) above can be estimated by basic unit multiplying the entire households (HHs) in the project area, for (2), (3) and (4): the number of HHs connected, for (5): the incremental bathing population, and (6): the incremental irrigation area (ha).

Using annual cash stream of economic cost and benefit, the following results of economic evaluation are obtained. The EIRR is estimated at 7.2 %.

Index	Discount rate 10 %	Discount rate 5%
NPV	- 588 million Rs.	1,011 million Rs.
EIRR	7.2 %	7.2 %
B/C	0.81	1.18

(2) Financial Evaluation

Sewerage projects are public works and their financial viability cannot be worked out using standard financial evaluation techniques as they cannot generate profit or expect cost recovery as their objective. The main objective of such project is to provide better living conditions to the residents of the city and also make the environment clean and friendly. Hence it cannot be evaluated as a commercial project for cost recoveries and profit objectives.

The financial evaluation is made only for operation and maintenance cost recovery. The project is financially evaluated preparing a cash stream. The required user charge to recover the entire O&M and replacement cost assuming exiting bill collection rate is estimated at Rs. 1,720 per annum per household. The estimated average current sewer charge per bill is Rs.1,221 per annum. The required user charge is about 1.4 times higher than the current charge level and is close to the estimated maximum affordability to pay of Rs. 1,648 per annum.

The amount of revenue generated from taxes and charges by the Service Provider, Kanpur Jal Sansthan, could cover only around 59 % of the total O&M cost in 2015 under existing conditions.

(3) Case Study for Improvement of Financial Situation

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.

- Improvement of billing and bill collection
- Utilise the by-products of sewerage system
- Others such as improvement of accounting system

Following figure shows the conservative projection of the number of the entire household in the city area, the households in the sewer area, the sewer connected household (or sewer charge billing household) and sewer bill collected households until the target year 2015 based on existing collection rate. As seen in the figure, there is a high potential to increase sewer connection and improve sewer charge collection efficiency.

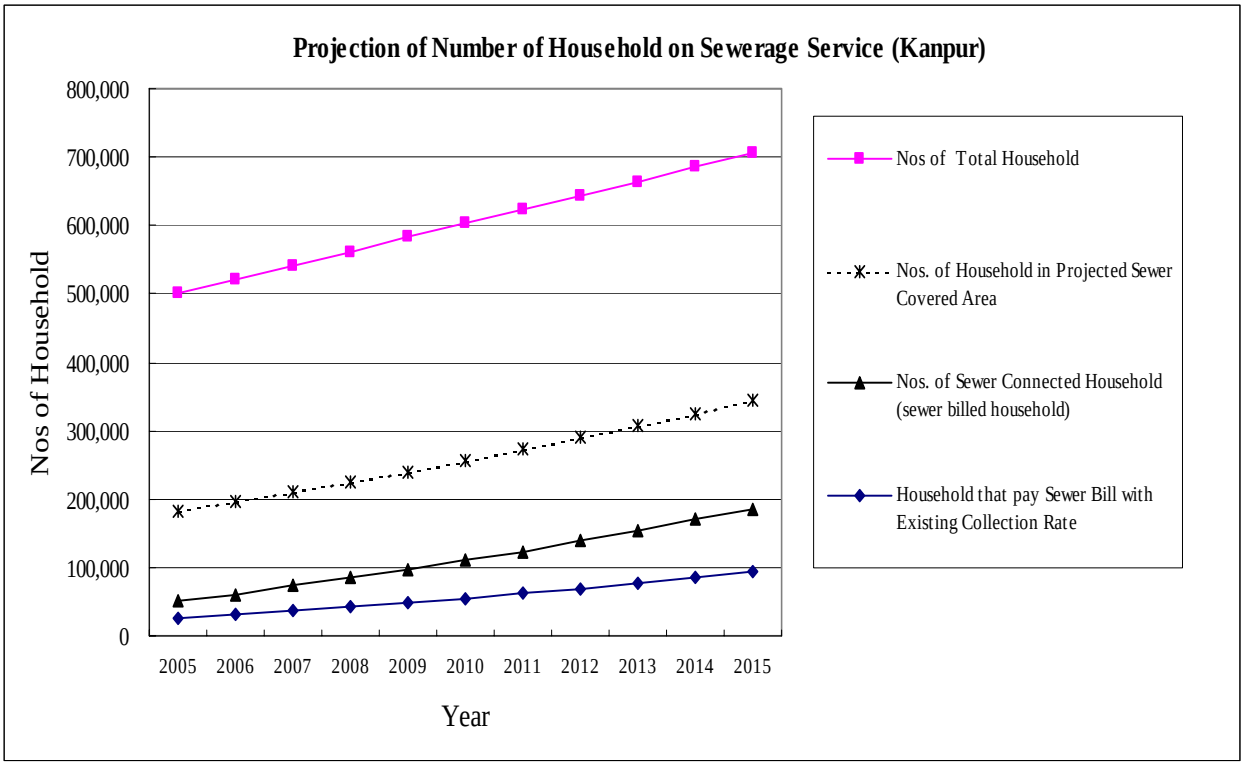


Figure 4.8 Number of Total Households in the City, Household in the Sewerage Service Area, Sewer Connected Household and Sewer Bill Collected Households

Following table shows a result of the case study taking into account the additional sources of revenue and improvement in the charge collection rate and charge level and sewer connection rate.

Table 4.36 Summary of Case Studies for Recovering of O&M Cost

Case in Sewer Charge level	Total O&M Cost required	Base Case		Case - 1			
		Revenue from sewer charge	Amount to be borne by State Transfer	Revenue from sewer charge	Optional Sources		Amount to be borne by State Transfer
					Revenue from treated water sales	Revenue from sludge sales	
Million Rs./year							
Existing	260.5	153.2	107.3	245.1	3.9	13.7	-2.2
70 % up	260.5	260.4	0.1				
Conditions		Exiting sewer collection rate		1) 0% increase of sewer charge 2) Increase of collection rate from 50 % to 80 % 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)			

Note:

City	Existing Collection Rate of Bills	Existing Charge Level (Rs./Bill/ Year)	Affordability to Pay based on the income level: 1.5 % of average annual income per HH (Rs. per annum)
Lucknow:	80%	573	2,775
Kanpur:	50%	1,221	1,648
Allahabad:	56%	265	1,964
Varanasi	78%	112	1,889

In case that sewer charge remain same as the existing level and sewer bill collection rate is increased from 50 % to 80 % O&M cost expenditure and sewerage revenue would be balanced. This result is derived from the current average sewer charge per bill of Rs. 1,221.

(4) Recommendations

To improve financial feasibility of the project, following measures are recommended:

1. Improvement of billing and bill collection, consisting of:
   - Increase in tax net
   - Reassessment of property values and annual rental value
   - Reduction of process time per bill
   - Increase in productivity by introducing incentive schemes

2. Utilisation of by-products, consisting of:
   - Treated water for irrigation
   - Generated sludge as fertiliser

3. Finding of government subsidy or other financial source for operation and maintenance cost

4.3.9 Stakeholder Meeting for Kanpur Project

In accordance with the JICA guideline of Environmental and Social Considerations, a stakeholder meeting was held for the purpose of informing the feasibility study (F/S) project for Kanpur city to the stakeholders and public. The objective of stakeholder meeting was to encourage the recipient governments to take appropriate considerations of environmental and social factors in the project.

The meeting was organised by Department of Urban Development, Government of UP, and under this, Kanpur Nagar Nigam, UP Jal Nigam, Kanpur Jal Sansthan had the responsibility to hold the meeting in collaboration with the JICA Study Team. The organisers in consultation with JICA Study Team decided the range of stakeholders to be invited to the meeting and following stakeholders were selected;

- Elected Public Representatives
- Ministries and Govt. Agencies
- Project Affected People
- Officers of UP State Government and State Undertakings
- International Organisations and Donors
- NGOs
- Well-Informed Persons / Experts
- Media

(1) Joint-Meeting

Before stakeholder meetings, a joint preparatory meeting was held on 28th January 2005 to present and discuss the contents of the project and the procedure of the proposed stakeholders meetings in three towns and resort necessary modifications based on the feed back of the discussions with counterpart agencies of Nagar Nigams, Jal Sansthans, UP Jal Nigam officers of three cities. Besides, representatives from Govt. of UP also participated in the meeting.

(2) Press Release

To inform about the Stakeholder Meetings and brief on the project contents to the general public, press releases to newspapers were conducted on 29th January 2005.

(3) Stakeholder Meeting

Based on the guideline, a stakeholder meeting was held at Kanpur. The details are as below:

- Date: 4th February 2005
- Venue: Merchant's Chamber of UP
- Participants: Over 200 participants from various stakeholders

The key issues raised by participants and reaction of the organisers/JICA Study Team are as below:

Question	Answer
What about the provision of branch sewers especially in areas like Labour Colonies and adjoining villages?	For slum areas like Labour Colonies and adjoining villages there is a provision of community toilets in the scheme.
Provision of treating industrial waste has been made in the scheme or not?	The project under consideration does not include provision to tackle the industrial waste. Provision of tackling pollution of river due to the untreated discharge of domestic sewage only has been made in this scheme.
How about the provision of funding of operation and maintenance cost in this scheme?	There is no provision for operation and maintenance cost in this scheme. However, to improve the income, different measures have been out lined in the report of the scheme.

Comment from participants:

- A concrete planning for keeping river Ganga clean should be made and implemented as the earlier action taken could not be result oriented.
- O&M cost need to be ensured as existing STP in Kanpur has almost completely collapsed due to scarcity of O&M cost.
- It is suggested that groups should be formed before the start up work so that the results of the scheme is fruitful. If the scheme gets full cooperation of the groups, public will also join hands in this scheme.
- Dead bodies of animals, unclaimed dead bodies etc. are thrown in river Ganga. A procedure should be designed so that last rites of above can be performed at a specific place. The people who perform these types of acts should be punished.
- The population of slums in Kanpur has been mentioned as 4.3 lacs. The Institute of Urban Studies, about 10 years ago made a study and said that out of the 1991 census population of 24 lacs, 2/3rd were slum dwellers. The figures should be rechecked for a realistic sewage disposal plan.
- The cost of construction should not be more than the budgeted figure to avoid complications in future.
- All the treatment plants should run regularly which will automatically make the project successful. If operation and maintenance of above scheme is not strictly monitored, this scheme will also remain like the other previous schemes.

The answers to the comments are attached in Volume IV-2, Part VI.

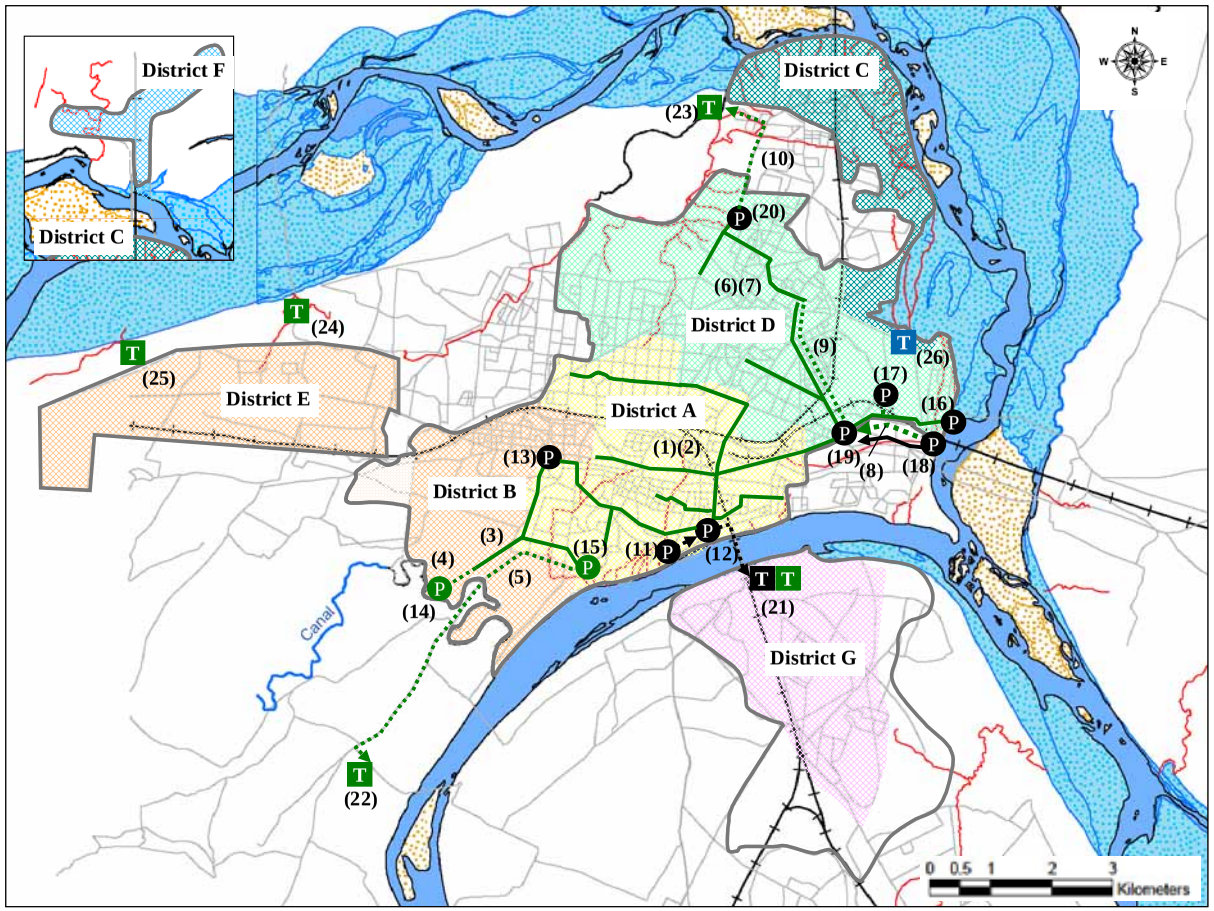
The minutes of meeting, participants' list, comments from participants and answers from the organisers were made available to the public at the offices of KNN, UPJN and KJS. The same are also available to the public in JICA Study Team's Homepage.

4.4 FEASIBILITY STUDY FOR ALLAHABAD

4.4.1 Sewerage Scheme

(1) Proposed Components for Feasibility Study

The JICA Study Team has prepared the Master Plan (M/P) for the Allahabad sewerage system. The Master Plan identified certain 'Priority Projects' that are to be implemented within 1-5 years of adopting the MP, with the aim of reducing the pollution load on Ganga and Yamuna rivers at Allahabad. These proposed facilities are shown in Figure 4.9. These facilities shall work together with the major sanctioned and commissioned projects listed in the same table.



Legend

- Municipal Boundary
- Sewer
- Rising Main
- Pump Station
- Treatment Plant

Black : Existing Facility
Blue : Sanctioned Facility
Green : Proposed Facility

	Sewer / Rising Main	District	Status	Diameter / Length
1	Existing trunk sewer in District A	A	E/R/Rp	Desilting: 600-1150 mm, 4.1 km Rehb.: 700-1400 mm, 1.7 km Replace.: 700-1400 mm, 5.2 km
2	New trunk sewer in District A	A	P	500-700 mm, 4.0 km
3	New trunk sewer in District B	B	P	300-1000 mm, 4.9 km
4	Rising main of Sasur Kaderi SPS	B	P	600 mm, 0.2 km
5	Rising main of Ghaghar Nala SPS	B	P	1000 mm, 7.7 km
6	Existing trunk sewer in District D	D	E/R	Desilting: 500-1300 mm, 5.5 km
		D	E/Rp	Replace.: 500-1300 mm, 3.8 km
7	New trunk sewer in District D	D	P	450-1200 mm, 6.7 km
8	Rising main of Morigate SPS	D	P	800 mm, 1.8 km
9	Rising main of Alopibagh SPS	D	P	1000 mm, 3.1 km
10	Rising main of Mumfordganj SPS	D	P	1000 mm, 2.7 km

	Pumping Station	District	Status	Capacity (mld)	Remarks
11	Chachar nala SPS	A	E/R	30	Average flow in 2015
12	Gaughat SPS	A	E/R	80	
13	Lukerganj SPS	B	E/R	9.2	
14	Sasur Kaderi SPS	B	P	13	
15	Ghaghar nala SPS	B	P	50	
16	Daraganj SPS	D	E/R	2.6	
17	Allahpur SPS	D	E/R/A	2.8	
18	Morigate SPS (Additional)	D	E/A	6	
19	Alopibagh SPS	D	E/R/A	44.5	
20	Mumfordganj SPS	D	E/R/A	50	

	Treatment Plant	District	Status	Capacity (mld)	Remarks
21	Naini STP (ASP)	A	E/A	80	Average flow in 2015
22	Numaya Dahi STP (WSP)	B	P	50	
23	Rajapur STP (UASB)	D	P	65	
24	Kodara STP (UASB)	E	P	15	
25	Ponghat STP (WSP)	E	P	10	
Total				220	

Existing / Sanctioned Facility

	Facility	District	Status	Remarks
26	Salori STP (FAB)	C	S	

E: Existing R: Rehabilitation
S: Sanctioned A: Augmentation
P: Proposed Rp: Replacement

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PROJECT	LOCATION	Figure 4.9
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	Allahabad City	Proposed Sewerage Facilities for Feasibility Study (Allahabad)

(2) Design Data and Parameters

Project Design Horizon

The design period considered for sewers is 30 years (single phase). Civil works for pumping station facilities are designed also for 30 years, Electrical and Mechanical (E&M) works are designed for two-staged implementation, first stage up to 2015 and second stage up to 2030. Treatment facilities will be implemented in two stages as well. First stage would be up to 2015 and wherever flow increases / raw wastewater quality changes after 2015, the treatment facility would be augmented for the requirement of 2030.

Sewerage Districts Planning

The Master Plan has divided Allahabad into seven sewerage districts viz. District A-G. All the Priority projects identified in the Master Plan falls into four districts viz. District A, B, D and E.

Design Population

The population of Allahabad as per 2001 census is 1,081,622. Growth rates for each district have been calculated based on the growth potential of the district. With these growth rates and with 2001 census figure as the base, the Master Plan has calculated population figures for each sewerage district; these are presented in the table below.

Table 4.37 Population Projection for Urban Area (Allahabad)

Sewer Service Areas	Population within Municipal Area		
	2003	2015	2030
District A	374,000	432,000	503,000
District B	120,000	182,000	262,000
District C	113,000	159,000	226,000
District D	275,000	364,000	502,000
District E	97,000	154,000	259,000
District F	21,000	37,000	56,000
District G	101,000	163,000	267,000
Total	**1,101,000**	**1,491,000**	**2,076,000**

Water Supply Status

The main water sources for municipal supply are the Yamuna river (from raw water pumping station located at Karelibagh) and deep tube-wells. In 2003, intake from the river was about 80 mld and from the deep tube wells was 137 mld. Hence, total estimated water production from municipal supplies in 2003 was 217 mld.

The per capita water consumption of municipal water calculates to 180 litres per capita per day (lpcd). This has been modified in the Master Plan, to account for water consumed from private supplies, unaccounted-for water (UFW) and industrial consumption. The final figures work out to 295 lpcd for 2003, 254 lpcd for 2015 and 221 lpcd for 2030.

Waste Water Quantity Generated

Per capita wastewater discharge has been arrived at in the Master Plan by applying a return factor of 0.7 on the per capita water consumption (lpcd). The final figures for wastewater generated in the seven districts are shown in the table below:

Table 4.38 Waste Water Generated

Sewer Service Areas	Wastewater Generated in mld		
	2003	2015	2030
District A	76.62	75.67	78.03
District B	24.60	31.77	40.69
District C	23.20	27.77	35.02
District D	56.34	63.78	77.87
District E	19.86	26.92	40.13
District F	4.37	6.46	8.74
District G	20.76	28.46	41.38
Total	**225.75**	**260.83**	**321.86**

Design Flow for Sewers

The design flows for all trunk sewers have been calculated and specified in the Master Plan based on the population of the catchment area and connection ratios. These flows have been considered for preliminary design.

Pumping Capacity and Configuration

For large capacity plants (or critical facilities) equal capacity pumps (6 to 8) have been proposed, with 50% or more stand-by on peak flow, and 100% or more standby for non-peak flow.

Design Capacities for STPs

As per the final sewerage system configuration adopted in the Master Plan, 4 new STPs are to be constructed and the existing 60 mld STP at Naini will be augmented to 80 mld.

Table 4.39 Design Capacity for STPs

Location	Catchment Area	Capacity (mld)	
		Year 2015	Year 2030
Naini STP	District A	80	80
Numaya Dahi STP	District B	50	50
Rajapur STP	District D	65	80
Ponghat STP	District E	10	10
Kodara STP	District E	15	30

Raw Sewage Characteristics

The raw sewage characteristics for the various STPs have been decided based on the ratio of flow tapped via nalas to the flow reaching the STP via piped sewers.

Table 4.40 Raw Sewage Characteristics

Sr.	Parameter	Rajapur STP		N.Dahi STP		Ponghat STP		Kodara STP	
		2015	2030	2015	2030	2015	2030	2015	2030
1	Minimum Temperature, ^{o}C	20	20	20	20	20	20	20	20
2	pH	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5
3	Biochemical Oxygen Demand (BOD5), mg/l	103	250	112	225	115	200	115	200
4	Total Suspended Solids, mg/l	185	450	200	400	207	360	207	360
5	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$

In stage I (year 2015), the wastewater will be diluted due to a greater proportion of nala flow in it. As the implementation of sewerage system progresses, the wastewater will become stronger. The strength of wastewater will also increase due to progressive reduction in the per capita water supply.

Treated Effluent Characteristics

The effluent standards considered in the design of STPs, as specified in the Master Plan and in accordance with NRCD guidelines, are listed in the table below.

Table 4.41 Treated Wastewater Quality

Parameter	Value
pH	5.5 – 9.0
Biochemical Oxygen Demand, mg/l	< 30
Total Suspended Solids, mg/l	< 50
Faecal Coliform Count, MPN/100ml	<10,000

Wastewater Treatment Technologies

Treatment technologies with a proven track record in the country have been compared. The comparison is considered in view of the following constraints, to recommend the final treatment technology to be adopted:

- Land availability within the urbanised area is limited
- The city faces long power cuts almost everyday

Hence, treatment technologies preferred are those that have less land area and power requirements and have a high reliability in face of long and frequent power cuts. In general, either Waste Stabilisation Ponds or Upflow Anaerobic Sludge Blanket (UASB) with a suitable post treatment has been chosen, based on the requirement of the specific site. Besides, if augmentation is proposed and land has been procured for that purpose in existing STP sites, same technology as existing one has been adopted considering coherence of the facility and operation and maintenance.

(3) Summary of Proposed Sewerage Facilities Under Feasibility Study

1) Sewerage District A

Sewerage District A covers the densely populated central core of the city and has a well developed existing sewerage system. It drains into Yamuna river, which forms its southern boundary. The existing sewerage system consists of the following:

- Six existing trunk sewers of total length 11.0 km– only 2.1 km stretch is of concrete pipes, rest are brick sewers.
- Gaughat MPS, peak capacity – 160 mld.
- Chachar nala SPS, peak capacity – 57 mld.
- 60 mld Naini STP.

i) Existing Sewerage Pattern

The trunk sewers of District A drain into the existing Gaughat MPS, which is located on the left bank of Yamuna river and is at present the main SPS of Allahabad. It pumps an average of 66 mld wastewater to the Naini STP located on the right bank of Yamuna river. The sewage flowing into Gaughat MPS is much more than the treatment capacity of Naini STP and the sewage overflows into Yamuna river untreated.

In addition to the flows of District A, Gaughat MPS also receives the waste water of Districts D via two rising mains from Alopibagh SPS (in District D), which in turn receives flows from Mumfordganj SPS, Daraganj and Allahpur SPS, all of which also lie in District D. A portion of District B also drains into the Gaughat MPS via an existing 54" trunk sewer, which carries sewage pumped from Lukerganj SPS located in District B.

ii) Proposed Sewerage Pattern

In the proposed system, the sewage from Alopibagh SPS will be diverted to Mumfordganj SPS. Flow from Lukerganj SPS will be diverted to the new proposed Ghaghar nala SPS in District B. Hence, Gaughat MPS will receive flow only from the catchment consisting of District A. This is expected to be below 80 mld till 2030. Naini STP will be augmented to treat 80 mld flow. In this manner, overflows from Gaughat MPS are proposed to be eliminated.

iii) Recommendations for Existing Sewers

- Desilting and continued use of existing trunk sewers: 600 - 1150 mm dia, 4.1 km
- Replacement of existing trunk sewers: 700 - 1400 mm dia, 5.2 km
- Rehabilitation of existing trunk sewer: 700 - 1400 mm dia, 1.7 km

iv) Recommendations for Existing Pumping Stations – Gaughat SPS

The Gaughat SPS was commissioned in the year 1988. At present it receives almost the entire volume of sewage collected by the sewerage system in Allahabad. Upon implementation of the scheme proposed in the Master Plan, this pumping station will receive only the wastewater generated in District A, including the wastewater intercepted at Chachar nala SPS. Present peak capacity - 160 mld; discharge in the year 2030 - 160 mld.

Rehabilitation proposed:

- Replace the two sets of mechanical bar screens
- Accurate alignment tools are required to minimise the vibration thus ensuring smooth operation of the pumps.

v) Recommendations for Existing Pumping Stations – Chachar Nala SPS

This SPS was implemented under the Ganga Action Plan (GAP) to intercept the Chachar

nala. The catchment of Chachar nala is a part of District A.

Present peak capacity: 57 mld;
Average flow: 34 mld in 2003, 25.6 mld in 2015 and 12 mld in 2030

Rehabilitation and augmentation proposed:

- Pump replacement, same capacity and head, as the existing pumps
- The sump must be enlarged by year 2015.
- Mechanical bar screens 2 Nos. and manual bar screens 3 Nos. with necessary sluice gates, channels for diverting the flow are to be provided.

vi) Recommendations for Existing STP

The Naini sewage treatment plant receives wastewater from Gaughat MPS through two mild steel (MS) rising mains, one of 900 mm dia. and other of 700 mm dia. These two mains are laid on the old rail cum road bridge. The existing rising mains can carry 80 mld flow to the STP. Construction of new rising mains along the existing bridges has been disallowed by the rail and road authorities. Furthermore, leaks or a large break in the rising main could have serious environmental consequences. Hence, ultimate capacity of Naini STP is limited to 80 mld.

Naini STP is based on Activated Sludge Process. Presently three streams (total 60 mld) have been constructed; provision has been kept for an additional stream of 20 mld. The treated effluent from the plant is being utilised for irrigation to the nearby areas and rest is finally discharged into Ganga river down stream of Sangam. However, the treated effluent being utilised for irrigation has a high MPN count.

Augmentation of the plant from the existing 60 mld to 80 mld can be done by adding a unit of grit removal, primary sedimentation tank (PST), aeration arrangement and a final settling tank or secondary sedimentation tank (SST) of 20 mld. The other structures are already existing for 80 mld.

Design summary of new plant units to be provided is as follows:

- Additional 20 mld AS unit
- Modification of the process to ensure disposal of excess sludge from SST directly to the digesters
- Providing gas engines for power production (cost considered in the report)
- Providing chlorination facilities for 80 mld capacity.

vii) New Sewers / Rising Mains proposed

The new facilities proposed for this district are:

- Construction of new trunk sewers – 500-700mm in dia, 4.0 km RCC pipes

2) Sewerage District D

Sewerage District D is the rapidly growing zone of the city; the existing sewerage system in this area is relatively new. The district is bound on the eastern side by Ganga river and on the south side by Yamuna river.

The existing sewerage system in District D consists of the following:

- 9.3 km of trunk sewers – only 2.6 km is of concrete pipes, rest are brick sewers.
- Alopibagh SPS, peak capacity – 74 mld.
- Mori gate SPS, peak capacity – 18 mld.
- Allahpur SPS, peak capacity – 5.6 mld.
- Daraganj SPS, peak capacity – 5.2 mld.
- Mumfordganj SPS, peak capacity – 13.7 mld.

i) Existing Sewerage Pattern

All sewage / pumped wastewater of the district converges towards the Alopibagh SPS which lies towards the southern boundary of the district.

The trunk sewers of the area flow southwards into the Alopibagh SPS. The Daraganj and Allahpur SPS pump collected flows into the trunk sewer on Allahapur road, which discharges into the Alopibagh SPS. The wastewater from Morigate SPS reaches the Alopibagh SPS via a 500 mm dia rising main. Flow from the Mumfordganj SPS is pumped half way to the Alopibagh SPS, up to a local ridgeline and from thereon travels under gravity. Alopibagh SPS pumps all collected flows to Gaughat MPS in District A.

ii) Proposed Sewerage Pattern

To divert flow in excess of 80 mld away from the Gaughat MPS, the flow pattern in District D will be reconfigured to some extent. The flows from Daraganj, Allahpur and Morigate SPS will continue as at present, to the Alopibagh SPS. However Alopibagh SPS itself will discharge into the Mumfordganj SPS instead of Gaughat MPS. From Mumfordganj, the wastewater will be pumped to the proposed Rajapur STP which is to be located towards the north, on the bank of Ganga river.

iii) Recommendations for Existing Sewers

- Desilting and continued use of existing trunk sewers: 500 - 1300 mm dia, 5.5 km
- Replacement of existing trunk sewers: 500 - 1300 mm dia, 3.8 km

iv) Recommendations for Existing Pumping Stations – Alopibagh SPS

This SPS was originally commissioned in the year 1964 and renovated as a part of Ganga Action Plan in the year of 1988. At present it receives wastewater through sewers from parts of District D. Furthermore, it receives sewage from Morigate, Allahpur, Daraganj and Mumfordganj SPS. The future catchment area will be reduced by the re-organisation of the sewer system.

Present peak capacity - 74 mld; flow in 2003 - 88 mld, in 2015 – 92 mld and 89 mld in 2030.

Rehabilitation and augmentation proposed:

- A new inlet chamber of 4.8 x 2.4 m to receive the wastewater from various sources.
- An additional wet sump has been created to cater to additional pumps; this sump is connected to the old sump for distribution of flow to the two wet sumps.
- 2 new submersible pumps of 15,960 liters per minute (lpm) at a head of 24 m have been provided in the new wet sump. Rising main and trunk sewers have to be connected from the old sump to new inlet chamber.

- Two fine mechanical bar screens along with conveyor belt and a 3rd channel with a manual bar screen.
- Existing two pumps of 20,000 lpm at 20 m head to be replaced with two pumps of 15,960 lpm at head 24 m.
- Existing two pumps of 11,300 lpm at 9 m head to be replaced with two pumps of 15,960 lpm at head 24 m.
- A new header of 600 mm dia collector pipe shall be provided for the new submersible pumps proposed in the newly created wet sump.
- 630 kVA transformers – 2 Nos.
- Necessary electrical system
- DG set to be connected through AMF panel to the LT panel.
- Existing Generator room to be modified for converting it to LT control room.
- Existing storeroom to be converted for installing DG set.
- Some rehabilitation of existing civil structure of the pump house is also required.
- Rising main: 1000 mm dia, 3.1km

v) Recommendations for Existing Pumping Stations – Morigate SPS

This SPS has been designed to divert flows from Morigate nala PS to Alopibagh PS. It was renovated in the year 2000.

The present peak capacity is 18.14 mld. Anticipated peak flow is 68 mld in 2003, 60 mld in 2015 and 24 mld in the year 2030.

Presently there are two tapping points at Mori nala from which, sewage is carried to Alopibagh pumping station through gravity sewers. Total capacity of these two sewer lines is 28 mld. Hence, required capacity at Morigate PS will be (60 – 28) 32 mld.

Rehabilitation and augmentation proposed:

- Since capacity of existing system is 20 mld and there is no space to provide additional pumps, hence an additional pump house of (32-20) = 12 mld capacity (peak in 2015) has been proposed. 6 mld (average)
- Rising main: 500 mm dia, 1.8 km

vi) Recommendations for Existing Pumping Stations – Allahpur SPS

This SPS was commissioned in 1988 under Ganga Action Plan. It has been designed to cater to Allahpur area and a part of Daraganj area. The pump house receives sewage through the sewer system of the area.

The present peak capacity is 5.6 mld. Anticipated peak flow is 4.6 mld in 2003, 6.3 mld in 2015 and 11.1 mld in year 2030.

Rehabilitation proposed:

- Installed capacity: 5.6 mld (peak)
- Install mechanical and manual bar screens
- Provide diesel for operation
- Align pumps
- In 2015, replace existing pumps and install two more pumps with similar characteristics, without changes in the civil structures, as adequate space for additional pumps is available.
- Update electrical equipment in year 2015.

vii) Recommendations for existing Pumping Stations – Daraganj SPS

The SPS was constructed in 1988 to receive discharge from the newly laid Daraganj ghat sewer. The sewer has been laid to receive discharge from 18 small nalas, draining a part of the Daraganj area. The Invert Level of the nalas does not permit flow by gravity to any of the treatment plants hence, lift pumping station has been provided.

The present peak capacity is 5.2 mld. Anticipated peak flow is 3 mld in 2003, 4.8 mld in 2015 and 8.5 mld in year 2030.

Rehabilitation proposed:

- The sump capacity must be enhanced to meet the peak sewage discharge in the year 2015.
- Mechanical bar screens 2 nos. and manual bar screens 3 nos. with necessary sluice gates, channels for diverting the flow are to be provided.
- Although the electrical and mechanical equipments have outlived their useful life, but their operation is still trouble free. The installed capacity is considered adequate for year 2015, hence no pump replacement is proposed.

viii) Recommendations for Existing Pumping Stations – Mumfordganj SPS

The SPS was commissioned in the year of 1968 and renovated under Ganga Action Plan. It receives sewage from a sewer serving the Mumfordganj, Naya Katra areas and also taps the Mumfordganj nala.

The present peak capacity is 14 mld. Anticipated peak flow is 92 mld in 2003, 100 mld in 2015 and 123 mld in year 2030.

Rehabilitation / Augmentation Proposed:

The present pumping station is totally inadequate for the increased flows it is anticipated to receive under the reconfigured sewage flow pattern for District D; hence, a new SPS is to be constructed. Only the existing DG housing facilities, transformer room and high tension (HT) panel room will be used.

The following major new works are envisaged:

- Pumps of capacity 289 lps at 22 m head – 6 nos.
- Squirrel cage TEFC motors of 95 kW capacity – 6 nos.
- Sump capacity required: 426 cubic meter
- Mechanical and manual bar screens with sluice gates and conveyor system
- Suction, delivery lines, rising main with necessary valves and other accessories

- 5 ton capacity HOT crane – 1 No.
- 630 kVA transformers – 2 Nos.
- 5 Panels HT vacuum circuit breakers
- One DG set of 160 kVA
- Necessary electrical panel and cabling works
- Rising main: 1100 mm dia, 2.7 km.

ix) New Sewers Proposed

New facilities proposed for this district are:

- Construction of new trunk sewers: 450 - 1200 mm dia, 6.7 km.

x) New STP Proposed – Rajapur STP

The wastewater of District D will reach Rajapur STP from the Mumfordganj SPS. As calculated in the Master Plan, the capacity of the STP will be 65 mld in 2015 and 80 mld in year 2030.

Life cycle costs were calculated for various options and UASB followed by Aerated Lagoons was found to have the least life cycle cost and is hence, recommended for the Rajapur STP.

3) Sewerage District B

Sewerage District B lies along the southwestern municipal boundary of Allahabad. The population density in this district is less compared to Districts A and D, so is the extent of urbanization and infrastructure development.

i) Existing Sewerage Pattern

A small area lying north and west of Nurullah road is sewered; the sewers carry the flow to Lukerganj SPS, the only existing SPS in the district. This SPS pumps the wastewater to an existing sewer laid along Shaukat Ali Marg, the sewer carries the wastewater to Gaughat MPS. Wastewater from one section of the unsewered part of the district flows westwards into a nala, which joins the Sasur Khaderi river. Another section drains into Ghaghar nala. Both Ghaghar nala and Sasur Khaderi river fall into Yamuna river.

ii) Proposed Sewerage Pattern

Two new pumping stations, one at Ghaghar nala outfall and another near Sasur Khaderi river, will be constructed. The Ghaghar nala SPS will tap the nala and also receive wastewater from Lukerganj pumping station as well as from Sasur Khaderi PS, in addition to wastewater from its own command area. From Ghaghar nala SPS, the wastewater will be pumped to the Numaya Dahi STP.

iii) Recommendations for Existing Pumping Stations – Lukerganj SPS

The SPS was commissioned in the year 1964 to handle the discharges from the 680 mm sewer collecting wastewater from Lukerganj area. It pumps the wastewater to the old 560 mm x 840 mm sewer on Shaukat Ali Marg. The discharge will be re-directed to a new gravity sewer leading to Ghaghar nala SPS.

Present peak capacity – 18.3 mld;

Flow in 2003 - 9 mld, in 2015 – 19 mld and 36.5 mld in 2030 (peak)
Flow in 2003 - 4.5 mld, in 2015 – 9.5 mld and 18.25 mld in 2030 (average)

Rehabilitation proposed:

- Two mechanical bar screens and three manual screens
- One set of conveyor belt for removal of screenings.
- Addition of a wet sump capacity.

iv) New Sewers Proposed

The new facilities proposed for this district are:

- Construction of new trunk sewers: 300 - 1000 mm dia, 4.9 km.

v) New Pumping Stations Proposed – Ghaghar SPS

The Ghaghar pumping station will be located near outfall of Ghaghar nala at its left bank in District B. It will receive all the wastewater from District B via Lukerganj and Sasur Khaderi pumping stations and via trunk sewers.

Total design flow (average)
- 2015 : 50 mld
- 2030 : 50 mld

Major works proposed:

- 6 pumps of 273 lps, 37 m head
- Wet sump – 327 cum
- Mechanical and manual bar screens with sluice gates and conveyor system
- Suction, delivery lines, rising main with necessary valves and other accessories
- Necessary electrical system
- Rising main: 1000 mm dia, 7.7 km

vi) New Pumping Stations Proposed – Sasur Khaderi SPS

This pumping station will tap the sewage flowing to the drains discharging towards Sasur Khaderi river. It has been proposed upstream of the point where the drain joins the Sasur Khaderi river. This pumping station will also cater to the surrounding areas, which are expected to grow quickly.

Proposed pumping station will pump the sewage to the receiving chamber of the proposed trunk sewer at Numaya road. This sewer will carry the discharge to the trunk sewer at Karamat ki chowki and finally to Ghaghar nala SPS.

Total design flow (average)
- 2015 : 13 mld
- 2030 : 27.5 mld

Major works proposed:

- 6 pumps 93 lps, 17 m head
- Mechanical and manual bar screens with sluice gates and conveyor system

- Suction, delivery lines , rising main with necessary valves and other accessories
- 2 ton capacity HOT crane – 1 no.
- Electrical power will be taken from nearby UPSEB distribution network at 415 V.
- One DG set of 63 kVA
- Other minor E&M works
- Rising main: 600 mm dia, 0.2 km

vii) New STP Proposed – Numaya Dahi STP

The wastewater of District B will reach Numaya Dahi STP from the Ghaghar nala SPS. As calculated in the Master Plan, the capacity of the STP will be 50 mld in year 2015 and 2030.

Two possible locations were identified in the Master Plan, for locating the Numaya Dahi STP. The chosen site is located along the borders of Numaya, Dahi, Karehndha and Sayyedpur villages.

The major points of consideration for this site are :

- Availability of land is not a major constraint, as the site is located outside the main town, along the borders of Numaya, Dahi, Karehndha and Sayyedpur villages.
- Although the treated effluent is proposed for irrigation use, the balance effluent is to be discharged into Yamuna river. However, the discharge point would lie upstream of the raw water intake at Kareli bagh. Hence, the slightest increase in pollution levels could have a major impact on the health of the city's residents.

Hence, the preferred technology for this STP is Waste Stabilisation Pond technology. Anaerobic, Facultative and Maturation Ponds have been provided in series to achieve the desired effluent quality.

4) Sewerage District E

i) Existing Sewerage Pattern

District E has no existing sewage collection or treatment facilities.

ii) Proposed Sewerage Pattern

Two new STPs are proposed for this district. The first one, located near the outfall of the Ponghat nala, will tap the nala and in future, receive flows from sewers. The second one, located near the outfall of the Kodara nala, will tap the Kodara nala and Nehru Park nala and in future, will receive flows from sewers.

iii) New STP Proposed – Ponghat STP

As calculated in the Master Plan, the capacity of the STP will be 10 mld in year 2015 and 2030.

The STP has been located along the borders of Mariyadih and Ponghat. The area being used for agricultural purposes, no resettlement issues are involved. The STP site is located slightly upstream of the Ponghat nala's outfall into Ganga river.

A small sump with screening and pumping arrangements has been provided to tap the Ponghat nala. The trunk sewer for the area, to be laid in future (and not included in the priority projects) can be joined into this chamber for pumping of sewage to the STP, as the

STP has been located on a local plateau to avoid costly flood protection works.

The major points of consideration for this site are:

- Availability of land is not a major constraint
- The site is surrounded by agricultural land and hence, the treated effluent can be used for irrigation.

The STP will be based on Waste Stabilisation Pond technology. Anaerobic, Facultative and Maturation Ponds have been provided in series to achieve the desired effluent quality.

Treated effluent from Ponghat STP will be discharged back into the nala, downstream of the tapping point. The effluent will be suitable for re-use as irrigation water in the fields adjoining the STP site.

iv) New STP Proposed – Kodara STP

As calculated in the Master Plan, the capacity of the STP will be 15 mld in year 2015 and 30 mld in 2030.

The STP has been located near the outfall of the Kodara nala into Ganga river, near the Manoharpur village.

Three nalas flowing near the STP site are to be tapped; these are the Kodara nala, the Nehru Park nala and a third small local nala, which bisects the STP site. The Kodara and Nehru Park nalas will be tapped via inlet chambers followed by screening arrangements.

The preferred treatment technology for this site is UASB followed by aerated lagoons because of the low life cycle cost.

Treated effluent from Kodara STP will be discharged into the Ganga river. The effluent will flow by gravity except during the monsoon period when the water level in the river rises, at which time the effluent will be pumped into the Ganga by submersible pumps.

(4) Project Cost Estimation and Implementation Schedule

1) Capital Cost Estimation of the Priority Projects

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated using Allahabad rates on the basis of Delhi Schedule of Rates taking localities and deflator into account. Furthermore, prices of items such as sewer pipes, reinforcing steel bars, manhole covers and so on that are not found in UPJN Schedule or DSR are obtained by quotation. The following are cost estimation conditions for physical contingencies, engineering and project administration. The abstract of the capital cost is shown in Table 4.43.

- Physical contingencies: 5% of capital cost
- Engineering costs (detailed design (6%) and project management (5%)): 11 % of capital cost
- Project administration: 5 %

2) Implementation Programme

The implementation programme for the priority projects has been prepared assuming following conditions.

- Preparation of detailed project reports and tender documents for project component shall be completed within 2006 and 2007.
- Actual execution of various priority project components shall start from 2008.
- During execution, various project components shall be executed in parallel.
- UPJN, Allahabad, will acquire 100 % of the land required for construction of proposed sewage treatment plants and pumping stations before the commencement of tendering.

The implementation schedule of the total project works and the year-wise fund flow requirement is presented in Table 4.44.

3) Operation & Maintenance Cost Estimation

The O&M costs for sewers, pumping stations and sewage treatment plants including existing, sanctioned and proposed facilities for 2015 are estimated based on following two cases in terms of power supply conditions.

- Operation by power from grid (24 hours a day)
- Operation by power from grid (20 hours a day) and diesel (4 hours)

The estimated annual O&M costs for all major facilities for 2015 is summarised in the following table.

Table 4.42 Summary of Annual O&M Costs for 2015
(1,000 Rs./year)

Facility	Case-1 Grid Power Supply	Case-2 Grid Power Supply Supplemented by Diesel
(1) Sewers and Rising Mains	10,374	10,374
(2) Pumping Stations	44,276	49,524
(3) Sewage Treatment Plants	90,014	90,214
Total	**144,663**	**150,111**

Table 4.43 Summary of Preliminary Project Costs (Allahabad)

	Sewerage District	Capital Cost (Rs.)	Contingencies	Detailed Design	Supervision	Project Administration	Total Cost (Rs.)	Land Acquisition (Rs.)	Total Project Cost (Rs.)
			5%	6%	5%	5%			
SEWERAGE SCHEMES									
Installation / Replacement of Trunk Sewer									
Trunk Sewers in District A	A	88,063,000	4,403,000	5,284,000	4,403,000	4,403,000	106,556,000	0	106,556,000
Trunk Sewers in District B	B	49,976,000	2,499,000	2,999,000	2,499,000	2,499,000	60,472,000	0	60,472,000
Trunk Sewers in District D	D	110,958,000	5,548,000	6,657,000	5,548,000	5,548,000	134,259,000	0	134,259,000
Construction of Sewerage Pumping Station									
Ghaghar Nala PS and rising main	B	117,959,000	5,898,000	7,078,000	5,898,000	5,898,000	142,731,000	963,000	143,694,000
Sasur Khaderi PS and rising main	B	40,676,000	2,034,000	2,441,000	2,034,000	2,034,000	49,219,000	963,000	50,182,000
Construction of Sewerage Treatment Plant									
Numaya Dahi STP	B	327,920,000	16,396,000	19,675,000	16,396,000	16,396,000	396,783,000	78,287,000	475,070,000
Rajapur STP	D	583,680,000	29,184,000	35,021,000	29,184,000	29,184,000	706,253,000	32,752,000	739,005,000
Kodara STP	E	85,520,000	4,276,000	5,131,000	4,276,000	4,276,000	103,479,000	10,115,000	113,594,000
Ponghat STP	E	83,220,000	4,161,000	4,993,000	4,161,000	4,161,000	100,696,000	18,592,000	119,288,000
Desilting of Existing Trunk Sewer									
Trunk Sewers in District A	A	15,950,000	798,000	957,000	798,000	798,000	19,301,000	0	19,301,000
Trunk Sewers in District D	D	21,990,000	1,100,000	1,319,000	1,100,000	1,100,000	26,609,000	0	26,609,000
Rehabilitation of Existing Trunk Sewer									
Trunk Sewers in District A	A	120,410,000	6,021,000	7,225,000	6,021,000	6,021,000	145,698,000	0	145,698,000
Rehabiltation/Upgrading of Existing Pumping Station									
Chachar Nala PS	A	16,820,000	841,000	1,009,000	841,000	841,000	20,352,000	4,800,000	25,152,000
Gaughat PS	A	28,100,000	1,405,000	1,686,000	1,405,000	1,405,000	34,001,000	0	34,001,000
Lukerganj PS	B	16,760,000	838,000	1,006,000	838,000	838,000	20,280,000	0	20,280,000
Daraganj PS	D	10,510,000	526,000	631,000	526,000	526,000	12,719,000	0	12,719,000
Allapur PS	D	13,840,000	692,000	830,000	692,000	692,000	16,746,000	0	16,746,000
Morigate PS and rising main	D	39,910,000	1,996,000	2,395,000	1,996,000	1,996,000	48,293,000	16,800,000	65,093,000
Alopibagh PS and rising main	D	61,050,000	3,053,000	3,663,000	3,053,000	3,053,000	73,872,000	0	73,872,000
Mumfordganj PS and rising main	D	74,870,000	3,744,000	4,492,000	3,744,000	3,744,000	90,594,000	45,500,000	136,094,000
Upgrading of Existing Treatment Plant									
Naini STP (ASP, 20mld)	A	151,630,000	7,582,000	9,098,000	7,582,000	7,582,000	183,474,000	0	183,474,000
Total		2,059,812,000	102,995,000	123,590,000	102,995,000	102,995,000	2,492,387,000	208,772,000	2,701,159,000

Table 4.44 Preliminary Implementation Schedule (Allahabad)

(Unit:Rs.)

	Capital Cost	Detailed Design	Total Project Cost	2007	2008	2009	2010	2011	2012
				Capital and Detailed Design Cost Schedule					
Installstion of Trunk Sewer									
Trunk Sewers in District A	88,063,000	5,284,000	106,556,000	5,284,000	17,613,000	17,613,000	17,613,000	26,419,000	8,805,000
Trunk Sewers in District B	49,976,000	2,999,000	60,472,000	2,999,000	9,995,000	9,995,000	9,995,000	14,993,000	4,998,000
Trunk Sewers in District D	110,958,000	6,657,000	134,259,000	6,657,000	22,192,000	22,192,000	22,192,000	33,287,000	11,095,000
Construction of Sewerage Pumping Station									
Ghaghar Nala PS	117,959,000	7,078,000	143,694,000			7,078,000	39,320,000	39,320,000	39,319,000
Sasur Khaderi PS	40,676,000	2,441,000	50,182,000			2,441,000	13,559,000	13,559,000	13,558,000
Construction of Sewerage Treatment Plant									
Numaya Dahi STP	327,920,000	19,675,000	475,070,000	19,675,000	65,584,000	65,584,000	65,584,000	98,376,000	32,792,000
Rajapur STP	583,680,000	35,021,000	739,005,000	35,021,000	116,736,000	134,246,000	116,736,000	175,104,000	40,858,000
Kodara STP	85,520,000	5,131,000	113,594,000	5,131,000	28,507,000	28,507,000	28,506,000		
Ponghat Nala STP	83,220,000	4,993,000	119,288,000	4,993,000	27,740,000	27,740,000	27,740,000		
Desilting of Existing Trunk Sewer									
Trunk Sewers in District A	15,950,000	957,000	19,301,000	957,000	7,975,000	7,975,000			
Trunk Sewers in District D	21,990,000	1,319,000	26,609,000	1,319,000	10,995,000	10,995,000			
Rehabiltation of Existing Trunk Sewer									
Trunk Sewers in District A	120,410,000	7,225,000	145,698,000	7,225,000	60,205,000	60,205,000			
Rehabiltation of Existing Pumping Station									
Chachar Nala PS	16,820,000	1,009,000	25,152,000	1,009,000	8,410,000	8,410,000			
Gaughat PS	28,100,000	1,686,000	34,001,000	1,686,000	14,050,000	14,050,000			
Lukerganj PS	16,760,000	1,006,000	20,280,000	1,006,000	8,380,000	8,380,000			
Daraganj PS	10,510,000	631,000	12,719,000	631,000	5,255,000	5,255,000			
Allapur PS	13,840,000	830,000	16,746,000	830,000	6,920,000	6,920,000			
Morigate Nala PS	39,910,000	2,395,000	65,093,000	2,395,000	19,955,000	19,955,000			
Alopibagh PS	61,050,000	3,663,000	73,872,000				3,663,000	30,525,000	30,525,000
Mumfordganj PS	74,870,000	4,492,000	136,094,000				4,492,000	37,435,000	37,435,000
Upgrading of Existing Treatment Plant									
Upgrading of Existing Treatment Plant	151,630,000	9,098,000	183,474,000	9,098,000	75,815,000	75,815,000			
Total	2,059,812,000	123,590,000	2,701,159,000	105,916,000	506,327,000	533,356,000	349,400,000	469,018,000	219,385,000

(Unit:million Rs.)

Items		Total	2007	2008	2008	2009	2009	2010
Capital Cost		2,059.83	0.00	506.33	523.84	341.25	469.02	219.39
Detailed Design		123.60	105.92	0.00	9.52	8.16	0.00	0.00
Contingencies		102.99	0.00	25.32	26.19	17.06	23.45	10.97
Supervision		102.99	0.00	25.32	26.19	17.06	23.45	10.97
ProjectAdmin		102.99	0.00	25.32	26.19	17.06	23.45	10.97
Total Cost		2,492.40	105.92	582.29	611.93	400.59	539.37	252.30
Land Acquisition		208.77	161.34	0.00	1.93	45.50	0.00	0.00
Total Project Cost		2,701.17	267.26	582.29	613.86	446.09	539.37	252.30

Detaied Design
Construction Cost

4.4.2 Environmental Impact Assessment

(1) Justification of the Project

Allahabad is an important pilgrim centre for Hindu community with growing population. The proper drainage network is lacking. A substantial quantum of sewage is disposed to river Ganga or Yamuna through natural drains without treatment, thus endangering the surface water source as well as the entire environment. The estimated load of wastewater from the city is 226 mld while the capacity of the existing STP at Naini is hardly 60 mld. Therefore it is essential to develop proper system of treatment and disposal of wastewater in order to protect the natural environment and maintain the hygienic conditions of the town to improve health condition of local inhabitant.

The existing sewerage system which is old and ill maintained does not fulfil the need of handling the storm water which directly enters through manholes into trunk sewer causing overflows and deteriorating environment. New colonies are coming up from where wastewater goes either to old trunk sewer or directly to rivers through natural drains. In fact, the regular sewer system is lacking. Keeping in view the growth, a sound master plan for disposal and treatment of wastewater and its implementation is urgently required.

(2) Positive Benefits

Project benefits of the sewerage and pollution control projects is to ameliorate overall development and betterment of public health and hygiene coupled with upgradation of environmental management in the target project area through abatement of pollution; improvement of public health and aesthetics leading to improvement in quality of living and inducing economic growth.

(3) Key Impacts Identified and Mitigation

The overall identification of the negative impacts has been done by using a matrix table (Master Plan). As identified in the table, all the possible key negative impacts are associated with construction and operation of STP. The following impacts are identified.

- Resettlement and economic activities due to the land acquisition
- Landscape change due to construction of STP
- Groundwater, surface water and soil contamination due to discharge of treated sewage that is not properly treated in STP and usage of dried sludge
- Odour problems due to operation

In addition to negative impacts in construction and operation phase, contingent impact or risk shall be analysed. The identified risk of the project is disruption of power supply. In the city, frequent power supply cuts occur, which causes breaking down of operation of STP and PSs.

1) Sewage Treatment Plant (Construction Phase)

The key potential impacts of construction phase of STP are loss of village houses, agricultural land and few trees and such impacts are long term. The other impacts of construction phase will be small in magnitude because of temporary nature and are expected to decrease gradually once the construction activity is completed.

a) Landscape Change (Visual Impacts)

Impacts

The construction of STP will alter landscape and change the land use of the area. The visual impacts at the construction site would be unaesthetic for the villagers.

Mitigation Measures

To minimise visual impacts and landscape change, provision of open space and plantation of trees in the surrounding area of the STP sites are recommended. Plantation of trees in the open spaces would provide a visual comfort.

b) Land Acquisition

Impacts

Four new STPs are proposed for Allahabad city and the areas required are shown in the table below. The resettlement is avoided by selecting appropriate sites without displacement of villages and sites for the STPs will be acquired in agricultural, un-cultivated land, flood plain and sand quarrying.

STP (ha)	Land use	Name of village	No. of land owners affected
Numaya Dahi (75 ha)	Agricultural land	Sayyedpur	64
		Numaya	25
		Dahi	4
		Karendha	35
Rajapur (25 ha)	Flood plain	Mahendari Kacchar	22
Kodara (11 ha)	Sand quarrying + agriculture	Manoharpur	19
Ponghat (19 ha)	Uncultivated land	Kashipur	145

Mitigation Measures

- Minimisation or avoidance of village displacement

As stated in the impacts, the sites for all STPs have been properly selected and no village displacement will occur.

- Appropriate Compensation

Land is normally acquired under the provisions of the Land Acquisition Act, 1894 that is general and basic law in the country for the acquisition of land for public purposes and companies. This Act was comprehensively amended in the year 1984, taking into consideration the recommendations of the Law Commission, the Land Acquisition Review Committee.

There are two types of compensation. Monetary compensation has to be provided to direct Project Affected Persons (PAPs) if their houses have to be acquired and demolished. It has to be provided also to indirect PAPs for their agricultural land to be acquired. Alternate land has to be provided to displaced persons for their resettlement. If land for resettlement can not be provided or PAPs are not willing to resettle in the new resettlement site, then monetary compensation has to be provided to direct PAPs for their homestead (i.e. residential) land to be acquired.

c) Socio-cultural Environment

Impacts

The proposed sites do not have any national monuments / national parks / reserve forests. However, a small temple is located in the proposed STP site at Kodara.

Mitigation Measures

This aspect has been studied carefully while designing the layout of the STP. The boundary of the STP has been drawn up such that the temple lies outside the proposed STP campus.

2) Sewage Treatment Plant (Operational Phase)

Overall, the predicted adverse impacts during the operational phase will be minor as compared to the construction phase. During the operation phase all the beneficial impacts of the project will be realised.

However, treatment works will not perform satisfactorily unless they are operated and maintained properly. Malfunctioning of the system would pose risks of health hazards. Hence, this system should be operated and maintained properly by trained technicians. Following preventive measures should be adopted:

- Provision of two power supply lines
- Provision of generator sets at sewage treatment sites
- Provision of diesel for the generator sets
- All spare parts should be readily available in case of emergency
- Provision of adequate maintenance staff with accessories
- Regular training of system staff, skilled technicians and craftsman
- Proper operating budgets and attractive salaries

a) Ground Water Quality

Impacts

The potential source of ground water contamination would be of three kinds; percolation of wastewater from the bed of the STP, percolation from the canal where treated effluent will be discharged and percolation from the agricultural land where wastewater is applied.

Wastewater in the aerated lagoons and waste stabilisation ponds, which will be basically water-tight, may percolate through the underlain soil layer by seepage and pollute the ground water table of the nearest unconfined upper aquifer. These aquifers are connected with a number of open wells from which nearby villagers draw water for drinking and other purposes. There is some possibility that the aquifer is contaminated by partly treated wastewater.

Mitigation Measures

First and foremost, care should be taken to ensure adequate treatment to meet the discharge standards.

It has been planned that the lagoons and treated water channels will be lined with waterproof material to avoid seepage of wastewater in the lagoons into the soil and thus contamination of ground water.

It has also been planned that chlorination facility or maturation will be installed in proposed

STPs and therefore any bacterial contamination will not occur in the irrigation canal and through land application of treated effluent. If the STP is well functioned and wastewater is appropriately treated, the groundwater in the aquifer is remote from any contamination. Removal of pathogens is the prime objective in treating wastewater for re-use.

b) Treated Effluent Use

Impacts

The treated effluent from the proposed STPs will be discharged into the rivers and/or irrigation canals. This effluent would be rich in phosphate and nitrate and therefore contribute increased fertility of the agricultural land and increased area of irrigated land. This would be a positive impact to the nearby villagers.

The effluent quality of the proposed STPs will comply with the national standards and thus no negative impact is foreseen on the river Ganga or Yamuna or the proposed canals. However, the project has to be aware of the following impacts as well.

If a large concentration of inorganic salts or the metals are contained in the treated effluent, it will eventually influence the growth of the crops.

Toxic substances such as heavy metals that might be present in the irrigation water stay as alimentation in the soil and then absorbed into vegetation. Taking in such vegetables might harm human health.

Quality of soil governs the pattern and quality of the vegetation. The different heavy metals in the treated effluent will be adsorbed by the soil grains, which may affect the vegetation and crop quality. This may lead to a negative impact to the soil.

Insoluble inorganics make soil tough, and obstruct absorption of water. And excess organics in irrigation water may give direct effect to the cultivated land, and indirect effect as abnormal growth due to lack of oxygen in the water. This eventually gives negative influences to vegetation.

Mitigation Measures

As it is proposed that the treated wastewater of proposed STPs may be reused for irrigation purposes, treated wastewater should meet the required standards for irrigation re-use. Also treated water quality should be monitored carefully so as to meet the discharge standards effectively.

With regard to application of sewage for land farming the ‘Manual on Sewerage and Sewage Treatment’, CPHEEO, Ministry of Urban Development, Govt. of India, provides guidelines on characteristics of irrigation waters. These include conductivity, salinity, sodium absorption ratio, chlorides, boron, etc. In addition, the manual provides maximum permissible concentrations of toxic heavy metal, etc.

c) Sludge production and disposal

Impacts

The sludge production will be to the tune of several tens ton/day from the STPs. It will be dried on the sludge drying beds. During the drying process, there will be nuisance of insects and odour around the sludge drying beds.

The dried sludge may be given or sold to farmers as manure if it could be handled properly by them. The value of sludge as an organic fertilizer has long been recognized and this offers reduced fertilizer costs to the farmer. Besides, the dry sludge can be disposed of in specified landfill sites.

Mitigation Measures

The sludge from the STPs should be disposed of in an environmentally acceptable manner. The sludge should be dewatered in sludge drying beds and the dried sludge is proposed to be used as fertilizer in the nearby agricultural lands since it is biological in nature and has soil quality enhancing properties.

Nuisance of insects can be minimised by spraying insecticides on sludge drying beds, also by proper maintenance of sludge drying beds and proper drainage. The precautions should be taken in handling and disposal of the sludge.

Monitoring of the quality of the sludge is required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials.

The effectiveness of the sludge production for agricultural/vegetation use is not constant to any crops. Use of the sludge production at the region must be done with soil observation of its effect to avoid negative effects to crops. After the observation period, recommended method of the use should be established and educated to the local farmers. Parameters of soil observation monitored are Zinc, Copper, Total Carbon, Total Nitrogen, Phosphate and pH.

Use of the sludge product must be done strictly under the continuous monitoring of sludge product's contents especially the toxic substances.

d) Odour Production

Impacts

There is a possibility of bad odour in the case of anaerobic and facultative lagoons proposed at the site of Numaya Dahi and Ponghat, if the STPs are not properly operated / maintained. For the other treatment processes, bad odour may be present but to a lesser extent. However, the impact will be higher where the plant is near to residential areas such as at the Kodara STP site.

Mitigation Measures

To mitigate this, the width of peripheral green belt at Kodara STP site has been increased. All required pollution prevention measures should be considered and implemented. Besides, the normal mitigation measures about dried sludge shall be taken to minimise odour problem although the impact is minimal in the STPs that are located in remote area.

3) Pumping Station (Construction Phase)

i) Land Acquisition

Impacts

Three new PSs and one augmentation are proposed for Allahabad city and the areas of two new PSs out of four required and one augmentation are shown in the table below. The

resettlement is avoided by selecting appropriate sites and sites for the PSs will be acquired in un-cultivated land.

PS (ha)	Land use	Name of village	No. of land owners affected
Ghaghar Nala (1.0ha)	Waste land, within the natural channel of the nala	Sadiyapur	3
Sasur Khaderi (1.0 ha)	Agricultural land, not being cultivated	Bajupur	2
Mumfordganj (0.65 ha, augmentation)	Designated agricultural land, not being cultivated	Beli Upparhar	6

Mitigation Measures

Refer 1) Sewage Treatment Plant (Construction Phase) b) Land Acquisition.

(4) Analysis of Alternatives

Different treatment processes are available for biodegradation of organic material present in domestic wastewater. Individual treatment process has its own limitation and advantage in terms of land requirement, environmental impacts, power consumption and operation and maintenance. Several treatment processes have been selected for detailed evaluation before finalising the suitable one that would be environmentally, technically and financially viable option.

Numaya Dahi STP

The major points of consideration for this site are:

(i) Availability of land is not a major constraint, as the site is located outside the main town, along the borders of Numaya, Dahi, Karendha and Sayyedpur villages.
(ii) The site is surrounded by agricultural land and hence, the treated effluent can be used for irrigation.
(iii) The balance effluent is to be discharged into the Yamuna. However, the discharge point would lie upstream of the raw water intake at Kareli bagh. Hence, the slightest increase in pollution levels could have an impact on the health of the city's residents.
(iv) Odour problems are not a major concern as the site is at least 500 m away from major inhabited areas.

In view of the above, waste stabilization pond (WSP) is selected.

Rajapur STP

The site for this STP is a low lying area bounded on the eastern and western sides by two streams branching out from the Ganga. For flood protection, a high bund (8-10m) would have to be constructed to enclose this STP site. Hence, for the site, footprint technologies, minimising the land requirements, are preferable. After analysis of alternatives, UASB followed by AL has been selected. It would be a better environmental solution than aerobic technologies like ASP and FAB in view of the frequent and long power cuts in Allahabad.

Kodara STP

This site is surrounded on the northern side by the Ganga. On the other three sides it is bounded by the residential area of the Manoharpur village. Sufficient land is not available at this site for providing waste stabilisation ponds. Also there is no potential for re-use of treated effluent for irrigation.

Hence, UASB followed by AL would be a better environmental solution than aerobic technologies like

ASP and FAB in view of the frequent and long power cuts in Allahabad.

Ponghat STP

The general discussions for Allahabad apply to this site too. The other major issues are:

(i) Like Numaya Dahi, availability of land is not a major constraint.
(ii) Potential for re-use of a portion of treated effluent for irrigation exists as the site lies amidst agricultural fields.
(iii) The balance effluent is to be discharged back to the drain.

WSP technology offers the least cost, highest reliability and the least environmental risk while treating the wastewaters at this site to make them fit for reuse as irrigation waters.

(5) Contingency Impacts and Mitigation

1) Contingency and Risk

The major risks, which can result in breakdowns and disruptions, are described below.

Power Supply

One of the main reasons for disruption during the operation phase of the treatment works is power cuts, which are routine at Allahabad.

It is recommended that the new treatment plants and pumping stations receive their power supply through dedicated feeders from two different power sources. It is also suggested that standby power generators are provided to ensure at least minimum services in case of prolonged power cuts, and also that cost of diesel be built into the O&M costs.

Also the sewage treatment technology chosen should be able to survive short spells of power cuts.

Electric & Mechanical Equipment Disruptions

Operational disruption due to E&M equipment can be avoided by proper preventive maintenance activities and provision of adequate spare parts and stand-by equipment.

O&M manuals should be available in the treatment plant with training of the operation staff for the new plant.

2) Contingency Measures Plan

Contingency measures plans have been prepared for:

i) sewage treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (i.e. maintenance, etc. or breakdown);
ii) discharge of sub-standard wastewater into the environment from treatment plant which could cause a significant public health impact, and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.
iii) accidents which may occur while laying sewers or during construction of the treatment works;

(6) Environmental Management Plan

The success of the Environmental Mitigation Plan depends on the efficiency of the organisational set up responsible for the implementation of the programme.

For a sanitation project of this magnitude, the Environmental Management Plan needs to be entrusted, in both the construction and the operation phases, to an Environmental Management Cell (EMC), and regular monitoring of various environmental parameters is also necessary to evaluate the effectiveness of the management programme so that necessary corrective measures could be taken in case there are some drawbacks in the proposed programme. Thus, the Environmental Management Plan will consist of:

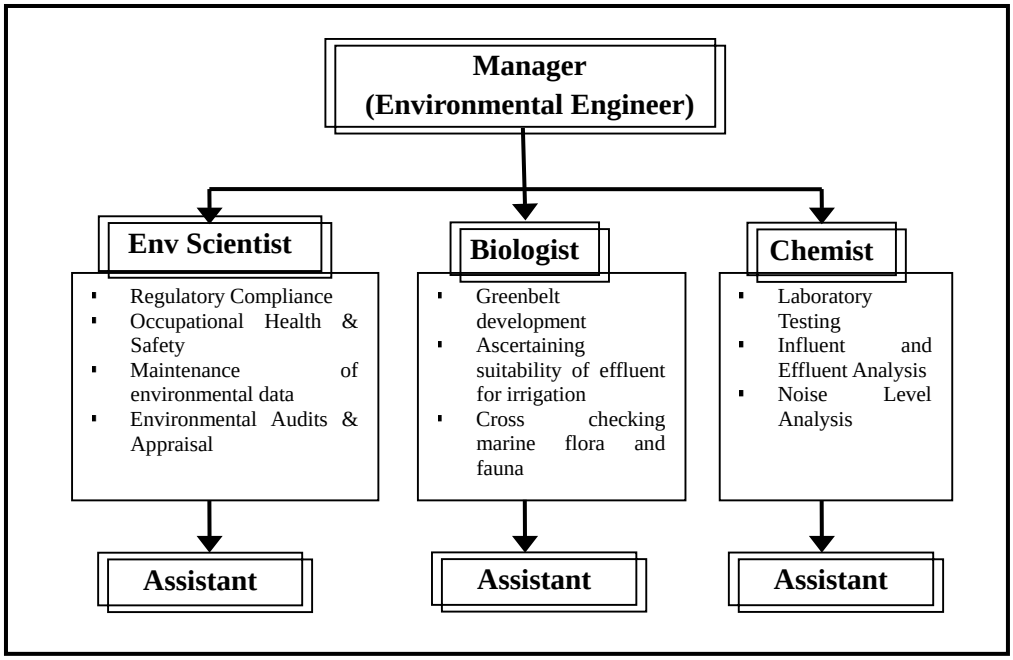
- Setting up an EMC to implement the mitigation measures in operation phase,
- Ensuring proper operation and maintenance of the treatment works,
- Ensuring proper maintenance of the sludge drying beds and the disposal of dry chemical sludge in a proper landfill site,
- Monitoring the waste and treated water quality,
- Monitoring the built in pollution control equipment, for vehicles and equipment, and
- Maintaining tree plantations around the pumping stations and the periphery of the sewage treatment plant.

(7) Environmental Management Cell (EMC)

The Environmental Management Cell will be part of the staff in charge of the operation and maintenance of the sewerage works, since the laboratory will be housed at the treatment plant site. But this staff will be in charge of the overall management of the environmental aspects of the Sanitation Project.

Under the supervision of an Environmental Engineer, the EMC will comprise an Environmental Scientist, a Chemist and a Biologist, plus three assistants, as shown in the following organisation chart. The main functions of the EMC will be:

- Collecting water, air, soil and sludge samples,
- Analysing the samples collected or getting analysis done from outside sources,
- Preparing and updating a database of environmental parameters,
- Implementing the environmental control and protective measures,
- Controlling the sludge treatment, disposal and re-use,
- Collecting statistics of health of workers and the population of surrounding areas,
- Ensuring the development and maintenance of the green belts,
- Monitoring the progress of implementation of Environmental Management Programme,
- Co-coordinating the environment related activities within the project as well as with outside agencies.



(8) Monitoring Plan

To evaluate the effectiveness of the Environmental Management Plan, regular monitoring of the important environmental parameters as follows will be taken up by UPJN/JS in environmental testing laboratory.

1) Water quality
2) Air quality and odour
3) Noise
4) Green belt and compensatory plantation

(9) Environmental Training

The environmental monitoring plan will be successful only if trained and skilled staff implements it. The training of the qualified staff should be necessary not only in day-to-day operation and maintenance of the treatment plant, but also in environmental aspects.

It will be essential to involve the staff that will be responsible for the execution of the Environmental Management Plan, in the construction phase, as well as to train the staff in practicing the mitigation actions and the day to day monitoring programmed during the operation phase of the water supply units. The training should include:

- Basic concepts of pollution control techniques in the various methods of sewage treatment,
- Operation and maintenance of the sewage treatment plant,
- Emergency preparedness to handle adverse situations,
- Principles of wastewater analysis,
- Other environmental monitoring techniques,
- Development of green belt and its maintenance,
- Sewage farming, and
- Communication with farmers and general public.

This training is different from the mandatory training required for operation and maintenance of the sewage treatment plant.

4.4.3 Non-Sewerage Scheme (CTC Programme and Constructed Dhobighat Programme)

The objectives of this study are to formulate programmes of development/ management of Community Toilet Complexes (CTCs) and Constructed Dhobighats (DG); to assess the technical, institutional, financial and economic viability; and to assess the environmental and social soundness of the proposed programmes.

The objective of the proposed programmes is to improve slums and DGs' sanitary conditions, thus improving water quality of rivers.

The shortcomings in the operation and maintenance (O&M) of existing CTCs in slum areas and DGs are causing serious problems in proper functioning and general sanitation in the surrounding areas. O&M aspect is one of the main factors to be considered in formulating sustainable programmes of CTC and Constructed DG. Keeping this in mind and on the basis of the assessment of existing conditions of the target areas and facilities as well as the needs and demand of slum dwellers / Dhobis, the proposed programmes are formulated.

The proposed programmes adopt a needs-driven and community-driven approach in planning, implementing, operating and maintaining the facilities and suggest that the O&M is facilitated through local CBOs/SHGs or local Dhobi Associations. Implementation by this approach will make the programmes technically, financially, socially and culturally viable.

For successful implementation of the programmes, the following are required:

- Involvement and assistance of NGOs/Consultants for training and monitoring
- Regular monitoring, evaluation and feedback on the functioning of CTCs and Constructed DGs by Nagar Nigam in coordination with SUDA, DUDA and representatives of CBO/SHG.
- Appropriate implementation steps as follows to ensure involvement and training of CBOs/SHGs or Dhobi Associations:

Step 1:	Needs survey of slum / Constructed DG
Step 2:	Creation of CBOs/SHGs/ Dhobi Association
Step 3:	Planning and designing
Step 4:	Selection of location of CTC/Constructed DG including land acquisition clearance
Step 5:	Construction
Step 6:	Training of CBOs/SHGs/ Dhobi Association during construction
Step 7:	Operation and maintenance
Step 8:	Monitoring, evaluation and learning
Step 9:	Feed back

Creation of a CBO/SHG for O&M of CTCs has not been attempted earlier. Therefore, it is proposed that a pilot project to manage CTC through CBO be implemented and a good model for O&M of CTC be created before implementing full-scale project. Similarly, to manage the improved or new facilities of Constructed DGs in an appropriate manner, the functioning of the existing Dhobi Associations will require improvements through a process of capacity building. This capacity building will be also tested through a pilot project. This model project can then be extended to other proposed facilities.

One of the important constraints relating to O&M is the lack of funds. To make the project financially feasible, a minimum monthly charge of Rs. 70 per household, is required to be levied along with subsidy for electricity and sludge disposal costs (where applicable) by the local bodies and part of manpower costs being provided by the community through voluntary activities. This level of user charge was assessed affordable and acceptable even for low-income communities, as their willingness to participate in the project is very high. Besides, if the facilities are well maintained and kept clean the willingness to pay will improve and the project will become financially more viable.

The estimated monthly user charge per member for O&M of a Constructed DG is Rs. 35 to Rs. 92. Based on the results of the primary survey, which indicated a willingness to pay user charges up to Rs. 100 per month, the project is expected to be financially feasible.

If following factors are considered in the proposed facilities, the projects are expected to be technically feasible and would also ensure adequate O&M of the facilities.

CTCs
- Constant water supply for flushing and cleaning of water closets (seats)
- Sufficient capacity of storage tank for constant water supply
- Regular electricity for tube well and lighting

Constructed DGs
- Appropriate design and quality of construction to ensure no leakage
- Constant water supply
- Amenities (toilet, rest room, safety measure, shed, etc)

Land availability for both CTC and Constructed DG facilities is the most critical aspect for the feasibility study. The result of a rapid survey to assess the land availability in ten of slums indicated that the land for CTC can be made available in half of the slums surveyed. These lands are mostly owned by the various Government bodies and efforts have been made to select lands without any disputes or encumbrance. However, more detailed surveys are required to decide the best location by matching the demand for CTC and the availability of land. A detailed study should be done at the detailed design stage with the help of hired NGO/Consultants and communities.

The project shall generate tangible and intangible benefits as follows:

- Environmental benefits are expressed through reduction of pollution load caused by open defecation
- Health-related benefits include reduction of the incidence of water-borne diseases resulting from poor sanitation
- Economic benefits include productive gains, secondary economic benefits and developmental impact due to improved health and reduced health costs
- Social or equity benefits include gender, regional and income-related equity through appropriate sanitation for women and girls who are most affected by poor sanitation
- Institutional benefits are expressed to strengthen the CBO/SHGs through capacity-building

The proposed facilities and total capital costs in these programmes are summarised in the following table.

Table 4.45 Cost Estimation for Non-Sewerage Scheme (Allahabad)

Allahabad	No of Proposed Facilities	Total Cost (Rs.)
CTCs		
10 Seater	95	67,307,000
20 Seater	14	17,304,000
Sub-total	109	84,611,000
Constructed DGs		
New CDG	0	0
Improvement works	5	1,750,000
Sub-total	5	1,750,000
Total	-	**86,361,000**

Study Summary for Proposed Programmes (Allahabad)

Community Toilet Complex (CTC) Programme in Slums	
Existing situation	• The total slum population is estimated as 0.33 million; there are 185 slums in Allahabad. • Lack of adequate sanitation facilities has led to a high incidence of water-borne diseases. • There are 111 existing CTC out of which 84 are connected to sewer lines and 27 have septic tanks • CTCs are operated and maintained by NGOs, DUDA (both through contractors) and other private contractors. • Main problems of existing CTCs – lack of cleanliness and adequate maintenance. • 67 per cent of the slum population, based on the sample survey, practice open defecation. • 23 per cent of the slum dwellers, who do not have any toilet facilities, are willing to pay Re. 1 per usage; 57 per cent are willing to pay Re. 0.50 (sample survey). • 86 per cent of the slum dwellers expressed willingness to participate in O&M of CTCs (sample survey).
Proposed Design Options	• A seat (water closet) is designed to be used by 30 users per day. • The maximum travel distance for a user from his or her place of residence to the CTC should be less than 500 m. • 10-seater or 20-seater CTC with required amenities are recommended. • The preferred wastewater disposal option is connecting the CTC to a sewer line; in its absence, a septic tank and soak pit is recommended.
CTCs Needs	• The total number of new CTCs was estimated on the basis of need assessment (number of persons practicing open defecation) and the percentage thereof willing to pay user charges obtained through sample survey. • Total number of new CTCs is estimated as 109; 95 No. 10-seater and 14 20-seater.
Capital Costs	• Total capital cost of 109 CTCs is Rs. 84.6 million spread over 5 years.
Benefits	• Reduction in river pollution • Health and environmental benefits • Improved sanitation in slums decreases the incidence of water-borne diseases and thereby improving productivity • Women and children are the biggest beneficiaries
Recommendation	• O&M by Community-Based Organisation (CBO) or Self-Help Group (SHG) • Voluntary participation of project beneficiaries in O&M to reduce O&M costs especially the wages payable to a caretaker • Electricity costs and de-sludging (where applicable) to be covered by Nagar Nigam • Monthly user charge of Rs. 60 to 90, or a per day charge of Rs. 2 to 3 per family • Implementation of a pilot project first to create model O&M through CBO/SHG • Training centre for O&M to provide hand-on training to the members of the CBO, and facilitate extension of the model project to full-scale • Need assessment for CTCs to be conducted for each location at the time of commencement of the project
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, CBOs/SHGs • Participation of member(s) of CBO/SHG in construction supervision • Day to day O&M by CBOs/SHGs comprising members of the community benefiting from the project

Constructed Dhobighats (CDG) Programme	
Existing situation	• No major traditional riverside Dhobighats and 5 small Constructed Dhobighats • About 180 Dhobis use traditional river-side ghats • Dhobis satisfied with existing CDG, but want improvement in amenities • Chemicals used by Dhobis include detergents, solvents, bleaching agents, dyes etc.; high incidence of skin diseases • High willingness among Dhobis to participate in O&M of CDG • The existing CDG are being managed by respective Dhobi Associations • Current O&M not satisfactory; problems related to leakages, broken pumps, poor sanitation conditions, lack of shelter and space for drying clothes etc.
Proposed Design Options	• One cubicle is required for 6 washer-men; 3 shifts in a day and each washer-man use the ghat once in 2 days. • It is desirable that a washer-man is not required to travel more than 2 km from his residence • As for wastewater disposal, sewer connection is preferred but if unavailable open drain connection is selected and the latter is being tapped for diverting the wastewater to treatment plant. • No on-site treatment is recommended since high capital and operation & maintenance costs and the complicated process of treatment and considering current power supply situation in the city.
Needs of Constructed Dhobighat	• 5 new Dhobighats are planned and sanctioned by the State Government and are under implementation/planned to be implemented by DUDA, ADA and Nagar Nigam. These facilities are expected to meet the existing demand • No new Dhobighat proposed • Improvements/rehabilitation of existing 5 Dhobighats proposed • Improvement works include new pump, generator, roof, rest room, electrical work etc.
Project Costs	• The total capital cost for improvement works is estimated as Rs. 1.75 million
Benefits	• Reduction in river pollution • Health and environmental benefits • This project shall ensure access of quality services to the affected communities • Properly designed facility will reduce the incidence of diseases among the Dhobis thus enabling them to work for greater number of days (improved productivity) • Capacity building and training to Dhobi Associations
Recommendation	• O&M by Dhobi Associations; capacity building necessary in existing ones • Monthly user charge of Rs. 35 to 90 per member, depending on percentage of usage and number of cubicles in the CDG, to provide coverage for O&M costs be collected for adequate O&M of facilities. • Implementation of a pilot project first to create model O&M through CBO/SHG
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, Dhobi Associations • Participation of member(s) of Dhobi Association in construction supervision • Day to day O&M by Dhobi Association

4.4.4 Public Participation and Awareness

(1) General

For the sound operation and maintenance of sanitation facilities at city scale, generally, 'Public Participation' is indispensable. The construction and operation of such systems alone will not attain desired improvement in environmental sanitation, public health, surrounding environment and abatement of pollution of river water bodies. Therefore, greater public awareness on the health and environmental impacts, importance of those systems and facilities among communities, and the encouragement of their positive participation in the share of the obligation is essential. This would help work out problems related to operation and maintenance and long-term sustenance of these

systems and facilities.

Therefore, in this study, the JICA Study Team has:

1. Proposed the elaborated programmes on related activities and campaigns to promote public participation and heighten public awareness (PP/PA)
2. Analysed the existing formal and informal institutions in these cities that participate/had been participating in PP/PA programmes and suggested an institutional framework for successful implementation.

This is based on participatory techniques and the concept of the 'hygiene education', which has been prepared in the Master Plan and specifically responds to each event proposed in the Feasibility Studies in the four cities. Within this framework the programmes have been designed into two sets. Set I addresses the proposed priority projects and set II comprises regular activities to follow the hygiene education concept. The end achievable of these sets is to generate willingness to pay for the facilities and create awareness to a level that people participate for a cleaner river.

Whereas Varanasi and Allahabad are very religious and have emotional linking to the river, Kanpur and Lucknow are more urbanised. These and other distinctive characters and target groups for the four cities have been analysed and their flavour adequately addressed in the programmes.

(2) Programmes

Set I describes the necessary programmes that have to be undertaken in accordance to the timings of the projects (Sewerage and non-sewerage). These include:

Committee (SPC) Meetings	To monitor the progress of work on PP/PA (once in every month)
Necessary Publicity Programmes	To advertise widely the information on the projects through the mass media and printed materials to general public
Necessary Explanatory Meetings	To discuss with communities and stakeholders about PP/PA activities
Demonstration Programmes	In accordance with the priority projects of sewerage and non-sewerage works, demonstration programmes shall be launched

Set II includes programmes that run parallel to the first set and shall communicate the ideas on health, sanitation and better living environment in accordance with the hygiene education concept in the M/P. The programmes shall broadly constitute:

Entry point Activities	To build a platform for initiating the programmes
Regular Publicity	To keep the message fresh in the minds of the people
Yearly Campaign	A yearly campaign should be implemented in accordance with public participatory approach and the stepwise planning as discussed in Master Plan
Clean River Day and Clean River Week	To raise the awareness on river cleaning
Regular activities in slums and Dhobighats	To formulate the community-based organisation for O&M of the facilities created.

Further for ground implementation communication tools and communication activities have been detailed. A mix of all the activities and tools shall constitute a programme and the appropriate mix shall be selected by the implementing agency as per the guidelines given in the TOR and budgetary allocations that have been made.

Communication Tools

1) Media	**Contents**
Press	Press Conferences, Press Releases, Articles, Advertisements
Television	Talk Shows, Advertisements, News
Other Publicity Materials	Hoardings, Banners, Posters, Pamphlets, Hot Air Balloons
2) Other Means	
Theme Plays, School Programmes, Information Kiosks, Power Point Presentations, Documentary Films, Information Van, Site Visits, Shram Dan	

Summary of Activities for Communication

Communication Activities	**Intended Target population**
Focus Group Discussions (FGDs)	Lawyers, Doctors, Professors, Religious Leaders, Political Personalities, Municipal Officers, RA's and other Professionals
Transect walks/Padyatras	Women and Youth
Workshops	Beneficiaries and future beneficiaries of priority projects
Swasthya Mela in city	General Public encouraging women in particular.
Health Camp for slums	Slum community
School Programmes	School Children
Programmes for women	Women
Information Mela	Beneficiaries and future beneficiaries of priority projects
Competitive Programmes	Clubs, industry houses, hotels, private hospitals

(3) Implementation Structure

In the institutional front after analysing the institutional structures it is felt that there is no structure at present that takes care of the PP/PA activities in the state or the city. Therefore, for implementing the works Health Officer in the Nagar Nigam will be the main authority answerable to the Municipal Commissioner and provided with additional technical staff to support on the programme. This addition of technical staff is very important because at present the Nagar Nigam does not have a qualified person to deal with the PP/PA issues and monitor its progress.

The hierarchy of the implementation structure is as explained in Figure 4.10. The emphasis at the implementation level shall be on the Nagar Nigams of the four cities.

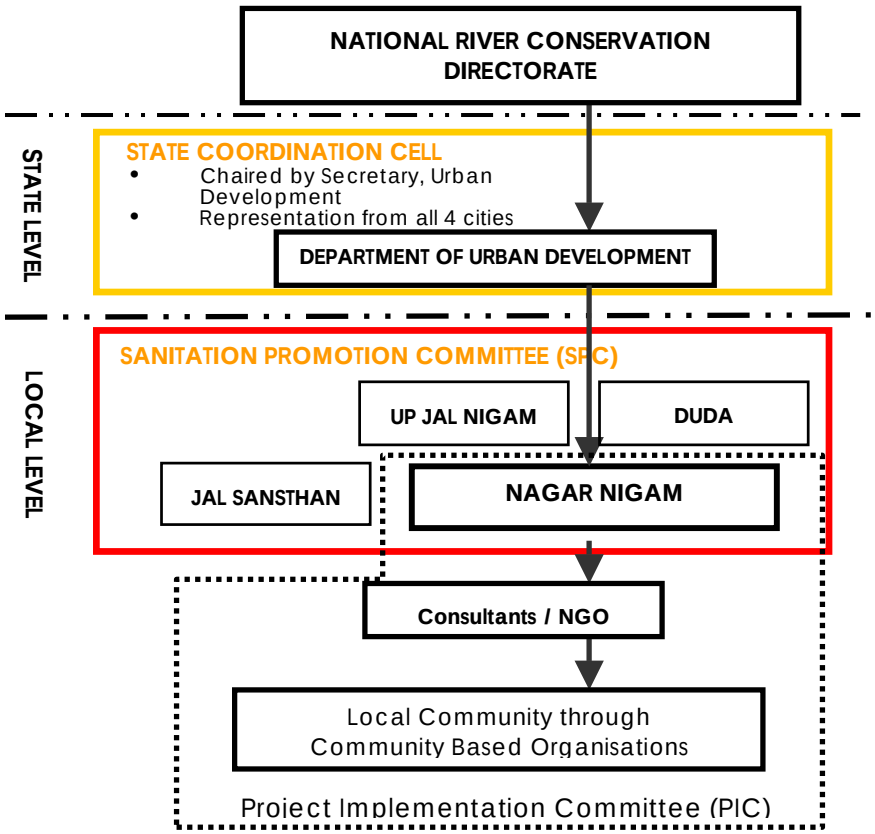


Figure 4.10 Proposed Organisational Structure of the Implementing Agency

(4) Monitoring and Evaluation

There will be two parallel monitoring and evaluation structures for the entire PP/PA programme:

i) Implementing Agency - Prepare reports on the progress of work based on monthly reports from the local consultant and send to NRCD PP/PA Cell (NPPAC).

ii) Community - On the people's side the groups of communities (ward committees and the citizens committee in each city) will report to Project Implementation Committee (PIC) and PIC will report to State Co-ordination Cell. These reports will be sent on quarterly basis.

Such a system will ensure that a check is maintained on the works that are being undertaken and the budgets allocated are utilised properly. Evaluation of Programme will be done in the regular State Co-ordination Cell meetings and once a year evaluation reports are a must.

For the purpose of evaluation, a set of Impact Indicators shall be developed by the local consultant that henceforth shall be circulated to the PIC, NN and the local groups who all shall rate the programmes. The essential function of the impact indicators is to evaluate the effectiveness of PP/PA programmes.

- Operational – Measure information provision, feasibility, and duplicity of each
- Effect – Direct and indirect influences

On the basis of reports and evaluation of the PP/PA Programme, necessary changes in the content and direction of the programme will be made, if required, to make it more effective.

(5) Project Costs

Table 4.46 Cost Estimation for PP/PA (Allahabad)

(Rs.)

Items	Allahabad
Activities SET I	1,354,000
Activities SET II	26,496,000
Fixed Costs (Equipments for NN)	3,810,000
Administrative Activity	14,335,000
Total	**45,995,000**

4.4.5 Operation & Maintenance and Institutional Development Programme

(1) Management Responsibility for Environmental Public Services

The major administrative units that are closely related to water quality management under GAP present hierarchic tiers of the national, the state (Uttar Pradesh State Government) and the municipal levels of organisations. There are two major groups of organisations: One group including Development Authority and Nagar Nigam is associated with urban development and the second group including UP Jal Nigam and UP Pollution Control Board is associated with environmental conservation and pollution control. Both groups are administratively separate entities but coordination amongst these organisations is vital for implementation of NRCP activities.

The division of responsibilities amongst local and state organisations, for development and maintenance of sewerage collection and treatment systems is summarised as follows:

Table 4.47 Management Responsibilities for Environmental Public Services

Management Responsibility	Organisation	Functions
• Master planning	UPJN	• Physical infrastructure (water supply, sewerage and pollution control) • Capacity and location of facilities
	DA	• Spatial arrangement • Land use • Population projections
	UPJS	• Physical infrastructure for water supply facilities • Capacity and location of facilities (water supply)
• Design and construction	UPJN	• Sewerage infrastructure for river pollution abatement Action Plans. • Water supply and sewerage infrastructure for urban development
	DA	• Infrastructure for new development areas
	HDB	• Infrastructure for state housing developments
• Operation and maintenance	UPJN	• Trunks sewers • Interception and treatment works • Storm water pumping stations • Compliance with environmental regulations
	NN	• Storm water drains • Solid waste disposal
	JS	• Sewers and pumping stations • Water supply treatment and distribution works
• Pollution control and monitoring	UPPCB	• Monitoring and preventing entry of polluted wastewater (if they do not meet discharge standards) into nalas and rivers. • Regulating industries

Currently, sewerage facilities are planned, constructed and maintained by many parties without effective coordination. UP Jal Nigam is constructing interception and diversion facilities and sewage treatment plants (downstream facilities) to improve river water quality and Urban Development Agency, Housing and Development Board and Development Authorities is constructing branch sewers (upstream facilities) as and while they develop new urban areas and housing complexes.

Jal Sansthans as well as Nagar Nigams are legally responsible for the sewerage service but they are, in practice, doing only maintenance of the upstream facilities as long as the funds are available. The downstream facilities are operated and maintained by UP Jal Nigam.

Various parts of the sewerage system are constructed, operated and maintained by various organisations for various purposes different from each other. The existing sewerage system has neither been planned, envisaged nor conceived as an integrated one. As a result, inefficient facilities have been constructed and maintained insufficiently without a definite ownership.

(2) Key Issues

There are several institutional and financial weaknesses that adversely affect the quality and extent of sewer coverage as well as ability to provide adequate operation and maintenance. The key issues are summarised as follows:

1) No master plans for urban infrastructure

There is no master planning for physical infrastructure. The absence of a master plan leads to the fragmented and uncoordinated implementation of infrastructure by several implementing agencies, each fulfilling their immediate short-term objectives. As a result several schemes cannot be integrated into the main trunk sewer network.

2) Lack of single point responsibility

Several implementing agencies at state and local levels are developing land and infrastructure in the city. Their efforts are not well coordinated, especially in the absence of a master plan. Although taxes and water charges are collected at the local level, accountability to the citizens for sewerage and drainage problems is obscured by the lack of single point responsibility. Similarly, accountability for achieving water quality objectives is unclear.

3) Insufficient revenue for O&M

Municipal Corporations have the power to implement a tax for water, and a separate sewer/drainage tax. These taxes are based on the annual rental value of the property, which does not reflect the real value of the property. Municipal Corporations also collect revenue from the sale of water through their Jal Sansthans; however the State Government controls the water tariff. Municipal Corporations are allowed to pool all sources of revenue to finance maintenance and development of municipal infrastructure. The revenues are at present insufficient to cover O&M costs.

UPJN has no such source of revenue. It depends on state funding to operate and maintain facilities. At present, local Jal Sansthans are expected to operate all new assets created by other implementing agencies however they do not in general have the required financial or human resources. As a result most Jal Sansthans have refused to accept responsibility for O&M of assets created by UP Jal Nigam.

(3) Improvement of Operation and Maintenance

1) Current O&M Status

The current maintenance practices are reactive rather than preventive and routine as per manual. Most of the maintenance is carried out in response to customer complaints related to overflows etc. These problems are normally resolved by clearance of blockages in the sewer. There is no evidence of a planned regime of cleaning or inspection of the system. Any repairs to the system arise from problems noted during blockage clearance or from customer complaints. Besides this, record keeping is highly limited and in some cases even inaccurate.

From discussions and site visits, it could be stated that maintenance management (for sewerage as well as for water supply) is undertaken on an ad hoc basis. Site work is not always carried out in an organised way. Indeed, at some of the sites, it was not very clear, who was the in-charge official(s). Working practices observed were not in accordance with The Manual on Sewerage and Sewage Treatment (i.e. The Manual on Sewerage and Sewage Treatment, Second Edition prepared by the Expert Committee constituted by the Ministry of Urban Development, Government of India, and published in 1995). During maintenance works, the safety was either non-existent or of very poor quality.

2) Collection System O&M improvements required

Ideally all elements of a sewerage system should receive the highest levels of maintenance to ensure its performance. However, this is an unrealistic aspiration for any sewerage authority to contemplate.

There are three broad policy options:
- Purely reactive
- Totally planned
- Selective planned/reactive

A more appropriate and cost-effective approach is to achieve a balance between planned and reactive maintenance in providing an acceptable and reasonable level of service.

Many parts of a sewer system operate quite satisfactorily with minimum maintenance. The key to a cost effective maintenance strategy is the recognition that maintenance and rehabilitation programmes should retain as much as is practicable of the existing network by a combination of optimising hydraulic performance and the use of renovation. Therefore regular inspection and assessment is required to identify those elements of the sewer system that will require attention on a regular and planned basis. Elsewhere the sewers only need to be dealt with on a reactive basis.

<u>Immediate priorities</u>

- Establish System Records and Maps

  There is an immediate need to collect and to store centrally all existing records of the sewerage network by setting up a comprehensive computerised database at the local level. This database is typically referred to as a sewer inventory.

- Inspect Critical Sewers and Assess Conditions

  A comprehensive survey of critical sewers is required in order to:
  - Develop the sewer inventory data
  - Assess the physical condition of sewers
  - Identify critical sewers and priorities
  - Identify maintenance, rehabilitation or replacement needs

- Upgrade Pumping Stations O&M Procedures

The primary objective of operating and maintaining a pump station is to keep the station in continuous operation in order to prevent sewage overflows to the environment and flooding in upstream reaches of the incoming sewers. The following activities are critical to the successful operation of pumping stations:

- Developing equipment operation and maintenance manuals
- Developing procedures for normal, abnormal, and emergency conditions
- Developing systems for recording daily operating conditions
- Establishing systems for recording equipment maintenance and breakdown history

Long term needs

Long-term measures in line with standard international practices are given in the main report and need to be integrated into a long-term maintenance programme, summarised in the table below:

Table 4.48 Outline of Sewerage Maintenance Programme

Type of activity	Description
Sewer inventory	GIS base maps, data collection, updating
Sewer survey and inspection	Cleaning, CCTV inspection, assess condition, identify critical sewers
Routine inspection & cleaning	Follow-up routine cleaning, CCTV survey
Emergency blockage clearance	Sewer clearance
Sewer & manhole repairs	Emergency repair
Planned maintenance & rehabilitation	Sewer replacement or other rehabilitation technologies
Service connections	Check and repair of existing connections, Installation of new connections
Control of storm water discharge into sewers	Identification of connections, remove connections

3) Treatment facilities O&M improvements required

Operation and maintenance improvements should initially be carried out at the existing sewage treatment works, but this work will effectively be a training ground for establishing procedures and an organisation capable of running the proposed future sewage treatment works.

Accurate records should be maintained which give full details of the design criteria and sizes of treatment units, etc. and comprise a diary of every significant event at the works. These records should be checked on each routine supervisory site visit. The records should include comprehensive details, with drawings and service manuals, for all electrical and mechanical components indicating their dates of manufacture and installation, and a detailed service/maintenance history for each unit. Detected faults should be recorded and reported to ensure that remedial action will be taken as soon as possible to have the faults rectified. Other routine O&M requirements are listed in the main report.

4) Contracting Out

Strengthening the capacity of local Jal Sansthan for O&M of sewerage system is recommended, however, ‘contracting out’ can make good sense economically in the alternatives given below. A decision regarding what tasks/components will be ‘contracted out’ and for what total periods needs to be treated as an urgent matter, as it will greatly influence the staffing requirements of the new sewerage division to be created within JS.

- Contracting out sewer inspection surveys to establish the sewer inventory
- Contracting out design, tender document

- Contracting out sewerage construction supervision
- Contracting out sewage treatment construction supervision
- Contracting out sewerage operation and maintenance
- Contracting out sewage treatment operation and maintenance

The operation and maintenance of the proposed new sewage treatment works for a fixed period could be included as part of a 'turn-key' design and construction contract. Even if it is decided to let some tasks out to another public agency (e.g. UPJN) or to private sector contractors, the Sewerage Authority (NN/JS) should always retain overall responsibility for and should closely control and supervise the work carried out by others, and so it will still require competent managers and supervisors.

(4) Institutional Development and Capacity Building

1) Institutional Development Programme

A single agency should cover the entire sewerage system; from planning to operation and maintenance; from house connection to sewage treatment plant. By this way, comprehensive and organised sewerage will be attained. To achieve this objective, Institutional Development Programme (IDP) was proposed in the Master Plan. The contents of IDP, which have been identified in the Feasibility Study, are as follows:

Framework	Contents
Organisational strengthen	Create and organise sewerage division on basis of objective, principles and guidelines
Operational resource development	Stocktaking of sewerage facilities (asset list), current status of them
Human resource development	Recruitment and training of engineers, operators and business handlers
Financial resource development	Identify or create financial source or revenue source

2) Future Management Structure

The responsibility for O&M should rest with a single sewerage authority that should be integrated with the existing Jal Sansthan. However, in the context of this Report, the proposals made are, for clarity, for the management of sewerage functions only. Several of the technical services, administration and financial functions can be provided by the existing water supply departments. The recommended organisational structure is represented here:

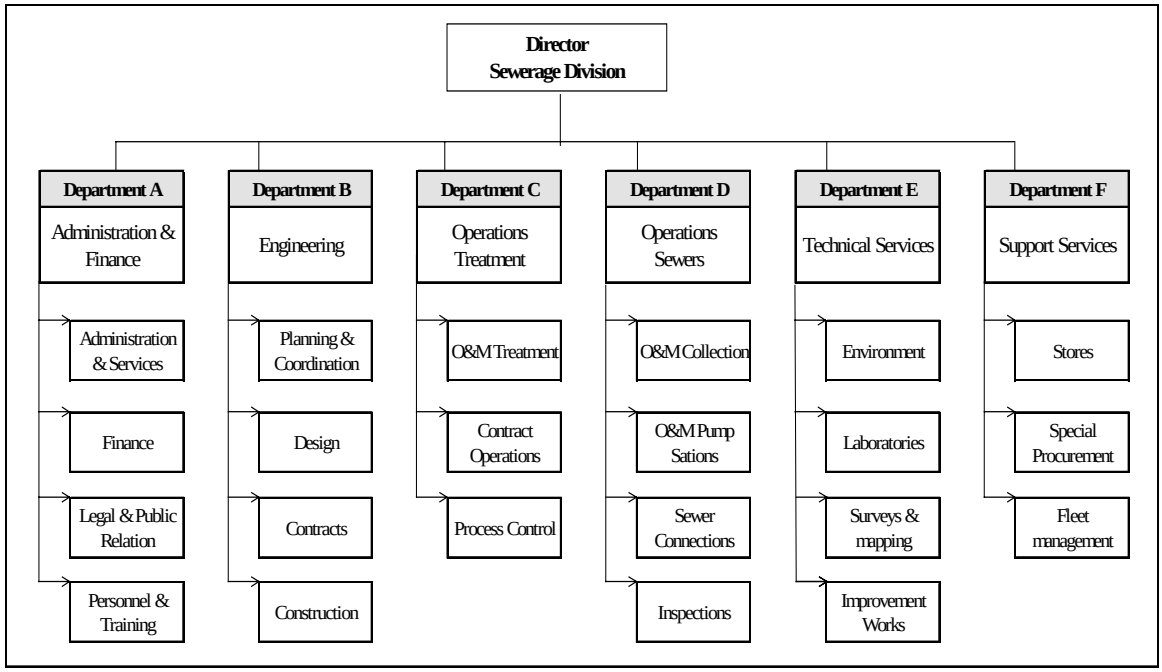


Figure 4.11 Future Management Structure

3) Methodology for setting up proposed new organisation

The following are a methodology for setting up the proposed new organisation.

STEP 1: Decide responsibilities of the Sewerage Division

STEP 2: Decide personnel requirements for Managerial level

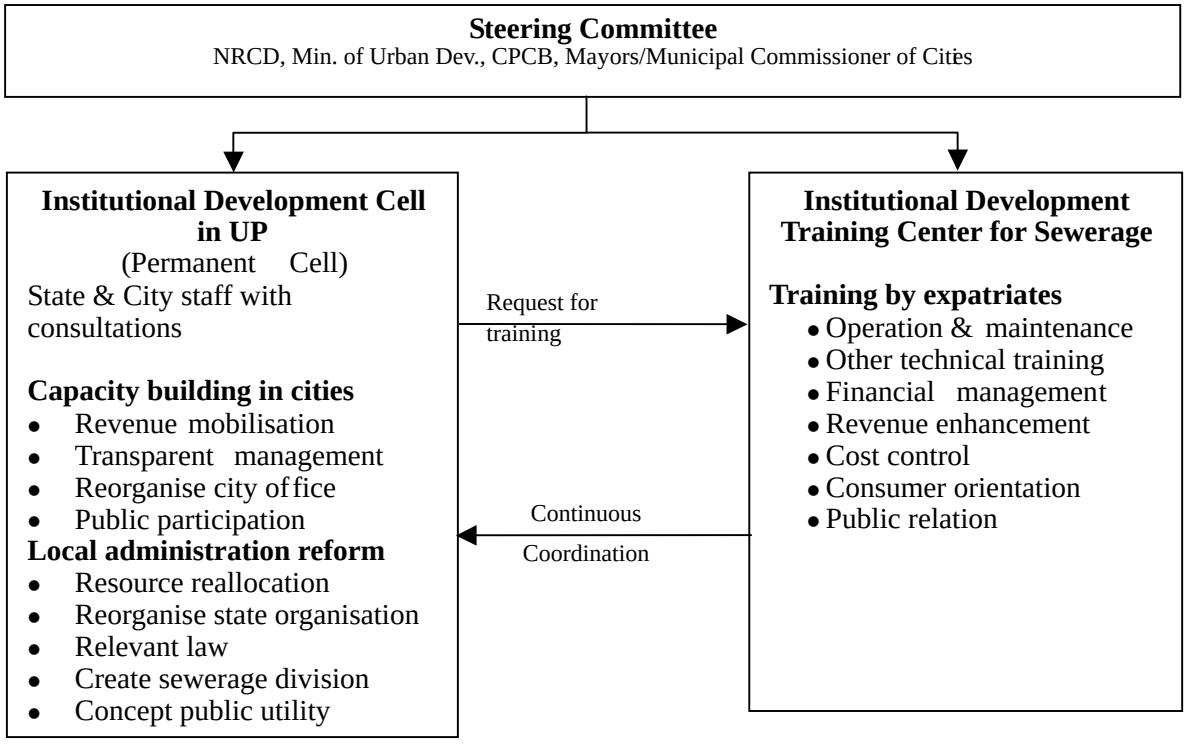
STEP 3: Locate office space and other practical details for management structure

STEP 4: Decide personnel requirements for Worker level

STEP 5: Chalk out policy framework

4) Institutional Development Programme

To implement IDP, Institutional Development Cell (IDC) should be created in the UP State Department of Urban Development. It is also suggested that an "ID Training Centre for Sewerage" should be established at the national or state level to satisfy the training needs for the personnel. Staff shall be selected from the State Government (UP Jal Nigam) and city offices (Nagar Nigams and Jal Sansthans). The implementation structure is presented in the following figures.



5) Institutional Development and Capacity Building (IDCB)

The strategic action plan for Institutional Development and Capacity Building (IDCB) is primarily identified and summarised as presented in Table 4.50.

(5) Cost Estimation of IDCB

Table 4.49 Cost Estimation for IDCB (Allahabad)

Sr.	Description	Cost
1	IDP Consultancy Services	70,700
2	Training	84,000
3	Infrastructure Enhancement	33,300
Total		**188,000**

Table 4.50 Action Plan for Institutional Development and Capacity Building (IDCB)

Sr.	Objective	Action	Agency
A. Financial Sustainability			
1	1. Reduce Costs	Measures to reduce power consumption have to be implemented.	Organisation
2		Reduce number of non-technical staff.	Organisation
3		An "on the job" training should be implemented to increase the productivity of the personnel.	Consultant
4		The expenditure - "Interest/dividends" on Government capital – has to be reduced/eliminated, if possible.	Organisation
5	2. Increase Revenue	• Carry out property survey along with the size and type of water connection and broaden the tax net in the short term. • As a long term planning strategy, create a GIS database of the existing properties, water and sewerage system and integrate this database with the property permission applications.	Consultant Consultant
6		Along with the property survey, a re-assessment of the property values should be carried out to have realistic basis for property tax.	Consultant
7		• Start the process of water and sewerage charges based on dual criteria of property tax and size of water connection. • Initiate, a study to evaluate the implementation of metering over the entire city.	Consultant Consultant
8		The whole billing system has to be computerized and the staff to be trained to undertake this assignment.	Consultant
9		Formulation of the incentive scheme, based on the amount collected and the number of bills collected	Organisation
10		Carry out a detail study to assess the market for selling the by products generated from the STP	Consultant
11		As a long term strategy, the JS should pursue the UP Government to link the tariff with the cost of production, specifically the cost of electricity charges.	Organisation/ Consultant
B. Institutional Capacity Building			
12	Human Resource Development	Determine the requirement of technical manpower and recruit/ contract requisite manpower	Consultant
13		Identification of the training needs, development of training programs and selection of the training institute.	Consultant
14		Conduct a detail study to identify the opportunities for public private partnership programs	Consultant
15	Infrastructure Development	Procure hardware and software for creating a sewerage system inventory and develop a GIS based sewer application for visual interpretation.	Consultant
16		Procure engineering equipment for proper maintenance of the sewerage system.	Consultant
C. Communication			
17	Communication	Establish a comprehensive and reliable communication system between the organisations involved and PMC.	Consultant
D. Institutional Development			
18	Institutional Setting up	Establishment of Sewerage Division in Jal Sansthan and Nagar Nigam	Organisation/ Consultant
19		Capacity Building of City Office (Nagar Nigam)	Organisation/ Consultant

4.4.6 Summary of Total Project Costs and Implementation Schedule

The project costs of Sewerage, Non-sewerage, Public Participation and Awareness and Institutional Development Programme for Allahabad are summarised in the table below.

Table 4.51 Summary of Project Cost by Components (Allahabad)

(Million Rs.)

Item	Capital Cost	Physical contingencies, Engineering, Project administration	Land Acquisition	Total Project Cost
Sewerage Scheme	2,059.8	432.6	208.8	2,701.2
Non-Sewerage Scheme	86.4	21.6	0.0	108.0
Public Participation and Awareness	0.0	0.0	0.0	46.0
Institutional Development Programme	0.0	0.0	0.0	188.0
Total	2,146.2	454.2	208.8	3,043.2

The implementation of the total project and year wise fund flow requirement is presented in the table below.

Table 4.52 Summary of Project Implementation (Allahabad)

(Million Rs.)

Item	Total Project Cost	2007	2008	2009	2010	2011	2012
Sewerage Scheme	2701.2	267.2	582.3	613.9	446.1	539.4	252.3
Non-Sewerage Scheme	108.0	2.2	28.3	26.6	26.6	24.3	0.0
Public Participation and Awareness	46.0	9.5	6.9	7.4	7.6	7.1	7.5
Institutional Development Programme	188.0	37.6	56.4	56.4	18.8	9.4	9.4
Total	3,043.2	316.5	673.9	704.3	499.1	580.2	269.2

4.4.7 Water Quality Estimation With Project

Estimated water quality with project and without project scenarios for 2015 is compared in the table below. The without scenario includes the sanctioned project. The water quality is estimated at the confluence of Ganga and Yamuna rivers (Sangam).

Table 4.53 Comparison of With and Without Project in year 2015

Item	Without Project	With Project
Estimated wastewater discharged in 2015 upstream of the Sangam	240.5 mld	240.5 mld
Treatment capacity in 2015	89 mld	239 mld
Untreated wastewater in 2015	151.5 mld	6.5 mld
Percentage of untreated wastewater in 2015	63.0 %	2.7 %
Estimated BOD discharge (untreated + treated)	48.12 ton-BOD/day	8.97 ton-BOD/day
BOD concentration at upstream (u/s) of city (assumption)	2.5 mg/l	2.5 mg/l
BOD contribution to the river (if treated water is used for irrigation)	+1.8 mg/l (1.7 mg/l)	+0.3 mg/l (0.0 mg/l)
BOD concentration at downstream (d/s) of city. (if treated water is used for irrigation)	4.3 mg/l (4.2 mg/l)	2.8 mg/l (2.5 mg/l)
Environment for bathing	Large volume of wastewater will be discharged in the Ganga and Yamuna, by which unhygienic condition for bathing will be further degraded.	All wastewater except in District F and G will be intercepted before entering the Ganga and Yamuna, and treated. The bathing environment will improve.
Protection of water source of drinking water	The current municipal water intake is located at the upstream of the city. Thus there is no impact on the intake.	The current municipal water intake is located at the upstream of the city. Thus there is no impact on the intake.
Water quality of effluent of existing and proposed STP	Bacterial pollution will increase because of no disinfection facility	Chlorination will be applied to both existing and proposed STPs. Bacterial pollution will be reduced.

Note: 1) The dry flow of the Ganga and Yamuna rivers is used for analysis.
2) BOD concentrations of untreated and treated wastewater of 300 mg/l and 30 mg/l are used for analysis.
3) The sanctioned project includes 29 mld STP at Salori and is assumed to be implemented.
4) The water quality is evaluated at the confluence of Ganga and Yamuna (Sangam)

If the project is implemented (with the project scenario), 97 % of the wastewater discharged will be intercepted and treated in 2015 while if the project is not implemented (without the project scenario) only 37 % is treated and the rest of wastewater discharged finds its way to the Ganga and Yamuna degrading bathing environment of ghats and Sangam, one of the most sacred and famous bathing places in India. The preliminary estimation shows that the BOD concentration in Allahabad will be 4.3 mg/l without the project and 2.8 mg/l with the project.

4.4.8 Economic and Financial Evaluation

(1) Economic Evaluation

Economic benefits of the proposed project are identified as follows:

1) Increment of willingness to pay (WTP) for improvement of water quality of the river Gomti estimated by Contingency Valuation Method (CVM)
2) Increment of WTP for improvement of sewage treatment systems estimated by CVM
3) Saving of medical expenditure due to decrease of suffering rate of water borne diseases derived from the improvement of water environment
4) Increase in saving due to decrease of suffering rate of water borne diseases also derived from the improvement of water environment
5) Contribution to regional economy derived from incremental increase of bathing population at the ghats along the river Gomti, and
6) Agricultural benefit from utilisation of treated effluent for irrigation.

Following table shows their estimated unit values.

As of 2004 Price Level

WTP for Improvement of Water Quality of the River Ganga	WTP for Improved Sewerage Treatment Services	Saving of Medical Expenditure Caused by Decrease of Suffering Rate of Water Borne Diseases		Saving of Salaries/Wages Caused by Decrease of Suffering Rate of Water Borne Diseases		Contribution to Local Economy Caused by Increase of Bathing Population		Agricultural Benefit (Paddy + Wheat)
		Outpatients	Inpatients	Outpatients	Inpatients	Regular Users	Occasional Users	
Rs./household/annum						Rs./person/annum		Rs./ha/annum
354	553	11.0	139.4	3.6	10.5	17,852	59,507	11,603

Annual economic benefits for (1) above can be estimated by basic unit multiplying the entire households (HHs) in the project area, for (2), (3) and (4): the number of HHs connected, for (5): the incremental bathing population, and (6): the incremental irrigation area (ha).

Using annual cash stream of economic cost and benefit, the following results of economic evaluation are obtained. The EIRR is estimated at 8.9 %.

Index	Discount rate 10 %	Discount rate 5%
NPV	-181 million Rs.	1,436 million Rs.
EIRR	8.9 %	8.9 %
B/C	0.91	1.41

(2) Financial Evaluation

Sewerage projects are public works and their financial viability cannot be worked out using standard financial evaluation techniques as they cannot generate profit or expect cost recovery as their objective. The main objective of such project is to provide better living conditions to the residents of the city and also make the environment clean and friendly. Hence it cannot be evaluated as a commercial project for cost recoveries and profit objectives.

The financial evaluation is made only for operation and maintenance cost recovery. The project is financially evaluated preparing a cash stream. The required user charge to recover the entire O&M and replacement cost assuming exiting bill collection rate is estimated at Rs. 2,360/per annum per household. The estimated average current sewer charge per bill is Rs.265 per annum. The required

user charge is about 8.9 times higher than the current charge level and higher than the estimated maximum affordability to pay of Rs. 1,964 per annum.

The amount of revenue generated from taxes and charges by the Service Provider, Allahabad Jal Sansthan, can cover only around 13 % of the total O&M cost in 2015 under existing conditions.

(3) Case Study for Improvement of Financial Situation

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.

- Improvement of billing and bill collection
- Utilisation of the by-products of sewerage system
- Others such as improvement of accounting system

Following figure shows the conservative projection of the number of the entire household in the city area, the households in the sewer area, the sewer connected household (or sewer charge billing household) and sewer bill collected households until the target year 2015 based on existing collection rate. As seen in the figure, there is a high potential to increase sewer connection and improve sewer charge collection efficiency.

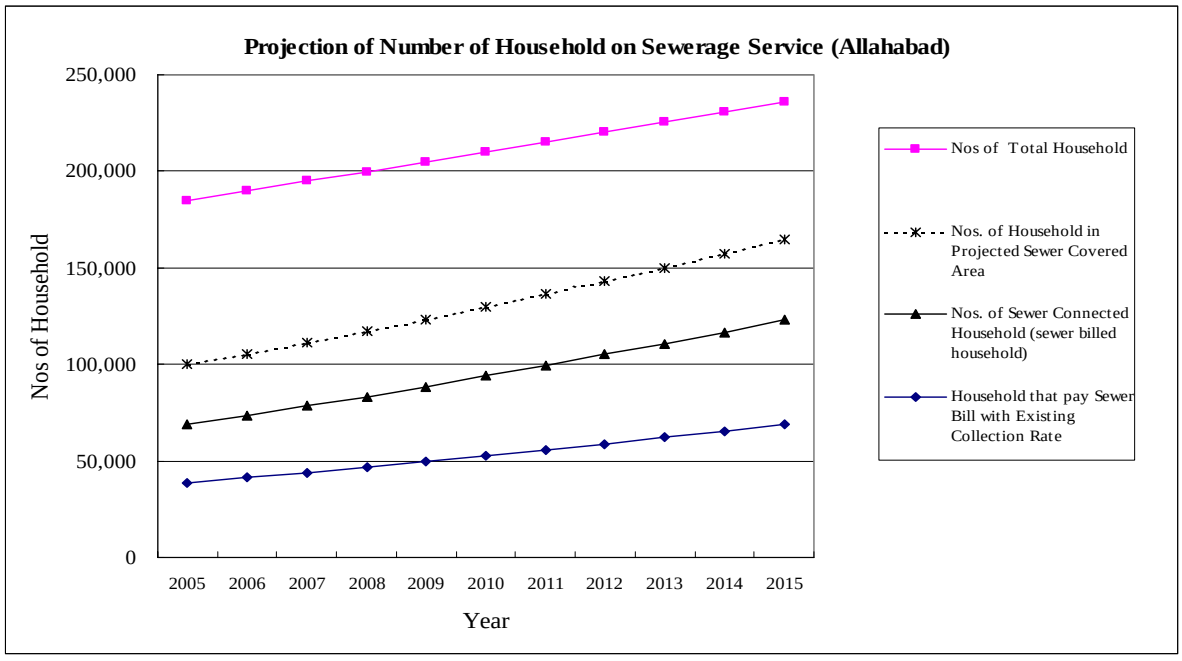


Figure 4.12 Number of Total Households in the City, Household in the Sewerage Service Area, Sewer Connected Household and Sewer Bill Collected Households

Following table shows a result of the case study taking into account the additional sources of revenue and improvement in the charge collection rate and charge level and sewer connection rate.

Table 4.54 Summary of Case Studies for Recovering of O&M Cost

Case in Sewer Charge level	Total O&M Cost required	Base Case		Case - 1				Case - 2			
		Revenue from sewer charge	Amount to be borne by State Transfer	Revenue from sewer charge	Optional Sources: Revenue from treated water sales	Optional Sources: Revenue from sludge sales	Amount to be borne by State Transfer	Revenue from sewer charge	Optional Sources: Revenue from treated water sales	Optional Sources: Revenue from sludge sales	Amount to be borne by State Transfer
Million Rs./year											
Existing	144.7	18.1	126.6	20.0	1.0	3.4	120.4	31.0	1.0	3.4	109.3
50%	144.7	27.2	117.5					46.6	1.0	3.4	93.7
100%	144.7	36.2	108.5					62.1	1.0	3.4	78.3
350%	144.7	81.5	63.2					139.7	1.0	3.4	0.6
Conditions		Exiting sewer collection rate		1) 5% increase of sewer charge 2) 5 % increase of collection rate 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)				1) Increase in bill collection rate to 90 % 2) Increase in connection rate to 80 % in sewered area 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)			

Note:

	Existing Collection Rate of Bills	Existing Charge Level (Rs./Bill/ Year)	Affordability to Pay based on the income level: 1.5 % of average annual income per HH (Rs./Rs. per annum)
Lucknow:	80%	573	2,775
Kanpur:	50%	1,221	1,648
Allahabad:	56%	265	1,964
Varanasi	78%	112	1,889

Case-2		Case-1	
Estimated percentage of house connections in the sewered area	69%	charge %	0.05
Estimated percentage of households in the sewered area	54%	collection %	0.05
Estimated percentage of bill collected households out of total households in sewered area	42% in 2015		
Proposed collection rate	90% fixed		
Proposed connection rate	80% fixed		

Assuming the connection rate of 80 % in sewer area and the bill collection rate of 90 %, the amount to be borne by the State transfer will be reduced from Rs.126 million to Rs.109 million.

In this case, if the charge level is increased by 100 % (2 times of the existing charge level of Rs.265/HH per annum, in other words, if the charge level is revised to Rs.530/HH per annum), the amount to be borne by the state transfer will be reduced to Rs.78 million.

Furthermore, if the charge level is increased by 350 % (4.5 times of the existing charge level, in other words, if the charge level is revised to Rs. 1,192/HH per annum), the revenue and O&M cost will be balanced. Even at this charge level, the revised charge will be within the affordability to pay for sanitation (Rs. 1,964/HH per annum).

From this viewpoint, a revision of the charge level is recommended by means of not only the revision of the existing tariff system but also the reassessment of the Annual Rental Value of properties since the charge level is closely linked with the Annual Rental Value of properties.

(4) Recommendations

To improve financial feasibility of the project, following measures are recommended:

1. Improvement of billing and bill collection, consisting of:
   - Increase in tax net
   - Reassessment of property values and annual rental value
   - Reduction of process time per bill
   - Increase in productivity by introducing incentive schemes

2. Utilisation of by-products, consisting of:
   - Treated water for irrigation
   - Generated sludge as fertiliser

3. Finding of government subsidy or other financial source for operation and maintenance cost

4.4.9 Stakeholder Meeting for Allahabad Project

In accordance with the JICA guideline of Environmental and Social Considerations, a stakeholder meeting was held for the purpose of informing the feasibility study (F/S) project for Allahabad city to the stakeholders and public. The objective of stakeholder meeting was to encourage the recipient governments to take appropriate considerations of environmental and social factors in the project.

The meeting was organised by Department of Urban Development, Government of UP, and under this, Allahabad Nagar Nigam, UP Jal Nigam, Allahabad Jal Sansthan had the responsibility to hold the meeting in collaboration with the JICA Study Team. The organisers in consultation with JICA Study Team decided the range of stakeholders to be invited to the meeting and following stakeholders were selected;

- Elected Public Representatives
- Ministries and Govt. Agencies
- Project Affected People
- Officers of UP State Government and State Undertakings
- International Organisations and Donors
- NGOs
- Well-Informed Persons / Experts
- Media

(1) Joint-Meeting

Before stakeholder meeting, a joint preparatory meeting was held on 28th January 2005 to present and discuss the contents of the project and the procedure of the proposed stakeholders meetings in three towns and resort necessary modifications based on the feed back of the discussions with counterpart agencies of Nagar Nigams, Jal Sansthans, UP Jal Nigam officers of three cities. Besides, representatives form Govt. of UP also participated in the meeting.

(2) Press Release

To inform about the Stakeholder Meetings and brief on the project contents to the general public, press releases to newspaper were conducted on 6th February 2005.

(3) Stakeholder Meeting

Based on the guideline, a stakeholder meeting was held at Allahabad. The details are as below:

- Date: 7th February 2005
- Venue: State Institute of Education Management Training
- Participants: 141 participants from various stakeholders

The key issues raised by participants and reactions of the organisers/JICA Study Team are as below:

Question	Answer
Only 25% area of the Allahabad has sewerage connection and in the rest of the area there is no mechanism for the management of domestic waste water and it flows around the roads unmanaged thus, creating a very unhygienic conditions which further leads to a lot of health risks. Has the plan proposed by JICA considered this problem and proposed any solution to this problem?	JICA Study Team's plan primarily focuses on the Trunk sewers through which the domestic waste water flowing in various drains, after interception, will be carried to different STPs that have been proposed and where it will be treated and discharged to irrigation canal. The primary objective of the proposed project is to improve the water quality of rivers thus entire sewerage plan focuses on the measures to address the domestic waste water that flows to river untreated. The branch sewers can not be funded under the said project and is to be taken care of by the state govt and local bodies
Industrial waste water is one of the main reason of the river pollution. What measure JICA Study Team proposes to address the pollution from Industrial waste?	Industrial waste water is not the mandate of the under this study and it is to be tackled by CPCB. As per CPCB guidelines, all industrial units have to have ETPs and the same has to be monitored by CPCB.
Whether the land availability for the proposed nos. of CTCs in the slum are confirmed or not, and also what kind of disposal/ treatment measures are proposed?	At this stage, only the needs of CTCs has been estimated and the location and availability of land will be worked out during the implementation stage in coordination with Nagar Nigam. Regarding treatment, it has been proposed to prefer the construction of CTCs in the area where the sewerage networks exist or are proposed, however, in absence of sewerage connection, septic tank/ soak pit has been proposed.

Comments from participants:

- It is very unfortunate that various important points have been left untouched in this major Project without deliberations due to which this project cannot be useful. For example, the local geographical features, unplanned residential area, the increase in the expenditure whether, whether it could be paid back by the people and similar many other points are there towards which your attention has not attracted at all.
- Dhobighat be not constructed over polluted nalas because flow of sulpher-di-oxide cannot be prevented.
- Waste water purification could be achieved if pond treatment plant is adopted.
- What provision has been made in your survey and project for prevention of water pollution due to the situation such as unclaimed corpses, some practices due to certain beliefs to dispose the dead bodies into the river water or to bury them on the river bank instead of cremation?
- "I would like to say that if you adopt bio-monitoring, it would be very nice which would activate continuous process. Monitoring should be done at the right time, at least ten times in a day. If Allahabad is to be saved, Ganga will have to be saved, this is my hope".
- The work being done by JICA Study Team on the Ganga River Water Quality Management Plan is highly praise worthy. In future pure water would be available in our Ganga river, due to which the situation of cleanliness in our city will improve and there will be reduction in the diseases, public health will improve.

The answers to the comments are attached in Volume IV-3, Part VI.

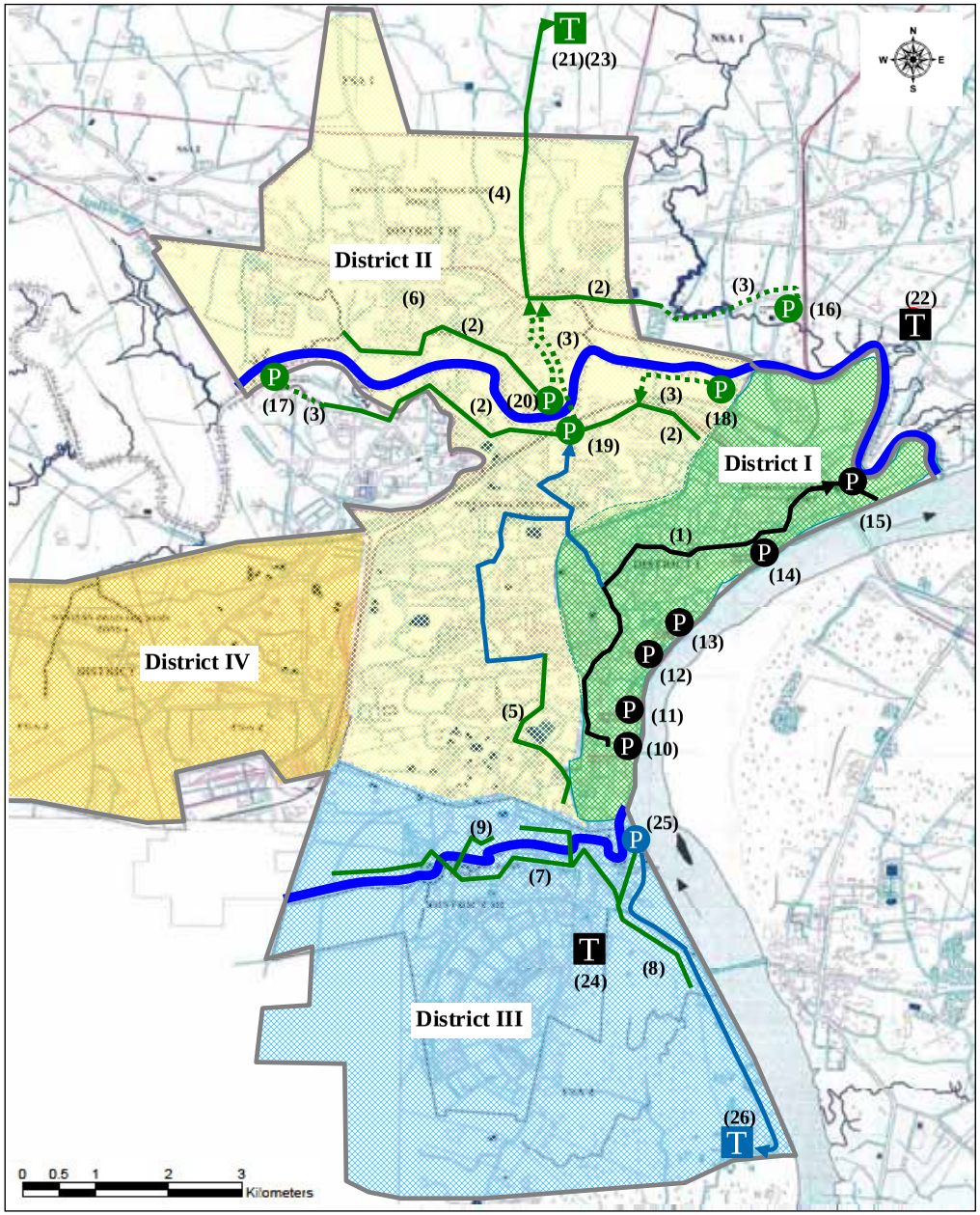
The minutes of meeting, participants' list, comments from participants and answers from the organisers were made available to the public at the offices of ANN, UPJN and AJS. The same are also available to the public in JICA Study Team's Homepage.

4.5 FEASIBILITY STUDY FOR VARANASI

4.5.1 Sewerage Scheme

(1) Proposed Components for Feasibility Study

The JICA Study Team has prepared the Master Plan (M/P) for the Varanasi sewerage system. The Master Plan identified certain 'Priority Projects' that are to be implemented within 1-5 years of adopting the MP, with the aim of reducing the pollution load on Ganga and Varuna rivers at Varanasi. These proposed facilities are shown in Figure 4.13. These facilities shall work together with the major sanctioned and commissioned projects listed in the same table.



Legend

- Municipal Boundary
- Sewer
- Rising Main
- Pump Station
- Treatment Plant

Black : Existing Facility
Blue : Sanctioned Facility
Green : Proposed Facility

	Sewer / Rising Main	District	Status	Diameter / Length
1	Existing trunk sewer in District I	I	E/R	750-2400 mm, 7.5 km
2	Varuna river interceptor	II	P	500-1200 mm, 7.0 km
3	Rising mains for Varuna river Interceptor PS	II	P	350-1800 mm, 6.6 km
4	Sathwa trunk sewer	II	P	2400 mm, 3.9 km
5	Extension of relief trunk sewer in District II	II	P	600-900 mm, 2.2 km
6	Secondary sewer in District II	II	P	300-700 mm, 12.4 km
7	Assi nala interceptor	III	P	600-1200 mm, 5.2 km
8	Nakha and Samme ghat nala interceptor	III	P	400-500 mm, 2.0 km
9	Secondary sewer in District III	III	P	300-400 mm, 1.6 km

	Pumping Station	District	Status	Capacity (mld)	Remarks
10	Harischandra SPS	I	E/R/A	15	Average flow in 2015
11	Mansarovar SPS	I	E/R	5	
12	Dr. RP SPS	I	E/R	31	
13	Jalesan SPS	I	E/R	4.7	
14	Trilochan SPS	I	E/R/A	9	
15	Konia SPS	I	E/R	100	
16	Naroka nala SPS	II	P	14	
17	Phulwaria SPS	II	P	7.6	
18	Saraiya SPS	II	P	3.1	
19	Chaukaghat right bank SPS	II	P	130	
20	Chaukaghat left bank SPS	II	P	14	
21	MPS at Sathwa STP	II	P	200	

	Treatment Plant	District	Status	Capacity (mld)	Remarks
22	Dinapur STP (ASP)	I	E/R	80	Average flow in 2015
23	Sathwa STP (UASB + AL)	II	P	200	
	Treated water channel: 4km				
	Lining of existing irrigation cannal: 14 km				
24	Bagwanpur STP (ASP)	III	E/R	8	
	Total			288	

Existing / Sanctioned Facility

	Facility	District	Status	Remarks
25	Nagwa SPS	III	S	
26	Raman STP (WSP)	III	S	

E: Existing R: Rehabilitation
S: Sanctioned A: Augmentation
P: Proposed Rp: Replacement

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PROJECT	LOCATION	Figure 4.13
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	Varanasi City	Proposed Sewerage Facilities for Feasibility Study (Varanasi)

(2) Design Data and Parameters

Project Design Horizon

The design period considered for sewers is 30 years (single phase). Civil works for pumping station facilities are designed also for 30 years, Electrical and Mechanical (E&M) works are designed for two-staged implementation, first stage up to 2015 and second stage up to 2030. Treatment facilities will be implemented in two stages as well. First stage would be up to 2015 and wherever flow increases / raw wastewater quality changes after 2015, the treatment facility would be augmented for the requirement of 2030.

Sewerage Districts Planning

The Master Plan has divided Varanasi into four sewerage districts viz. District I to IV. The major priority projects identified in the Master Plan fall into three districts viz. District I to III.

Design Population

The population of Varanasi as per 2001 census is 1,081,622. Growth rates for each district have been calculated based on the growth potential of the district. With these growth rates and with 2001 census figure as the base, the Master Plan has calculated population figures for each sewerage district; these are presented in the table below.

Table 4.55 Population Projection for Urban Area (Varanasi)

Sewer Service Areas	2003	2015	2030
District I	512,737	560,292	604,734
District II	534,902	801,238	1,123,008
District III	148,194	292,905	473,969
District IV	79,709	172,752	291,085
Total	1,275,542	1,827,187	2,492,796
NSA 1	43,140	93,166	215,724
NSA 2	23,691	57,083	114,567
Non-sewer Service Area Total	66,831	150,249	330,291
Grand Total	**1,342,373**	**1,977,436**	**2,823,087**

Water Supply Status

The present estimated per capita consumption is 212 lpcd, which is higher than 150 lpcd proposed by Indian guidelines for planning water supply systems. The JICA Study Team recommends using the higher value for planning sewerage in order to provide a more realistic estimate of wastewater volumes for stage I projects. However, in accordance with planning guidelines, these higher per capita rates are decreased gradually to 150 lpcd by 2030 to reflect the effects of limited water resources.

The following values for domestic water consumption are adopted in the Master Plan (including allowance for commercial, institutional and minor industries)

2003: 212 lpcd + 30% UFW allowance = 276
2015: 180 lpcd + 25% UFW allowance = 225
2030: 150 lpcd + 15% UFW allowance = 173

Waste Water Quantity Generated

Per capita wastewater discharge has been arrived at in the Master Plan by applying a return factor of 0.7 on the per capita water consumption (lpcd). The final figures for wastewater generated in the four districts are shown in the table below:

Table 4.56 Projected Total Wastewater Production

Sewer Service Areas	Wastewater Generated in mld		
	2003	2015	2030
District I	110.2	103.7	93.7
District II	115.0	148.3	174.1
District III	31.9	54.2	73.5
District IV	17.1	32.0	45.1
Total	274.2	338.2	386.4

Design Flow for Sewers

The design flows for all trunk sewers have been calculated and specified in the Master Plan based on the population of the catchment area and connection ratios. These flows have been considered for preliminary design

Pumping Capacity and Configuration

For large capacity plants (or critical facilities) equal capacity pumps (6 to 8) have been proposed, with 50% or more stand-by on peak flow, and 100% or more standby for non-peak flow.

Design Capacities for STPs

As per the final sewerage system configuration adopted in the Master Plan, one new STP is to be constructed under this feasibility study and the existing STPs at Dinapur and Bhagwanpur will be renovated. Besides, one STP at Ramna has been sanctioned by the Indian government.

Table 4.57 Design Capacity for STPs

Location	Status/measure	Catchment Area	Capacity (mld)	
			Year 2015	Year 2030
Dinapur STP	Existing/renovation	District I	80	80
Sathwa STP	Priority project	District I and II, (IV)	200	200
Bhagwanpur/BHU STP	Existing/renovation Decommission in 2030	District III	8	0
Ramna STP	Sanctioned	District III	37	75

Note: Wastewater collected in District 4 will be tentatively diverted and treated in Sathwa STP until 2015.

Raw Sewage Characteristics

The wastewater characteristics used for design of the proposed sewage treatment plant at Sathwa are based on the projected wastewater characteristics presented in the table below.

Table 4.58 Raw Sewage Characteristics

Parameter	Design Value
Minimum Temperature, ^{o}C	20
pH	6.0 - 8.5
Biochemical Oxygen Demand (BOD5), mg/l	300
Total Suspended Solids, mg/l	600
Faecal Coliform Count, MPN/100ml	2×10^{7}

Treated Effluent Characteristics

The effluent standards considered in the design of STPs, as specified in the Master Plan and in accordance with NRCD guidelines, are listed in the table below.

Table 4.59 Treated Wastewater Quality

Parameter	Value
pH	5.5 – 9.0
Biochemical Oxygen Demand, mg/l	< 30
Total Suspended Solids, mg/l	< 50
Faecal Coliform Count, MPN/100ml	<10,000

Wastewater Treatment Technologies

Treatment technologies with a proven track record in the country have been compared. The comparison is considered in view of the following constraints, to recommend the final treatment technology to be adopted:

- Land availability within the urbanised area is limited
- The city faces long power cuts almost everyday

Hence, treatment technologies preferred are those that have less land area and power requirements and have a high reliability in face of long and frequent power cuts. In general, either Waste Stabilisation Ponds or Upflow Anaerobic Sludge Blanket (UASB) with a suitable post treatment has been chosen, based on the requirement of the specific site.

(3) Summary of Proposed Sewerage Facilities Under this Feasibility Study

1) Sewerage District I

i) Rehabilitation of STP at Dinapur

One 80 mld STP was constructed under GAP-I at Dinapur. This STP receives sewage from Konia pumping station. This plant is designed and constructed in three streams. This plant is based on activated sludge process with an extra provision of trickling filter to take care of high loads of BOD in the raw wastewater and thereby reducing the overall operation and maintenance cost of plant.

Based on inspection, the following major works are proposed to improve its performance:

- Rehabilitation of existing facilities
- Installation of chlorination facility

ii) Main Sewage Pumping Station at Konia

Main Pumping Station (MPS) was constructed under GAP-I at village Konia. This pumping station is located near Rajghat for conveyance of sewage from old trunk sewer to the treatment works at Dinapur. The pumping station has a capacity of 100 mld in average. In this MPS, pumping is carried out in two stages, three screw pumps in first stage followed by a set of centrifugal pumps in second stage.

A special manhole has been provided near Rajghat for diversion of sewage to this pumping station through a 305 m long and 2286 mm dia brick sewer. A sluice gate has been provided in this manhole to prevent flow of sewage into the outfall sewer and also to control the amount of sewage flowing to Konia MPS.

Following rehabilitation/upgradation measures are identified based on investigation:

- Existing capacity: 100 (average)
- Planned flow: 80 mld (average)
- Repair of existing manhole chamber and sluice gate for diversion works at Rajghat
- 1 no. of 2nd stage screw pump
- 1 no. Mechanical screen with 6mm spacing Screen for 2nd stage pump
- Replacement of 1 no. gear box for a 100 mld capacity for detritor of 2nd stage
- 1 pump of 740 lps and 1 of 420 lps for 2nd stage

iii) Ghat Pumping Station upgrades

The major observations made during the survey of these pumping stations are as follows:

- During peak hours all pumps are running including standby pumps and some amount of over flow also observed during the visit
- There is no capacitor panel provided in these pumping stations and no spare feeder in L.T. Panel
- Indication lamps on panels are either missing or not working
- Alternative power supply (DG Generator) is available at all Interception PSs (IPS). However, there is no standby generator, except at R.P.Ghat
- There is no instrument to measure level, flow, pressure, temperature, etc for proper operation at any of the IPS
- There is no mechanized screen available to screen the sewage water (only wire mesh is provided)
- There is no telecommunication facility provided at any of the IPS

Based on the above observations and analysis of available data, the following measures are proposed:

Trilochan Ghat SPS

- The total capacity provided is 308 lps (27 mld).
- Planned flow: 9 mld (average) in 2015
- In addition to three pumps acquired by UP Jal Nigam, two pumps are proposed to take care of the ultimate flow.

Jalesan Ghat SPS

- The total capacity provided is 145 lps (13 mld).
- Planned flow: 4.7 mld (average) in 2015
- All the pumps to be replaced.
- Four pumps are proposed to take care of the ultimate flow

Dr. R.P. Ghat SPS

- The total capacity provided is 1,084.8 lps (94 mld).
- Planned flow: 31 mld (average) in 2015
- All the pumps to be replaced.
- Three pumps are proposed to take care of the ultimate flow

Mansarovar Ghat SPS

- The total capacity provided is 108 lps (10 mld).
- Planned flow: 5 mld (average) in 2015
- All the pumps to be replaced.
- Three pumps are proposed to take care of the ultimate flow

Harischandra Ghat SPS

- The total capacity provided is 339 lps (30 mld)
- Planned flow: 15 mld (average) in 2015
- All the pumps to be replaced.
- Two pumps have already been acquired by UP Jal Nigam and same are to be installed
- In addition, one more pump is proposed to take care of the ultimate flow

iv) Operational plan for inspection and rehabilitation of main trunk sewer

Based on the flow measurement survey and hydraulic evaluation for the trunk sewer, present flow condition roughly indicates more than 50 % silting in sewers and corresponding loss in carrying capacity and internal brick surface of sewer from rough to bad condition.

Manhole survey shows major problem of silting, surcharge, unsatisfactory internal manhole plaster and possible structural deterioration (plaster). It gives very limited information about the internal condition of sewer, however it can be presumed that severe conditions can be expected on some of the sewer sections. A detailed investigation (diagnostic study) in accordance with the guidelines of the Sewer Rehabilitation Manual of WRc, UK is required as a first step of proposed rehabilitation plan to gather more information about the internal condition of sewer which will help in evaluating its performance in terms of hydraulic, environmental, structural integrity and operational performance indicators.

Rehabilitation programmes proposed are:

- Diagnostic study
  - Identification, cleaning and inspection of manholes
  - CCTV inspection of sewer along with sonar continuous depth measurement equipment
  - Structural assessment along the sewer alignment
- Rehabilitation of 750 mm – 2400 mm dia, 7.5 km sewer line by CIPP technology or GRP lining technology

2) Sewerage District II

i) Sathwa Treatment Plant

Deign Flow:
2015: 200 mld
2030: 200 mld

The technology for this site should:

- Minimise land area requirement
- Have low dependency on power for effective and reliable treatment of wastewater

A detailed techno-economic comparison of the various treatment technologies was carried out for choosing an appropriate technology. Life cycle costs were calculated for all the treatment technology options and UASB followed by Aerated Lagoons was found to have the least life cycle cost and is hence, recommended for Sathwa STP. Chlorination has been proposed in the treated effluent to avoid contamination of the receiving water body of irrigation canal.

- UASB followed by Aerated Lagoon (AL) and Chlorination
- Capacity of 200 mld for 2015
- Sludge drying beds
- Treated water disposal channel, 4 km

ii) Lining of Irrigation Canal

Lining of existing irrigation canal is proposed to increase its flow carrying capacity:

- Lining of the existing irrigation canal: 14 km

iii) Pump stations for Varuna River Interceptor Scheme

The specification of proposed pump stations and rising mains are:

Sr.	Pumping Station	Flow (mld in average)		Rising Main Details		
		2030	2015	MOC	Dia, mm	Length (m)
1	Sathwa MPS	200	200	PSC	2 x 1400	40
2	Chaukaghat right bankPS	140	130	PSC MS	1 x 1800 1 x 1800	1000 200
3	Chaukaghat left bank PS	19	14	CI	1 x 600	1000
4	Narokhar nala	18	14	CI	1 x 600	1600
5	Phulwaria nala	-	7.6	CI	1 x 400	1620
6	Saraiya nala	3.7	3.1	CI	1 x 350	1100

iv) Varuna River Interceptor Sewer

The design of Varuna interceptor sewers are:

Diameter, mm	***Sewer Length, meters***				
	Varuna river right bank (u/s)	**Varuna river right bank (d/s)**	**Varuna river left bank (u/s)**	**Varuna river left bank (d/s)**	**Sathwa Trunk Sewer**
500		180			
700	2,070	300			
800	570				
900		270	390		
1000	510		1,020	240	
1100			690	510	
1200				285	
2400					3,870
Total	**3,150**	**750**	**2,100**	**1,035**	**3,870**

v) Extension of Relief Trunk Sewer from Sigra to Durgakund

In year 2000-2001, U. P. Jal Nigam had prepared a Detailed Project Report on laying of relieving trunk sewer from Chuakhaghat to Durgakund. This total scheme is technically approved by NRCD. A part of this scheme from Chaukhaghat to Sigra is financially sanctioned and is currently under execution. Trunk relief sewer from Sigra to Durgakund, though technically sanctioned, financial sanction was not given due to lack of funds.

Under this feasibility report it is recommended that the extension of the trunk relief sewer, which is under execution, may be considered as a priority project as it will reduce considerable sewage load on the old trunk sewer preventing pollution of Ganga river. The route of this proposed sewer is from Sigra - Rathyatra Marg - Gurubag Crossing - UPPC Office - Vinaika - Khojwan Police Chowki-Vijaya Cinema-Gurudham up to Durgakund.

- 600-900 mm in dia, 2.2 km in length

vi) Secondary Sewers

Secondary sewers are proposed in the Trans Varuna catchment region in addition to main interceptor sewers (Left bank u/s, d/s and Sathwa trunk sewer).

- Secondary sewer: 300-700 mm dia, 12.4 km

3) Sewerage District III

i) Rehabilitation of STP at Bhagwanpur

The STP is provided in two parts for treating sewage from BHU campus and Assi area of Varanasi. One plant of 1.8 mld capacity consisting of trickling filter and another of 8 mld capacity based on activated sludge process. Currently, the STP is not appropriately functional and following works are required to make it functional and improve treated water quality.

- Rehabilitation of existing facilities
- Installation of chlorination facility

ii) Assi nala, Nakha nala and Samne ghat drain interceptor sewer and secondary sewer

Various feasible interceptor sewer alignments were evaluated for the laying of interceptor sewer considering the Master Plan provision. Based on detailed site survey, it was concluded that only a single interceptor alignment (along left bank of Assi nala in the stretch between Chitaipur up to Sunderpur Culvert and then along the right bank up to Nagwa pumping station) is feasible against the Master Plan provision of two interceptor sewers along both the banks of nala.

Nakha nala and Samne ghat drain situated on the upstream side of the Assi nala were left untapped in Stage-I works. These nalas are proposed to be tapped by providing interception and diversion works on these nalas and laying an interceptor, which will be connected to Assi Interceptor.

- Assi nala interceptor sewer: 600-1200 mm dia, 5.2 km
- Nakha nala and Samne ghat interceptor sewer: 400-500 mm dia, 2.0 km
- Secondary sewers: 300-400 mm dia, 1.6 km

(4) Project Cost Estimation and Implementation Schedule

1) Capital Cost Estimation of the Priority Projects

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated using Varanasi rates on the basis of Delhi Schedule of Rates taking localities and deflator into account. Furthermore, prices of items such as sewer pipes, reinforcing steel bars, manhole covers and so on that are not found in UPJN Schedule or DSR are obtained by quotation. The following are cost estimation conditions for physical contingencies, engineering and project administration. The abstract of the capital cost is shown in Table 4.61.

- Physical contingencies: 5% of capital cost
- Engineering costs (detailed design (6%) and project management (5%)): 11 % of capital cost
- Project administration: 5 %

2) Implementation Programme

The implementation programme for the priority projects has been prepared assuming following conditions.

- Preparation of detailed project reports and tender documents for project component shall be completed within 2005 and 2006.
- Actual execution of various priority project components shall start from 2007.
- During execution, various project components shall be executed in parallel.
- UPJN, Varanasi, will acquire 100 % of the land required for construction of proposed sewage treatment plants and pumping stations before the commencement of tendering.

The implementation schedule of the total project works and the year-wise fund flow requirement is presented in Table 4.62.

3) Operation & Maintenance Cost Estimation

The O&M costs for sewers, pumping stations and sewage treatment plants including existing, sanctioned and proposed facilities for 2015 are estimated based on following two cases in terms of power supply conditions.

- Operation by power from grid (24 hours a day)
- Operation by power from grid (20 hours a day) and diesel (4 hours)

The estimated annual O&M costs for all major facilities for 2015 is summarised in the following table.

Table 4.60 Summary of Annual O&M Costs for 2015

(1,000 Rs./year)

Facility	Case-1 Grid Power Supply	Case-2 Grid Power Supply Supplemented by Diesel
(1) Sewers and Rising Mains	15,825	15,825
(2) Pumping Stations	78,351	138,803
(3) Sewage Treatment Plants	83,205	83,205
Total	**177,382**	**237,834**

Table 4.61 Summary of Preliminary Project Costs (Varanasi)

	Capital Cost (Rs.)	Contingencies	Detail Design	Supervision	Project Administration	Total Cost (Rs.)	Land Acquisition (Rs.)	Total Project Cost (Rs.)
		5%	6%	5%	5%			
Assi Nala Interceptor Sewer								
Construction of Assi Interceptor	296,683,000	14,834,000	17,800,000	14,834,000	14,834,000	358,985,000		358,985,000
Construction of Nakhha and Samne Ghat Interceptor	28,389,000	1,419,000	1,703,000	1,419,000	1,419,000	34,349,000		34,349,000
Construction of Secondary Sewer	146,706,000	7,335,000	8,802,000	7,335,000	7,335,000	177,513,000		177,513,000
Varuna River Interceptor Sewer & Sathwa STP Sewer	0							
Construction of Varuna River Interceptor Sewer	495,470,000	24,773,000	29,728,000	24,773,000	24,773,000	599,517,000		599,517,000
Extension of Relief Trunk Sewer	250,000,000	12,500,000	15,000,000	12,500,000	12,500,000	302,500,000		302,500,000
Construction of Secondary Sewer	78,121,000	3,906,000	4,687,000	3,906,000	3,906,000	94,526,000		94,526,000
Pumping Stations	0							
Construction of Sathwa MPS	221,197,000	11,059,000	13,271,000	11,059,000	11,059,000	267,645,000		267,645,000
Construction of Chaukaghat Right Bank SPS	236,781,000	11,839,000	14,206,000	11,839,000	11,839,000	286,504,000	12,551,000	299,055,000
Construction of Chaukaghat Left Bank SPS	45,015,000	2,250,000	2,700,000	2,250,000	2,250,000	54,465,000	4,967,000	59,432,000
Construction of Narokhar Nala SPS	51,256,000	2,562,000	3,075,000	2,562,000	2,562,000	62,017,000	3,372,000	65,389,000
Construction of Pulwaria Nala SPS	29,903,000	1,495,000	1,794,000	1,495,000	1,495,000	36,182,000	3,620,000	39,802,000
Construction of Saraiya Nala SPS	22,478,000	1,123,000	1,348,000	1,123,000	1,123,000	27,195,000	1,592,000	28,787,000
Sathwa STP	0							
Construction of Sathwa STP	522,405,000	26,120,000	31,344,000	26,120,000	26,120,000	632,109,000	172,159,000	804,268,000
Lining for existing irrigation canal and treated water channel	135,800,000	6,790,000	8,148,000	6,790,000	6,790,000	164,318,000		164,318,000
Old Trunk Sewer Rehabilitation Work	0							
Detailed Investigation of Old Trunk Sewer	4,315,000	215,000	258,000	215,000	215,000	5,218,000		5,218,000
Rehabilitation Work of Old Trunk Sewer	608,146,000	30,407,000	36,488,000	30,407,000	30,407,000	735,855,000		735,855,000
Ghat PS Rehabilitation Works	0							
Rehabilitation Work of Trilochan Ghat PS	8,052,000	402,000	483,000	402,000	402,000	9,741,000		9,741,000
Rehabilitation Work of Harsichandra Ghat PS	4,959,000	247,000	297,000	247,000	247,000	5,997,000		5,997,000
Rehabilitation Work of Jalesan Ghat PS	5,153,000	257,000	309,000	257,000	257,000	6,233,000		6,233,000
Rehabilitation Work of Dr. R.P. Ghat PS	19,506,000	975,000	1,170,000	975,000	975,000	23,601,000		23,601,000
Rehabilitation Work of Mansarovar Ghat PS	4,074,000	203,000	244,000	203,000	203,000	4,927,000		4,927,000
Existing Sewage Treatment Renov/Rehab. Works	0							
Rehabilitation Work of Konia MPS	9,870,000	493,000	592,000	493,000	493,000	11,941,000		11,941,000
Rehabilitation Work of Dinapur STP	29,765,000	1,488,000	1,785,000	1,488,000	1,488,000	36,014,000		36,014,000
Rehabilitation Work of Bhagwanpur STP	8,321,000	416,000	499,000	416,000	416,000	10,068,000		10,068,000
Total	**3,262,365,000**	**163,108,000**	**195,731,000**	**163,108,000**	**163,108,000**	**3,947,420,000**	**198,261,000**	**4,145,681,000**

Table 4.62 Preliminary Implementation Schedule (Varanasi)

(Unit: Rs.)

Project	Capital Cost	Detailed Design	Total Project Cost	2006	2007	2008	2009	2010	2011
Assi Nala Interceptor Sewer				Capital and Detailed Design Cost Schedule					
Construction of Assi Interceptor	296,683,000	17,800,000	358,985,000	17,800,000	59,337,000	59,337,000	59,337,000	89,005,000	29,667,000
Construction of Nakhha and Samne Ghat Interceptor	28,389,000	1,703,000	34,349,000	1,703,000	5,678,000	5,678,000	5,678,000	8,517,000	2,838,000
Construction of Secondary Sewer	146,706,000	8,802,000	177,513,000		8,802,000	29,341,000	29,341,000	29,341,000	58,683,000
Varuna River Interceptor Sewer & Sathwa STP Sewer									
Construction of Varuna River Interceptor Sewer	495,470,000	29,728,000	599,517,000	29,728,000	99,094,000	99,094,000	99,094,000	148,641,000	49,547,000
Extension of Relief Trunk Sewer	250,000,000	15,000,000	302,500,000	15,000,000	125,000,000	125,000,000			
Construction of Secondary Sewer	78,121,000	4,687,000	94,526,000		4,687,000	15,624,000	15,624,000	15,624,000	31,249,000
Pumping Stations									
Construction of Sathwa MPS	221,197,000	13,271,000	267,645,000	13,271,000	44,239,000	44,239,000	44,239,000	66,359,000	22,121,000
Construction of Chaukaghat Right Bank SPS	236,781,000	14,206,000	299,055,000	14,206,000	47,356,000	47,356,000	47,356,000	71,034,000	23,679,000
Construction of Chaukaghat Left Bank SPS	45,015,000	2,700,000	59,432,000	2,700,000	9,003,000	9,003,000	9,003,000	13,505,000	4,501,000
Construction of Narokhar Nala SPS	51,256,000	3,075,000	65,389,000	3,075,000	10,251,000	10,251,000	10,251,000	15,377,000	5,126,000
Construction of Pulwaria Nala SPS	29,903,000	1,794,000	39,802,000	1,794,000	5,981,000	5,981,000	5,981,000	8,971,000	2,989,000
Construction of Saraiya Nala SPS	22,478,000	1,348,000	28,787,000	1,348,000	4,496,000	4,496,000	4,496,000	6,743,000	2,247,000
Sathwa STP									
Construction of Sathwa STP	522,405,000	31,344,000	804,268,000	31,344,000	104,481,000	104,481,000	104,481,000	156,722,000	52,240,000
Lining for existing irrigation canal and treated water channel	135,800,000	8,148,000	164,318,000	8,148,000	67,900,000	67,900,000			
Old Trunk Sewer Rehabilitation Work									
Detailed Investigation of Old Trunk Sewer	4,315,000	258,000	5,218,000	4,573,000					
Rehabilitation Work of Old Trunk Sewer	608,146,000	36,488,000	735,855,000	36,488,000	152,037,000	152,037,000	152,037,000	152,035,000	
Ghat PS Rehabilitation Works									
Rehabilitation Work of Trilochan Ghat PS	8,052,000	483,000	9,741,000	483,000	4,026,000	4,026,000			
Rehabilitation Work of Harsichandra Ghat PS	4,959,000	297,000	5,997,000	297,000	2,480,000	2,479,000			
Rehabilitation Work of Jalesan Ghat PS	5,153,000	309,000	6,233,000	309,000	2,577,000	2,576,000			
Rehabilitation Work of Dr. R.P. Ghat PS	19,506,000	1,170,000	23,601,000	1,170,000	9,753,000	9,753,000			
Rehabilitation Work of Mansarovar Ghat PS	4,074,000	244,000	4,927,000	244,000	2,037,000	2,037,000			
Existing Sewage Treatment Renov/Rehab. Works									
Rehabilitation Work of Konia MPS	9,870,000	592,000	11,941,000	592,000	4,935,000	4,935,000			
Rehabilitation Work of Dinapur STP	29,765,000	1,785,000	36,014,000	1,785,000	14,883,000	14,882,000			
Rehabilitation Work of Bhagwanpur STP	8,321,000	499,000	10,068,000	499,000	4,161,000	4,160,000			
Total	3,262,365,000	195,731,000	4,145,681,000	186,557,000	793,194,000	824,666,000	586,918,000	781,874,000	284,887,000

(Unit: Million Rs.)

Items		Total	2006	2007	2008	2009	2009	2010
Capital Cost		3,262.37	4.31	779.71	824.67	586.92	781.87	284.89
Detailed Design		195.73	182.24	13.49	0.00	0.00	0.00	0.00
Contingencies		163.11	0.22	38.99	41.23	29.34	39.09	14.24
Supervision		163.11	0.22	38.99	41.23	29.34	39.09	14.24
ProjectAdmin		163.11	0.22	38.99	41.23	29.34	39.09	14.24
Total Cost		3,947.43	187.21	910.17	948.36	674.94	899.14	327.61
Land Acquisition		198.26	198.26	0.00	0.00	0.00	0.00	0.00
Total Project Cost		4,145.69	385.47	910.17	948.36	674.94	899.14	327.61

Detaied Design
Construction Cost

4.5.2 Environmental Impact Assessment

(1) Justification of the Project

Varanasi is an important pilgrim centre for Hindu community for bathing in river Ganga. Currently a substantial quantum of sewage is disposed to river Ganga through natural drains and sewer outfalls without treatment, thus endangering the surface water source as well as the entire environment. The estimated load of wastewater from the city is 278 mld while the capacity of the existing STPs is hardly 88 mld. Therefore, it is essential to develop proper system of treatment and disposal of wastewater in order to protect the natural environment and maintain the hygienic conditions of the town to improve health condition of local inhabitant and pilgrims for bathing.

Sanitation services are inadequate for city's present population. The sewer infrastructure is old, and poorly maintained. Many of the existing trunk sewers do not have sufficient hydraulic capacity for projected wastewater loads. New colonies are coming up from where wastewater goes either to old trunk sewer or directly to river through natural drains. In fact, the regular sewer system is lacking. Keeping in view the growth, a sound master plan for disposal and treatment of wastewater and its implementation is urgently required.

(2) Positive Benefits

Project benefits of the sewerage and pollution control projects is to ameliorate overall development and betterment of public health and hygiene coupled with upgradation of environmental management in the target project area through abatement of pollution; improvement of public health and aesthetics leading to improvement in quality of living and inducing economic growth.

(3) Key Impacts Identified and Mitigation

The overall identification of the negative impacts has been done by using a matrix table (Master Plan). As identified in the table, all the possible key negative impacts are associated with construction and operation of STPs. The following key impacts are identified.

- Resettlement and economic activities due to the land acquisition
- Landscape change due to construction of STP
- Groundwater, surface water and soil contamination due to discharge of treated sewage that is not properly treated in STP and usage of dried sludge
- Odour problems due to operation

In addition to negative impacts in construction and operation phase, contingent impact or risk shall be analysed. The identified risk of the project is disruption of power supply. In the city, frequently power supply cuts have been occurring, which causes breaking down of operation of STPs and PSs.

1) Sewage Treatment Plant (Construction Phase)

The key potential impacts of construction phase of STP are loss of village houses, agricultural land and few trees and such impacts are long term. The other impacts of construction phase will be small in magnitude because of temporary nature and are expected to decrease gradually once the construction activity is completed.

a) Landscape Change (Visual Impacts)

Impacts

The construction of STP will alter landscape and change the land use of the area. The visual impacts at the construction site would be unaesthetic for the villagers.

Mitigation Measures

To minimise visual impacts and landscape change, provision of open space and plantation of trees in the surrounding area of the STP site is recommended. Plantation of trees in the open spaces would provide a visual comfort.

b) Land Acquisition

Impacts

The land requirement (41.0 ha) of proposed STP is of substantial amount, equivalent of a square of area of 640 m x 640 m. The land falls on the right side of the canal that crosses the Varanasi-Azamgarh road after the village Rajnahiya. As per the original proposal, the settlement of 1 village (Rajnahiya) is partly affected by land acquisition.

Mitigation Measures

- Minimisation or avoidance of village displacement

The original layout plan of Sathwa STP requires part displacement of 1 village. However, the revised layout plan can avoid displacement of the village but will require un-inhabited land such as agricultural field. The impact of both layouts is compared in the table below.

Table 4.63 Comparison of the Impact for Two Proposed Layouts

Item	Resettlement (HH)	Land owner (HH)	
		Rajnahiya	Goithahan
Original Layout	17	51	76
Revised Layout	0	15	149

The resettlement will be avoidable if the revised layout is adopted, although the number of landowners affected by land acquisition will increase. Taking into consideration the impact of resettlement, the revised layout plan is recommended.

- Appropriate Compensation

Land is normally acquired under the provisions of the Land Acquisition Act, 1894 which is general and basic law in the country for the acquisition of land for public purposes and companies. This Act was comprehensively amended in the year 1984, taking into consideration the recommendations of the Law Commission, the Land Acquisition Review Committee.

There are two types of compensation. According to the Act, monetary compensation has to be provided to direct Project Affected Persons (PAPs) if their houses have to be acquired and demolished. It has to be provided also to indirect PAPs for their agricultural land to be acquired. Alternate land has to be provided to displaced persons for their resettlement. If land for resettlement can not be provided or PAPs are not willing to resettle in the new resettlement site, then monetary compensation has to be provided to direct PAPs for their homestead (i.e. residential) land to be acquired.

2) Sewage Treatment Plant (Operational Phase)

Overall, the predicted adverse impacts during the operational phase will be minor as compared to the construction phase. During the operation phase all the beneficial impacts of the project will be realised.

However, treatment works will not perform satisfactorily unless they are operated and maintained properly. Malfunctioning of the system would pose risks of health hazards. Hence, this system should be operated and maintained properly by trained technicians. Following preventive measures should be adopted:

- Provision of two power supply lines
- Provision of generator sets at sewage treatment site
- Provision of diesel for the generator sets
- All spare parts should be readily available in case of emergency
- Provision of adequate maintenance staff with accessories
- Regular training of system staff, skilled technicians and craftsman
- Proper operating budgets and attractive salaries

a) Ground Water Quality

Impacts

The potential source of ground water contamination would be of three kinds; percolation of wastewater from the bed of the STP, percolation from the canal where treated effluent will be discharged and percolation from the agricultural land where wastewater is applied.

Wastewater in the aerated lagoon, which will be basically water-tight, may percolate through the underlain soil layer by seepage and pollute the ground water table of the nearest unconfined upper aquifer. These aquifers are connected with a number of open wells from which nearby villagers draw water for drinking and other purposes. There is some possibility that the aquifer is contaminated by partly treated wastewater.

Mitigation Measures

First and foremost, care should be taken to ensure adequate treatment to meet the discharge standards.

It has been planned that the aerated lagoon and treated water channel is lined with waterproof material to avoid seepage of wastewater in the lagoon into the soil and thus contamination of ground water.

It has also been planned that chlorination facility will be installed in proposed STP and therefore any bacterial contamination will not occur in the irrigation canal and through land application of treated effluent. If the STP is well functioned and wastewater is appropriately treated, the groundwater in the aquifer is remote from any contamination. Removal of pathogens is the prime objective in treating wastewater for re-use.

b) Treated Effluent Use

Impacts

The treated effluent from the proposed STP will be discharged into the irrigation canals. This effluent would be rich in phosphate and nitrate and therefore contribute increased fertility of

the agricultural land and increased area of irrigated land. This would be a positive impact to the nearby villagers.

The effluent quality of the proposed STP will comply with the national standards and thus no negative impact is foreseen on the river Ganga or the irrigation canal. However, the project has to be aware of following impacts as well.

If a large concentration of inorganic salts or the metals are contained in the treated effluent, it will eventually affect the growth of the crops.

Toxic substances such as heavy metals that might be present in the irrigation water stay as alimentation in the soil and then absorbed into vegetation. Taking in such vegetables might harm human health.

Quality of soil governs the pattern and quality of the vegetation. The different heavy metals in the treated effluent will be adsorbed by the soil grains, which may affect the vegetation and crop quality. This may lead to a negative impact to the soil.

Insoluble inorganics make soil tough, and obstruct absorption of water. And excess organics in irrigation water may give direct effect to the cultivated land, and indirect effect as abnormal growth due to lack of oxygen in the water. This eventually gives negative influences to vegetation.

Mitigation Measures

As it is proposed that the treated wastewater of proposed STPs will be reused for irrigation purposes, treated wastewater should meet the required standards for irrigation re-use. Also treated water quality should be monitored carefully so as to meet the discharge standards effectively.

With regard to application of sewage for land farming the 'Manual on Sewerage and Sewage Treatment', CPHEEO, Ministry of Urban Development, Govt. of India, provides guidelines on characteristics of irrigations waters. These include conductivity, salinity, sodium absorption ratio, chlorides, boron, etc. In addition, the manual provides maximum permissible concentrations of toxic heavy metal, etc.

c) Sludge production and disposal

Impacts

The sludge production will be to the tune of several tens ton/day from the STP. It will be dried on the sludge drying beds. During the drying process, there will be nuisance of insects and odour around the sludge drying beds.

The dried sludge may be given or sold to farmers as manure if it could be handled properly by them. The value of sludge as an organic fertilizer has long been recognized and this offers reduced fertilizer costs to the farmer. Besides, the dry sludge can be disposed of in specified landfill sites.

Mitigation Measures

The sludge from the STP should be disposed of in an environmentally acceptable manner. The sludge should be dewatered in sludge drying beds and the dried sludge is proposed to be

used as fertilizer in the nearby agricultural lands since it is biological in nature and has soil quality enhancing properties.

Nuisance of insects can be minimised by spraying insecticides on sludge drying beds, also by proper maintenance of sludge drying beds and proper drainage. The precautions should be taken in handling and disposal of the sludge.

Monitoring of the quality of the sludge is required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials.

The effectiveness of the sludge production for agricultural/vegetation use is not constant to any crops. Use of the sludge production at the region must be done with soil observation of its effect to avoid negative effects to crops. After the observation period, recommended method of the use should be established and educated to the local farmer. Parameters of soil observation monitored are Zinc, Copper, Total Carbon, Total Nitrogen, Phosphate and pH.

Use of the sludge product must be done strictly under the continuous monitoring of sludge product's contents especially the toxic substances.

d) Odour Production

Impacts

There is a possibility of bad odour in the case of UASB reactors and sludge drying beds proposed at the site of Sathwa, if the STP is not properly operated / maintained.

Mitigation Measures

To mitigate this, the width of peripheral green belt at Sathwa STP site has been increased. All required pollution prevention measures should be considered and implemented. Besides, the normal mitigation measures about dried sludge shall be taken to minimise odour problems although the impact is minimal in the STP, which is located in remote area.

(4) Analysis of Alternatives

Different treatment processes are available for biodegradation of organic material present in domestic wastewater. Individual treatment process has its own limitation and advantage in terms of land requirement, environmental impacts, power consumption and operation and maintenance.

Several treatment processes have been selected for detailed evaluation before finalising the suitable one that would be environmentally, technically and financially viable option.

The site of Sathwa STP is agricultural field and surrounded by several small villages. Sufficient land is not available at this site for providing waste stabilisation ponds. Therefore, after analysis of alternatives, UASB followed by AL that would be a better environmental solution than aerobic technologies like ASP and FAB in view of the frequent and long power cuts in Varanasi was selected.

(5) Contingency Impacts and Mitigation

1) Contingency and Risk

The major risks, which can result in breakdowns and disruptions, are described below.

Power Supply

One of the main reasons for disruption during the operation phase of the treatment works is power cuts, which are routine in Varanasi.

It is recommended that the new treatment plants and pumping stations receive their power supply through dedicated feeders from two different power sources. It is also suggested that standby power generators are provided to ensure at least minimum services in case of prolonged power cuts, and also that cost of diesel be built into the O&M costs.

Also the sewage treatment technology chosen should be able to survive short spells of power cuts.

Electric & Mechanical Equipment Disruptions

Operational disruption due to E&M equipment can be avoided by proper preventive maintenance activities and provision of adequate spare parts and stand-by equipment.

O&M manuals should be available in the treatment plant with training of the operation staff for the new plant.

2) Contingency Measures Plan

Contingency measures plans have been prepared for:

i) sewage treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (i.e. maintenance, etc. or breakdown);
ii) discharge of sub-standard wastewater into the environment from treatment plant which could cause a significant public health impact, and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.
iii) accidents which may occur while laying sewers or during construction of the treatment works;

(6) Environmental Management Plan

The success of the Environmental Mitigation Plan depends on the efficiency of the organisational set up responsible for the implementation of the programme.

For a sanitation project of this magnitude, the Environmental Management Plan needs to be entrusted, in both the construction and the operation phases, to an Environmental Management Cell (EMC), and regular monitoring of various environmental parameters is also necessary to evaluate the effectiveness of the management programme so that necessary corrective measures could be taken in case there are some drawbacks in the proposed programme. Thus, the Environmental Management Plan will consist of:

- Setting up an EMC to implement the mitigation measures in operation phase,
- Ensuring proper operation and maintenance of the treatment works,
- Ensuring proper maintenance of the sludge drying beds and the disposal of dry chemical sludge in a proper landfill site,
- Monitoring the waste and treated water quality,
- Monitoring the built in pollution control equipment, for vehicles and equipment, and
- Maintaining tree plantations around the pumping stations and the periphery of the sewage treatment plant.

(7) Environmental Management Cell (EMC)

The Environmental Management Cell will be part of the staff in charge of the operation and maintenance of the sewerage works, since the laboratory will be housed at the treatment plant site. But this staff will be in charge of the overall management of the environmental aspects of the Sanitation Project.

Under the supervision of an Environmental Engineer, the EMC will comprise an Environmental Scientist, a Chemist and a Biologist, plus three assistants, as shown in the following organisation chart. The main functions of the EMC will be:

- Collecting water, air, soil and sludge samples,
- Analysing the samples collected or getting analysis done from outside sources,
- Preparing and updating a database of environmental parameters,
- Implementing the environmental control and protective measures,
- Controlling the sludge treatment, disposal and re-use,
- Collecting statistics of health of workers and the population of surrounding areas,
- Ensuring the development and maintenance of the green belts,
- Monitoring the progress of implementation of Environmental Management Programme,
- Co-coordinating the environment related activities within the project as well as with outside agencies.

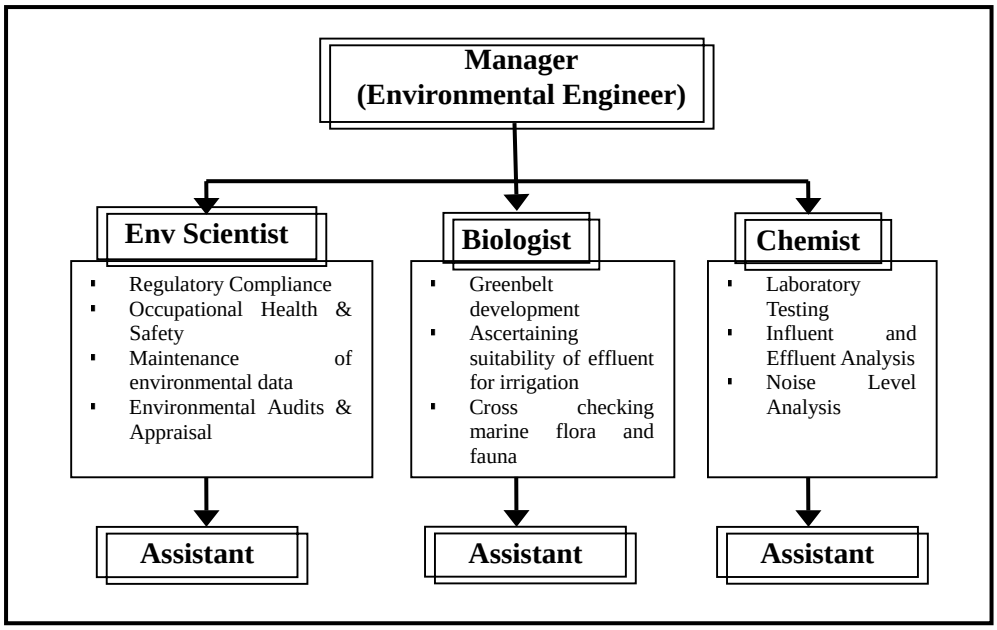
(8) Monitoring Plan

To evaluate the effectiveness of the Environmental Management Plan, regular monitoring of the important environmental parameters as follows will be taken up by UPJN/JS in environmental testing laboratory.

1) Water quality
2) Air quality and odour
3) Noise
4) Green belt and compensatory plantation

(9) Environmental Training

The environmental monitoring plan will be successful only if trained and skilled staff implements it. The training of the qualified staff should be necessary not only in day-to-day operation and maintenance of the treatment plant, but also in environmental aspects.



It will be essential to involve the staff that will be responsible for the execution of the Environmental Management Plan, in the construction phase, as well as to train the staff in practicing the mitigation actions and the day to day monitoring programmed during the operation phase of the water supply units. The training should include:

- Basic concepts of pollution control techniques in the various methods of sewage treatment,
- Operation and maintenance of the sewage treatment plant,
- Emergency preparedness to handle adverse situations,
- Principles of wastewater analysis,
- Other environmental monitoring techniques,
- Development of green belt and its maintenance,
- Sewage farming, and
- Communication with farmers and general public.

This training is different from the mandatory training required for operation and maintenance of the sewage treatment plant.

4.5.3 Non-Sewerage Scheme (CTC Programme Constructed Dhobighat Programme and Ghat Improvement Project)

The objectives of this study are to formulate programmes of development/ management of Community Toilet Complexes (CTCs) and Constructed Dhobighats (DG); to assess the technical, institutional, financial and economic viability; and to assess the environmental and social soundness of the proposed programmes. Besides, ghat improvement project was formulated considering the importance of Varanasi's famous ghats for bathing.

(1) CTC Programme and Constructed Dhobighat Programme

The objective of the proposed programmes is to improve slums and DGs' sanitary conditions, thus improving water quality of rivers.

The shortcomings in the operation and maintenance (O&M) of existing CTCs in slum areas and DGs are causing serious problems in proper functioning and general sanitation in the surrounding areas. O&M aspect is one of the main factors to be considered in formulating sustainable programmes of CTC and Constructed DG. Keeping this in mind and on the basis of the assessment of existing conditions of the target areas and facilities as well as the needs and demand of slum dwellers / Dhobis, the proposed programmes are formulated.

The proposed programmes adopt a needs-driven and community-driven approach in planning, implementing, operating and maintaining the facilities and suggest that the O&M is facilitated through local CBOs/SHGs or local Dhobi Associations. Implementation by this approach will make the programmes technically, financially, socially and culturally viable.

For successful implementation of the programmes, the following are required:

- Involvement and assistance of NGOs/Consultants for training and monitoring
- Regular monitoring, evaluation and feedback on the functioning of CTCs and Constructed DGs by Nagar Nigam in coordination with SUDA, DUDA and representatives of CBO/SHG.
- Appropriate implementation steps as follows to ensure involvement and training of CBOs/SHGs or Dhobi Associations:

Step 1:	Needs survey of slum / Constructed DG
Step 2:	Creation of CBOs/SHGs/ Dhobi Association
Step 3:	Planning and designing
Step 4:	Selection of location of CTC/Constructed DG including land acquisition clearance
Step 5:	Construction
Step 6:	Training of CBOs/SHGs/ Dhobi Association during construction
Step 7:	Operation and maintenance
Step 8:	Monitoring, evaluation and learning
Step 9:	Feed back

Creation of a CBO/SHG for O&M of CTCs has not been attempted earlier. Therefore, it is proposed that a pilot project to manage CTC through CBO be implemented and a good model for O&M of CTC be created before implementing full-scale project. Similarly, to manage the improved or new facilities of Constructed DGs in an appropriate manner, the functioning of the existing Dhobi Associations will require improvements through a process of capacity building. This capacity building will be also tested through a pilot project. This model project can then be extended to other proposed facilities.

One of the important constraints relating to O&M is the lack of funds. To make the project financially feasible, a minimum monthly charge of Rs. 70 per household, is required to be levied along with

subsidy for electricity and sludge disposal costs (where applicable) by the local bodies and part of manpower costs being provided by the community through voluntary activities. This level of user charge was assessed affordable and acceptable even for low-income communities, as their willingness to participate in the project is very high. Besides, if the facilities are well maintained and kept clean the willingness to pay will improve and the project will become financially more viable.

The estimated monthly user charge per member for O&M of a Constructed DG is Rs. 35 to Rs. 92. Based on the results of the primary survey, which indicated a willingness to pay user charges up to Rs. 100 per month, the project is expected to be financially feasible.

If following factors are considered in the proposed facilities, the projects are expected to be technically feasible and would also ensure adequate O&M of the facilities.

CTCs
- Constant water supply for flushing and cleaning of water closets (seats)
- Sufficient capacity of storage tank for constant water supply
- Regular electricity for tube well and lighting

Constructed DGs
- Appropriate design and quality of construction to ensure no leakage
- Constant water supply
- Amenities (toilet, rest room, safety measure, shed, etc.)

Land availability for both CTC and Constructed DG facilities is the most critical aspect for the feasibility study. The result of a rapid survey to assess the land availability in ten of slums indicated that the land for CTC could be made available in half of the slums surveyed. These lands are mostly owned by the various Government bodies and efforts have been made to select lands without any disputes or encumbrance. However, more detailed surveys are required to decide the best location by matching the demand for CTC and the availability of land. A detailed study should be done at the detailed design stage with the help of hired NGO/Consultants and communities.

The project shall generate tangible and intangible benefits as follows:

- Environmental benefits are expressed through reduction of pollution load caused by open defecation
- Health-related benefits include reduction of the incidence of water-borne diseases resulting from poor sanitation
- Economic benefits include productive gains, secondary economic benefits and developmental impact due to improved health and reduced health costs
- Social or equity benefits include gender, regional and income-related equity through appropriate sanitation for women and girls who are most affected by poor sanitation
- Institutional benefits are expressed to strengthen the CBO/SHGs through capacity-building

(2) Ghat Improvement Project

In addition to the pilot project for sanitary improvement of Manikarnika Ghat, several other projects are identified for ghat improvement. These projects should be planned in more detail and implemented using lessons learned from the pilot project. The preliminary cost estimation has been prepared for this project as shown below.

Project	Preliminary Cost Estimate (1,000 Rs.)
I: Manikarnika Ghat (Pilot Project)	(Grant aid from Japan)
II: Rajendra Prasad and adjoining Ghats	6,160
III: Assi Ghat	7,520
IV: Repair/renovation of steps along the ghats	65,000
V: Installation of pumps and hydrants for de-silting of the ghats	77,000
Capital cost	**155,680**

The project has been preliminarily identified. The contents of this project should be further justified and planned in detail for implementation.

The following steps should be taken to select appropriate components of the facility and to ensure sustainable operation and maintenance (O&M) and public participation / awareness (PP/PA).

Step 1 Evaluation of Pilot Project (Manikarnika Ghat Sanitary Improvement)
Step 2 Identification of project
Step 3 Conceptual design
Step 4 Basic design
Step 5 Operation and maintenance plan and public awareness
Step 6 Detailed design
Step 7 Construction
Step 8 Evaluation of usage, impact and feedback

In order to understand the knowledge, attitude, practices and behaviours of the people regarding the problems at ghats and make the improvement plan need-based and people-oriented, the following methodology should be adopted.

- Ghat inventory survey
- Survey of ghat users through questionnaire
- Workshop
- Focus group discussion

(3) Summary of Proposed Programmes

The proposed facilities and total capital costs in these programmes are summarised in the following table.

Table 4.64 Cost Estimation for Non-Sewerage Scheme (Varanasi)

Component	No of Proposed Facilities	Total Cost (Rs.)
CTCs 5, 10, 20 Seaters	205	102,725,000
New CDG and Improvement	10	20,000,000
Ghat Improvement Project	-	155,680,000
Total		**278,405,000**

Study Summary for Proposed Programmes (Varanasi)

Community Toilet Complex (CTC) Programme in Slums	
Existing situation	• The total slum population is estimated as 0.46 million; there are 227 slums in Varanasi. • Lack of adequate sanitation facilities has led to a high incidence of water-borne diseases. • There are 121 existing CTC out of which 84 are connected to sewer lines and 37 have septic tanks • CTCs are operated and maintained by NGOs, DUDA (both through contractors) and other private contractors. • Main problems of existing CTCs – lack of cleanliness and adequate maintenance. • 28 per cent of the slum population, based on the sample survey, practice open defecation. • 8 per cent of the slum dwellers, who do not have any toilet facilities, prefer to have CTC.
Proposed Design Options	• A seat (water closet) is designed to be used by 30 users per day. • The maximum travel distance for a user from his or her place of residence to the CTC should be less than 500 m. • 5, 10-seater or 20-seater CTC with required amenities are recommended. • The preferred wastewater disposal option is connecting the CTC to a sewer line; in its absence, a septic tank and soak pit is recommended.
CTCs Needs	• The total number of new CTCs was estimated on the basis of need assessment (number of persons practicing open defecation) and the percentage thereof willing to have CTC obtained through sample survey. • Total number of new CTCs is estimated as 205; 127 No. 5-seater, 65 No. 10-seater and 13 No. 20-seater.
Capital Costs	• Total capital cost of 205 CTCs is Rs. 102.7 million spread over 5 years.
Benefits	• Reduction in river pollution • Health and environmental benefits • Improved sanitation in slums decreases the incidence of water-borne diseases and thereby improving productivity • Women and children are the biggest beneficiaries
Recommendation	• O&M by Community-Based Organisation (CBO) or Self-Help Group (SHG) • Voluntary participation of project beneficiaries in O&M to reduce O&M costs especially the wages payable to a caretaker • Electricity costs and de-sludging (where applicable) to be covered by Nagar Nigam • Monthly user charge of Rs. 30 to 60, or a per day charge of Rs. 1 to 2 per family • Implementation of a pilot project first to create model O&M through CBO/SHG • Training centre for O&M to provide hand-on training to the members of the CBO, and facilitate extension of the model project to full-scale • Need assessment for CTCs to be conducted for each location at the time of commencement of the project
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, CBOs/SHGs • Participation of member(s) of CBO/SHG in construction supervision • Day to day O&M by CBOs/SHGs comprising members of the community benefiting from the project

Constructed Dhobighats (CDG) Programme	
Existing situation	• 29 traditional riverside Dhobighats and 3 Constructed Dhobighats • Dhobis want improvement in amenities • Chemicals used by Dhobis include detergents, solvents, bleaching agents, dyes etc.; high incidence of skin diseases • High willingness among Dhobis to participate in O&M of CDG • The existing CDG are being managed by respective Dhobi Associations • Current O&M not satisfactory; problems related to leakages, broken pumps, poor sanitation conditions, lack of shelter and space for drying clothes etc.
Proposed Design Options	• One cubicle is required for 6 washer-men; 3 shifts in a day and each washer-man use the ghat once in 2 days. • It is desirable that a washer-man is not required to travel more than 2 km from his residence • As for wastewater disposal, sewer connection is preferred but if unavailable open drain connection is selected and the latter is being tapped for diverting the wastewater to treatment plant. • No on-site treatment is recommended since high capital and operation & maintenance costs and the complicated process of treatment and considering current power supply situation in the city.
Needs of Constructed Dhobighat	• 7 new Dhobighats proposed • Improvements/rehabilitation of existing 3 Dhobighats proposed • Improvement works include new pump, generator, roof, rest room, electrical work etc.
Project Costs	• The total capital cost for improvement works is estimated as Rs. 20.0 million
Benefits	• Reduction in river pollution • Health and environmental benefits • This project shall ensure access of quality services to the affected communities • Properly designed facility will reduce the incidence of diseases among the Dhobis thus enabling them to work for greater number of days (improved productivity) • Capacity building and training to Dhobi Associations
Recommendation	• O&M by Dhobi Associations; capacity building necessary in existing ones • Monthly user charge of Rs. 95 per member, depending on percentage of usage and number of cubicles in the CDG, to provide coverage for O&M costs be collected for adequate O&M of facilities. • Implementation of a pilot project first to create model O&M through CBO/SHG
Institutional setting up for Monitoring	• Overall monitoring by Nagar Nigam • Creation of a Coordination Committee comprising representatives of NN, DUDA, Dhobi Associations • Participation of member(s) of Dhobi Association in construction supervision • Day to day O&M by Dhobi Association

4.5.4 Public Participation and Awareness

(1) General

For the sound operation and maintenance of sanitation facilities at city scale, generally, 'Public Participation' is indispensable. The construction and operation of such systems alone will not attain desired improvement in environmental sanitation, public health, surrounding environment and abatement of pollution of river water bodies. Therefore, greater public awareness on the health and environmental impacts, importance of those systems and facilities among communities, and the encouragement of their positive participation in the share of the obligation is essential. This would help work out problems related to operation and maintenance and long-term sustenance of these systems and facilities.

Therefore, in this study, the JICA Study Team has:

i) Proposed the elaborated programmes on related activities and campaigns to promote public participation and heighten public awareness (PP/PA).
ii) Analysed the existing formal and informal institutions in these cities that participate/had been participating in PP/PA programmes and suggested an institutional framework for successful implementation.

This is based on participatory techniques and the concept of the 'hygiene education', which has been prepared in the Master Plan and specifically responds to each event proposed in the Feasibility Studies in the four cities. Within this framework the programmes have been designed into two sets. Set I addresses the proposed priority projects and set II comprises regular activities to follow the hygiene education Concept. The end achievable of these sets is to generate willingness to pay for the facilities and create awareness to a level that people participate for a cleaner river.

Whereas Varanasi and Allahabad are very religious and have emotional linking to the river, Kanpur and Lucknow are more urbanised. These and other distinctive characters and target groups for the four cities have been analysed and their flavour adequately addressed in the programmes.

(2) Programmes

Set I describes the necessary programmes that have to be undertaken in accordance to the timings of the projects (Sewerage and non-sewerage). These include:

Committee (SPC) Meetings	To monitor the progress of work on PP/PA (once in every month)
Necessary Publicity Programmes	To advertise widely the information on the projects through the mass media and printed materials to general public
Necessary Explanatory Meetings	To discuss with communities and stakeholders about PP/PA activities
Demonstration Programmes	In accordance with the priority projects of sewerage and non-sewerage works, demonstration programmes shall be launched

Set II includes programmes that run parallel to the first set and shall communicate the ideas on health, sanitation and better living environment in accordance with the hygiene education concept in the M/P. The programmes shall broadly constitute:

Entry point Activities	To build a platform for initiating the programmes
Regular Publicity	To keep the message fresh in the minds of the people
Yearly Campaign	A yearly campaign should be implemented in accordance with public participatory approach and the stepwise planning as discussed in Master Plan
Clean River Day and Clean River Week	To raise the awareness on river cleaning
Regular activities in slums and Dhobighats	To formulate the community-based organisation for O&M of the facilities created.

Further for ground implementation communication tools and communication activities have been detailed. A mix of all the activities and tools shall constitute a programme and the appropriate mix shall be selected by the implementing agency as per the guidelines given in the TOR and budgetary allocations that have been made.

Communication Tools

1) Media	**Contents**
Press	Press Conferences, Press Releases, Articles, Advertisements
Television	Talk Shows, Advertisements, News
Other Publicity Materials	Hoardings, Banners, Posters, Pamphlets, Hot Air Balloons
2) Other Means	
Theme Plays, School Programmes, Information Kiosks, Power Point Presentations, Documentary Films, Information Van, Site Visits, Shram Dan	

Summary of Activities for Communication

Communication Activities	**Intended Target population**
Focus Group Discussions (FGDs)	Lawyers, Doctors, Professors, Religious Leaders, Political Personalities, Municipal Officers, RA's and other Professionals
Transect walks/Padyatras	Women and Youth
Workshops	Beneficiaries and future beneficiaries of priority projects
Swasthya Mela in city	General Public encouraging women in particular.
Health Camp for slums	Slum community
School Programmes	School Children
Programmes for women	Women
Information Mela	Beneficiaries and future beneficiaries of priority projects
Competitive Programmes	Clubs, industry houses, hotels, private hospitals

(3) Implementation Structure

In the institutional front after analysing the institutional structures it is felt that there is no structure at present that takes care of the PP/PA activities in the state or the city. Therefore, for implementing the works Health Officer in the Nagar Nigam will be the main authority answerable to the Municipal Commissioner and provided with additional technical staff to support on the programme. This addition of technical staff is very important because at present the Nagar Nigam does not have a qualified person to deal with the PP/PA issues and monitor its progress.

The hierarchy of the implementation structure is as explained in Figure 4.14. The emphasis at the implementation level shall be on the Nagar Nigams of the four cities.

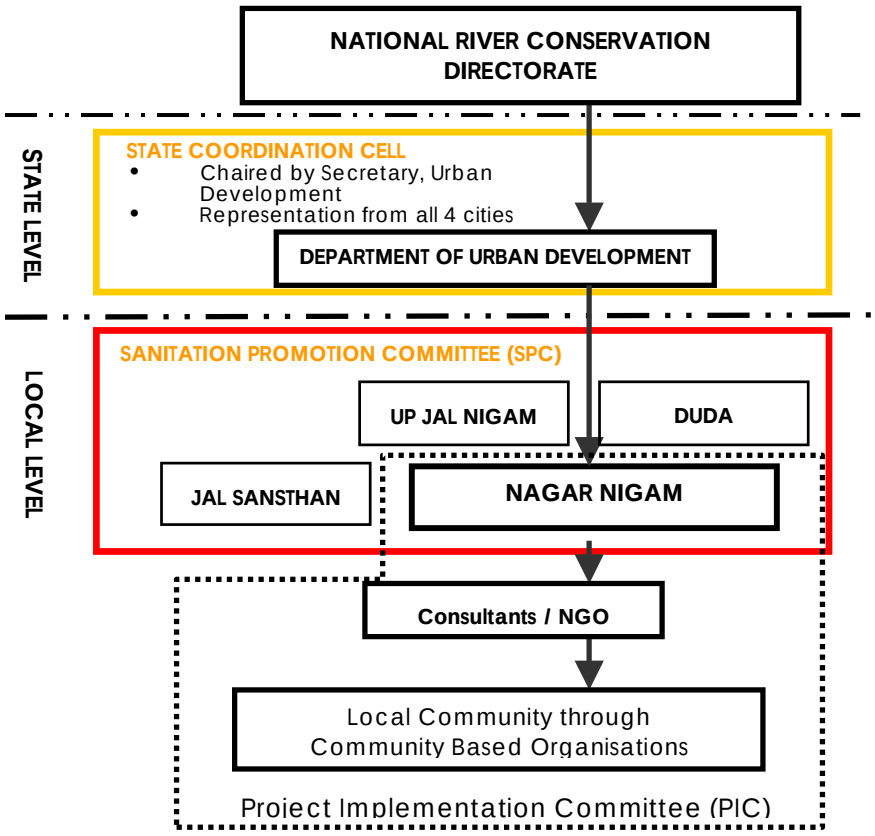


Figure 4.14 Proposed Organisational Structure of the Implementing Agency

(4) Monitoring and Evaluation

There will be two parallel monitoring and evaluation structures for the entire PP/PA programme:

(i) Implementing Agency - Prepare reports on the progress of work based on monthly reports from the local consultant and send to NRCD PP/PA Cell (NPPAC).

(ii) Community - On the people's side the groups of communities (ward committees and the citizens committee in each city) will report to Project Implementation Committee (PIC) and PIC will report to State Co-ordination Cell. These reports will be sent on quarterly basis.

Such a system will ensure that a check is maintained on the works that are being undertaken and the budgets allocated are utilised properly. Evaluation of Programme will be done in the regular State Co-ordination Cell meetings and once a year evaluation reports are a must.

For the purpose of evaluation, a set of Impact Indicators shall be developed by the local consultant that henceforth shall be circulated to the PIC, NN and the local groups who all shall rate the programmes. The essential function of the impact indicators is to evaluate the effectiveness of PP/PA programmes.

- Operational – Measure information provision, feasibility, and duplicity of each
- Effect – Direct and Indirect influences

On the basis of reports and evaluation of the PP/PA Programme, necessary changes in the content and direction of the programme will be made, if required, to make it more effective.

(5) Project Costs

Table 4.65 Cost Estimation for PP/PA (Varanasi)

Item	Varanasi
Activities SET I	1,169,000
Activities SET II	37,178,000
Fixed Costs (Equipments for NN)	3,810,000
Administrative Activity	14,295,253
Total Project Cost	56,452,253

4.5.5 Operation & Maintenance and Institutional Development Programme

(1) Management Responsibility for Environmental Public Services

The major administrative units that are closely related to water quality management under GAP present hierarchic tiers of the national, the state (Uttar Pradesh State Government) and the municipal levels of organisations. There are two major groups of organisations: One group including Development Authority and Nagar Nigam is associated with urban development and the second group including UP Jal Nigam and UP Pollution Control Board is associated with environmental conservation and pollution control. Both groups are administratively separate entities but coordination amongst these organisations is vital for implementation of NRCP activities.

The division of responsibilities amongst local and state organisations, for development and maintenance of sewerage collection and treatment systems is summarised as follows:

Table 4.66 Management Responsibilities for Environmental Public Services

Management Responsibility	Organisation	Functions
• Master planning	UPJN	• Physical infrastructure (water supply, sewerage and pollution control) • Capacity and location of facilities
	DA	• Spatial arrangement • Land use • Population projections
	UPJS	• Physical infrastructure for water supply facilities • Capacity and location of facilities (water supply)
• Design and construction	UPJN	• Sewerage infrastructure for river pollution abatement Action Plans. • Water supply and sewerage infrastructure for urban development
	DA	• Infrastructure for new development areas
	HDB	• Infrastructure for state housing developments
• Operation and maintenance	UPJN	• Trunks sewers • Interception and treatment works • Storm water pumping stations • Compliance with environmental regulations
	NN	• Storm water drains • Solid waste disposal
	JS	• Sewers and pumping stations • Water supply treatment and distribution works
• Pollution control and monitoring	UPPCB	• Monitoring and preventing entry of polluted wastewater (if they do not meet discharge standards) into nalas and rivers. • Regulating industries

Currently, sewerage facilities are planned, constructed and maintained by many parties without effective coordination. UP Jal Nigam is constructing interception and diversion facilities and sewage treatment plants (downstream facilities) to improve river water quality and Urban Development Agency, Housing and Development Board and Development Authorities is constructing branch sewers (upstream facilities) as and while they develop new urban areas and housing complexes.

Jal Sansthans as well as Nagar Nigams are legally responsible for the sewerage service but they are, in practice, doing only maintenance of the upstream facilities as long as the funds are available. The downstream facilities are operated and maintained by UP Jal Nigam.

Various parts of the sewerage system are constructed, operated and maintained by various organisations for various purposes different from each other. The existing sewerage system has neither been planned, envisaged nor conceived as an integrated one. As a result, inefficient facilities have been constructed and maintained insufficiently without a definite ownership.

(2) Key Issues

There are several institutional and financial weaknesses that adversely affect the quality and extent of sewer coverage as well as ability to provide adequate operation and maintenance. The key issues are summarised as follows:

1) No master plans for urban infrastructure

There is no master planning for physical infrastructure. The absence of a Master Plan leads to the fragmented and uncoordinated implementation of infrastructure by several implementing agencies, each fulfilling their immediate short-term objectives. As a result several schemes cannot be integrated into the main trunk sewer network.

2) Lack of single point responsibility

Several implementing agencies at state and local levels are developing land and infrastructure in the city. Their efforts are not well coordinated, especially in the absence of a master plan. Although taxes and water charges are collected at the local level, accountability to the citizens for sewerage and drainage problems is obscured by the lack of single point responsibility. Similarly, accountability for achieving water quality objectives is unclear.

3) Insufficient revenue for O&M

Municipal Corporations have the power to implement a tax for water, and a separate sewer/drainage tax. These taxes are based on the annual rental value of the property, which does not reflect the real value of the property. Municipal Corporations also collect revenue from the sale of water through their Jal Sansthans; however the State Government controls the water tariff. Municipal Corporations are allowed to pool all sources of revenue to finance maintenance and development of municipal infrastructure. The revenues are at present insufficient to cover O&M costs.

UPJN has no such source of revenue. It depends on state funding to operate and maintain facilities. At present, local Jal Sansthans are expected to operate all new assets created by other implementing agencies however they do not in general have the required financial or human resources. As a result most Jal Sansthans have refused to accept responsibility for O&M of assets created by UP Jal Nigam.

(3) Improvement of Operation and Maintenance

1) Current O&M Status

The current maintenance practices are reactive rather than preventive and routine as per manual. Most of the maintenance is carried out in response to customer complaints related to overflows etc. These problems are normally resolved by clearance of blockages in the sewer. There is no evidence of a planned regime of cleaning or inspection of the system. Any repairs to the system arise from problems noted during blockage clearance or from customer complaints. Besides this, record keeping is highly limited and in some cases even inaccurate.

From discussions and site visits, it could be stated that maintenance management (for sewerage as well as for water supply) is undertaken on an ad hoc basis. Site work is not always carried out in an organised way. Indeed, at some of the sites, it was not very clear, who was the in-charge official(s). Working practices observed were not in accordance with The Manual on Sewerage and Sewage Treatment (i.e. The Manual on Sewerage and Sewage Treatment, Second Edition prepared by the Expert Committee constituted by the Ministry of Urban Development, Government of India, and published in 1995). During maintenance works, the safety was either non-existent or of very poor quality.

2) Collection System O&M improvements required

Ideally all elements of a sewerage system should receive the highest levels of maintenance to ensure its performance. However, this is an unrealistic aspiration for any sewerage authority to contemplate.

There are three broad policy options:
- Purely reactive
- Totally planned
- Selective planned/reactive

A more appropriate and cost-effective approach is to achieve a balance between planned and reactive maintenance in providing an acceptable and reasonable level of service.

Many parts of a sewer system operate quite satisfactorily with minimum maintenance. The key to a cost effective maintenance strategy is the recognition that maintenance and rehabilitation programmes should retain as much as is practicable of the existing network by a combination of optimising hydraulic performance and the use of renovation. Therefore regular inspection and assessment is required to identify those elements of the sewer system that will require attention on a regular and planned basis. Elsewhere the sewers only need to be dealt with on a reactive basis.

<u>Immediate priorities</u>

- Establish System Records and Maps

  There is an immediate need to collect and to store centrally all existing records of the sewerage network by setting up a comprehensive computerised database at the local level. This database is typically referred to as a sewer inventory.

- Inspect Critical Sewers and Assess Conditions

  A comprehensive survey of critical sewers is required in order to:
  - Develop the sewer inventory data
  - Assess the physical condition of sewers
  - Identify critical sewers and priorities
  - Identify maintenance, rehabilitation or replacement needs

- Upgrade Pumping Stations O&M Procedures

The primary objective of operating and maintaining a pump station is to keep the station in continuous operation in order to prevent sewage overflows to the environment and flooding in upstream reaches of the incoming sewers. The following activities are critical to the successful operation of pumping stations:

- Developing equipment operation and maintenance manuals
- Developing procedures for normal, abnormal, and emergency conditions
- Developing systems for recording daily operating conditions
- Establishing systems for recording equipment maintenance and breakdown history

Long term needs

Long-term measures in line with standard international practices are given in the main report and need to be integrated into a long-term maintenance programme, summarised in the table below:

Table 4.67 Outline of Sewerage Maintenance Programme

Type of activity	Description
Sewer inventory	GIS base maps, data collection, updating
Sewer survey and inspection	Cleaning, CCTV inspection, assess condition, identify critical sewers
Routine inspection & cleaning	Follow-up routine cleaning, CCTV survey
Emergency blockage clearance	Sewer clearance
Sewer & manhole repairs	Emergency repair
Planned maintenance & rehabilitation	Sewer replacement or other rehabilitation technologies
Service connections	Check and repair of existing connections, Installation of new connections
Control of storm water discharge into sewers	Identification of connections, remove connections

3) Treatment facilities O&M improvements required

Operation and maintenance improvements should initially be carried out at the existing sewage treatment works, but this work will effectively be a training ground for establishing procedures and an organisation capable of running the proposed future sewage treatment works.

Accurate records should be maintained which give full details of the design criteria and sizes of treatment units, etc. and comprise a diary of every significant event at the works. These records should be checked on each routine supervisory site visit. The records should include comprehensive details, with drawings and service manuals, for all electrical and mechanical components indicating their dates of manufacture and installation, and a detailed service/maintenance history for each unit. Detected faults should be recorded and reported to ensure that remedial action will be taken as soon as possible to have the faults rectified. Other routine O&M requirements are listed in the main report.

4) Contracting Out

Strengthening the capacity of local Jal Sansthan for O&M of sewerage system is recommended, however, ‘contracting out’ can make good sense economically in the alternatives given below. A decision regarding what tasks/components will be ‘contracted out’ and for what total periods needs to be treated as an urgent matter, as it will greatly influence the staffing requirements of the new sewerage division to be created within JS.

- Contracting out sewer inspection surveys to establish the sewer inventory
- Contracting out design, tender document

- Contracting out sewerage construction supervision
- Contracting out sewage treatment construction supervision
- Contracting out sewerage operation and maintenance
- Contracting out sewage treatment operation and maintenance

The operation and maintenance of the proposed new sewage treatment works for a fixed period could be included as part of a 'turn-key' design and construction contract. Even if it is decided to let some tasks out to another public agency (e.g. UPJN) or to private sector contractors, the Sewerage Authority (NN/JS) should always retain overall responsibility for and should closely control and supervise the work carried out by others, and so it will still require competent managers and supervisors.

(4) Institutional Development and Capacity Building

1) Institutional Development Programme

A single agency should cover the entire sewerage system; from planning to operation and maintenance; from house connection to sewage treatment plant. By this way, comprehensive and organised sewerage will be attained. To achieve this objective, Institutional Development Programme (IDP) was proposed in the Master Plan. The contents of IDP, which have been identified in the Feasibility Study, are as follows:

Framework	Contents
Organisational strengthen	Create and organise sewerage division on basis of objective, principles and guidelines
Operational resource development	Stocktaking of sewerage facilities (asset list), current status of them
Human resource development	Recruitment and training of engineers, operators and business handlers
Financial resource development	Identify or create financial source or revenue source

2) Future Management Structure

The responsibility for O&M should rest with a single sewerage authority that should be integrated with the existing Jal Sansthan. However, in the context of this Report, the proposals made are, for clarity, for the management of sewerage functions only. Several of the technical services, administration and financial functions can be provided by the existing water supply departments. The recommended organisational structure is represented here:

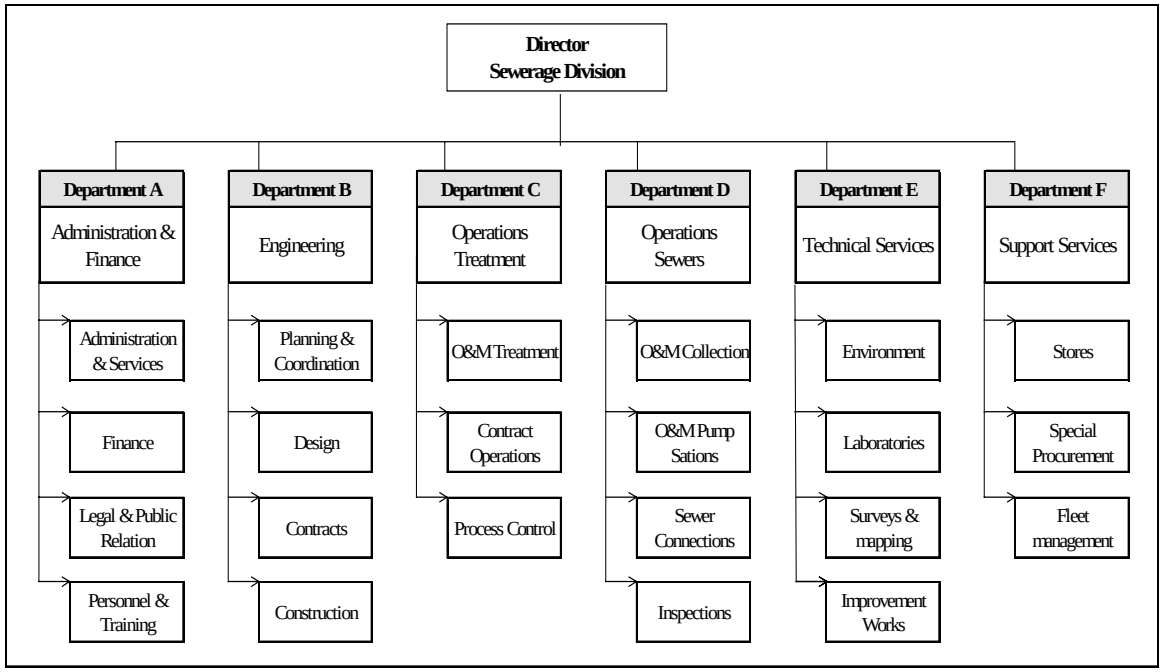


Figure 4.15 Future Management Structure

3) Methodology for setting up proposed new organisation

The following are a methodology for setting up the proposed new organisation.

STEP 1: Decide responsibilities of the Sewerage Division

STEP 2: Decide personnel requirements for Managerial level

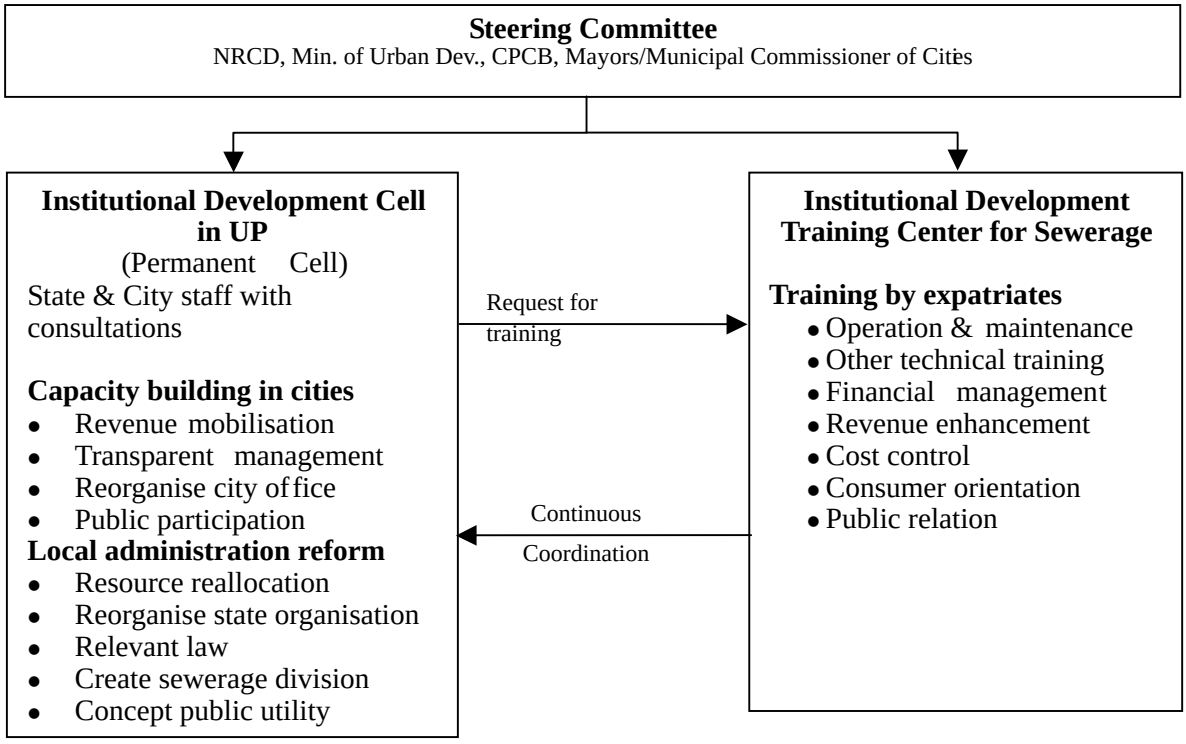
STEP 3: Locate office space and other practical details for management structure

STEP 4: Decide personnel requirements for Worker level

STEP 5: Chalk out policy framework

4) Institutional Development Programme

To implement IDP, Institutional Development Cell (IDC) should be created in the UP State Department of Urban Development. It is also suggested that an "ID Training Centre for Sewerage" should be established at the national or state level to satisfy the training needs for the personnel. Staff shall be selected from the State Government (UP Jal Nigam) and city offices (Nagar Nigams and Jal Sansthans). The implementation structure is presented in the following figures.



5) Institutional Development and Capacity Building (IDCB)

The strategic action plan for Institutional Development and Capacity Building (IDCB) is primarily identified and summarised as presented in Table 4.69.

(5) Cost Estimation of IDCB

Table 4.68 Cost Estimation for IDCB (Varanasi)

(Million Rs.)

Sr.	Description		Cost
1	IDP Consultancy Services	Task 1	93,600
		Task 2	70,700
2	Training		84,000
3	Infrastructure Enhancement		33,300
Total			281,600

Note: Task 1: Coordination activities among national, state and local governments (4 cities) and formulation of a comprehensive planning and implementation of municipal institutional reform to achieve Medium and Long term target (assuming 5 years programme).
Task 2: Internal city activities to attain short or immediate term target of capacity building of local government (assuming 2-3 years programme).

Table 4.69 Action Plan for Institutional Development and Capacity Building (IDCB)

Sr.	Objective	Action	Agency
A. Financial Sustainability			
1	1. Reduce Costs	Measures to reduce power consumption have to be implemented.	Organisation
2		Reduce number of non-technical staff.	Organisation
3		An "on the job" training should be implemented to increase the productivity of the personnel.	Consultant
4		The expenditure - "Interest/dividends" on Government capital – has to be reduced/eliminated, if possible.	Organisation
5	2. Increase Revenue	• Carry out property survey along with the size and type of water connection and broaden the tax net in the short term. • As a long term planning strategy, create a GIS database of the existing properties, water and sewerage system and integrate this database with the property permission applications.	Consultant Consultant
6		Along with the property survey, a re-assessment of the property values should be carried out to have realistic basis for property tax.	Consultant
7		• Start the process of water and sewerage charges based on dual criteria of property tax and size of water connection. • Initiate, a study to evaluate the implementation of metering over the entire city.	Consultant Consultant
8		The whole billing system has to be computerized and the staff to be trained to undertake this assignment.	Consultant
9		Formulation of the incentive scheme, based on the amount collected and the number of bills collected	Organisation
10		Carry out a detail study to assess the market for selling the by products generated from the STP	Consultant
11		As a long term strategy, the JS should pursue the UP Government to link the tariff with the cost of production, specifically the cost of electricity charges.	Organisation/ Consultant
B. Institutional Capacity Building			
12	Human Resource Development	Determine the requirement of technical manpower and recruit/ contract requisite manpower	Consultant
13		Identification of the training needs, development of training programs and selection of the training institute.	Consultant
14		Conduct a detail study to identify the opportunities for public private partnership programs	Consultant
15	Infrastructure Development	Procure hardware and software for creating a sewerage system inventory and develop a GIS based sewer application for visual interpretation.	Consultant
16		Procure engineering equipment for proper maintenance of the sewerage system.	Consultant
C. Communication			
17	Communication	Establish a comprehensive and reliable communication system between the organisations involved and PMC.	Consultant
D. Institutional Development			
18	Institutional setting up	Establishment of Sewerage Division in Jal Sansthan and Nagar Nigam	Organisation/ Consultant
19		Capacity Building of City Office (Nagar Nigam)	Organisation/ Consultant

4.5.6 Summary of Total Project Costs and Implementation Schedule

The project costs of Sewerage, Non-sewerage, Public Participation and Awareness and Institutional Development Programme for Varanasi are summarised in the table below.

Table 4.70 Summary of Project Cost by Components (Varanasi)

(Million Rs.)

Item	Capital Cost	Physical contingencies, Engineering, Project administration	Land Acquisition	Total Project Cost
Sewerage Scheme	3,262.4	685.0	198.3	4,145.7
Non-Sewerage Scheme	278.4	69.6	0.0	348.0
Public Participation and Awareness	0.0	0.0	0.0	56.5
Institutional Development Programme	0.0	0.0	0.0	281.6
Total	**3,540.8**	**754.6**	**198.3**	**4,831.8**

The implementation of the total project and year wise fund flow requirement is presented in the table below.

Table 4.71 Summary of Project Implementation (Varanasi)

(Million Rs.)

Item	Total Project Cost	2006	2007	2008	2009	2010	2011
Sewerage Scheme	4,145.7	385.5	910.2	948.4	674.9	899.1	327.6
Non-Sewerage Scheme	348.0	64.8	90.6	116.2	76.4	0.0	0.0
Public Participation and Awareness	56.5	13.0	10.3	9.6	7.8	8.1	7.7
Institutional Development Programme	281.6	56.3	84.5	84.5	28.2	14.1	14.0
Total	**4,831.8**	**519.6**	**1,095.6**	**1,158.7**	**787.3**	**921.3**	**349.3**

4.5.7 Water Quality Estimation With Project

Estimated water quality with project and without project scenarios for 2015 is compared in the table below. The without scenario includes the sanctioned project.

Table 4.72 Comparison of With and Without Project in year 2015

Item	Without Project *1)	With Project
Estimated wastewater discharged in Municipal area in 2015 (mld)	338 mld	338 mld
Treatment capacity in 2015 (mld)	137 mld	338.2 mld
Untreated wastewater in 2015 (mld)	201 mld	0 mld
Percentage of untreated wastewater in 2015 (%)	59 %	0 %
Estimated BOD discharge (untreated + treated) (ton/d)	64.4 ton-BOD/day	10.1 ton-BOD/day
BOD concentration at upstream (u/s) of city (mg/l) (assumption)	2.5 mg/l	2.5 mg/l
BOD contribution to the river (mg/l) (if treated water is used for irrigation)	+2.0 mg/l (+1.9 mg/l)	+0.3 mg/l (+0.0 mg/l)
BOD concentration at downstream (d/s) of city (mg/l) (if treated water is used for irrigation)	4.5 mg/l (4.4 mg/l)	2.8 mg/l (2.5 mg/l)
Environment for bathing	Large volume of wastewater will be discharged in the Ganga and Varuna, which will cause unhygienic condition for bathing	Wastewater will be intercepted before entering the Ganga and Varuna and treated. Bathing environment will be improved.
Protection of water source of drinking water	Discharge of wastewater upstream of the municipal water intake will be kept continued and thus the water quality of the water supply source will be further degraded.	The wastewater discharged upstream of the municipal intake will be intercepted and treated and thus the source will be protected.
Water quality of effluent of existing and proposed STP	Bacterial pollution will increase because of no disinfection facility	Chlorination will be applied to both existing and proposed STPs. Bacterial pollution will be reduced.

Note:
1) The sanctioned project includes 37 mld STP construction at Ramna and is assumed to be implemented.
2) The dry flow of the Ganga river is used for analysis.
3) BOD concentrations of untreated and treated wastewater of 300 mg/l and 30 mg/l are used for analysis.

If the project is implemented (with the project scenario), all of the wastewater discharged will be intercepted and treated in 2015 while if the project is not implemented (without the project scenario) only 41 % is treated and the rest of the wastewater finds its way to the Ganga and Varuna degrading bathing environment of ghats in Varanasi. The preliminary estimation shows that the BOD concentration in Varanasi will be 2.0 mg/l without the project and 0.6 mg/l with the project.

4.5.8 Economic and Financial Evaluation

(1) Economic Evaluation

Economic benefits of the proposed project are identified as follows:

1) Increment of willingness to pay (WTP) for improvement of water quality of the river Gomti estimated by Contingency Valuation Method (CVM)
2) Increment of WTP for improvement of sewage treatment systems estimated by CVM
3) Saving of medical expenditure due to decrease of suffering rate of water borne diseases derived from the improvement of water environment
4) Increase in saving due to decrease of suffering rate of water borne diseases also derived from the improvement of water environment
5) Contribution to regional economy derived from incremental increase of bathing population at the ghats along the river Gomti, and
6) Agricultural benefit from utilisation of treated effluent for irrigation.

Following table shows their estimated unit values.

As of 2004 Price Level

City	WTP for Improvement of Water Quality of the river Gomti	WTP for Sewage Treatment Services	Incremental Saving of Medical Expenses due to Decrease of Suffering Rate of Water Borne Diseases		Incremental Saving of Salaries/Wages due to Decrease of Suffering Rate of Water Borne Diseases		Contribution to Local Economy Derived from Bathing Population From Regular Users	Agricultural Benefit (Paddy + Wheat)
			Outpatient	Inpatient	Outpatient	Inpatient		
	(Unit: Rs./Annum per House Hold)						(Unit: Rs./Annum per person)	(Unit: Rs./Annum per hectare)
Lucknow	354	1,974	11	136	4	12	17,852	6,494

Annual economic benefits for (1) above can be estimated by basic unit multiplying the entire households (HHs) in the project area, for (2), (3) and (4): the number of HHs connected, for (5): the incremental bathing population, and (6): the incremental irrigation area (ha).

Using annual cash stream of economic cost and benefit, the following results of economic evaluation are obtained. The estimated EIRR is 10.7 %.

Index	Discount rate 10 %	Discount rate 5%
NPV	237 million Rs.	4,164 million Rs.
EIRR	10.7%	10.7 %
B/C	1.06	1.75

(2) Financial Evaluation

Sewerage projects are public works and their financial viability cannot be worked out using standard financial evaluation techniques as they cannot generate profit or expect cost recovery as their objective. The main objective of such project is to provide better living conditions to the residents of the city and also make the environment clean and friendly. Hence it cannot be evaluated as a commercial project for cost recoveries and profit objectives.

The financial evaluation is made only for operation and maintenance cost recovery. The project is financially evaluated preparing a cash stream. The required user charge to recover the entire O&M and replacement cost assuming exiting bill collection rate is estimated at Rs. 2,040 per annum per household. The estimated average current sewer charge per bill is Rs.112 per annum. The required user charge is about 18 times higher than the current charge level and slightly higher than the estimated maximum affordability to pay of Rs. 1,889 per annum.

The amount of revenue generated from taxes and charges by the Service Provider, Varanasi Jal Sansthan, can cover only around 5 % of the total O&M cost in 2015 under existing conditions.

(3) Case Study for Improvement of Financial Situation

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.

- Improvement of billing and bill collection
- Utilisation of the by-products of sewerage system
- Others such as improvement of accounting system

Following figure shows the conservative projection of the number of the entire household in the city area, the households in the sewer area, the sewer connected household (or sewer charge billing household) and sewer bill collected households until the target year 2015 based on existing collection rate. As seen in the figure, there is a high potential to increase sewer connection and improve sewer charge collection efficiency.

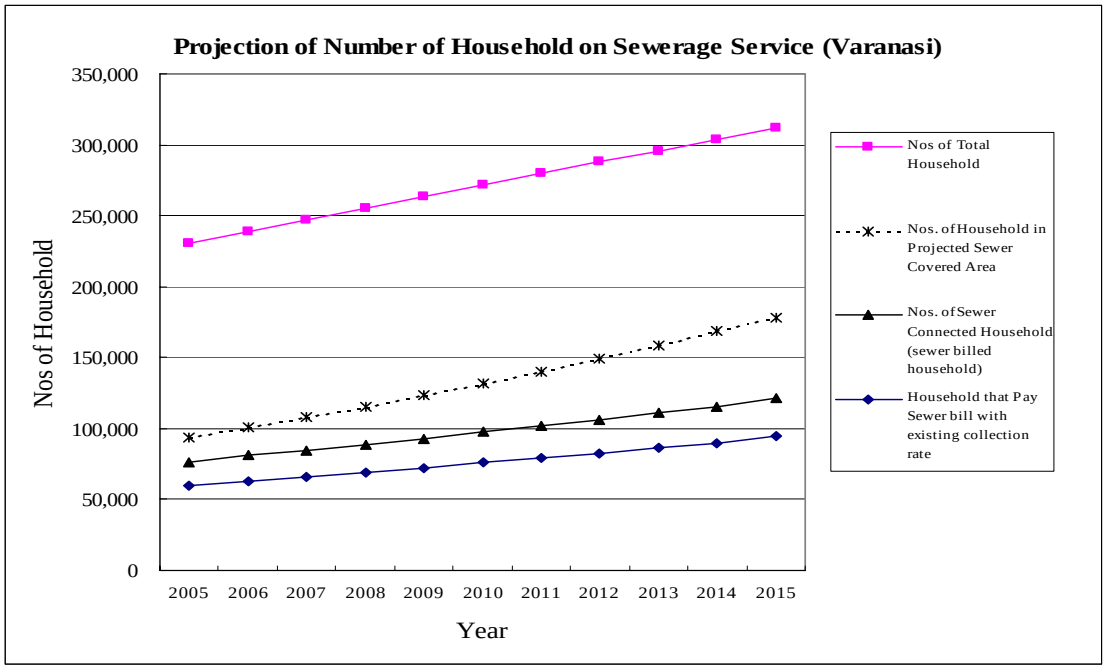


Figure 4.16 Number of Total Households in the City, Household in the Sewerage Service Area, Sewer Connected Household and Sewer Bill Collected Households

Following table shows a result of the case study taking into account the additional sources of revenue and improvement in the charge collection rate and charge level and sewer connection rate.

Table 4.73 Summary of Case Studies for Recovering of O&M Cost

Case in Sewer Charge level	Total O&M Cost required	Base Case		Case - 1				Case - 2			
		Revenue from sewer charge	Amount to be borne by State Transfer	Revenue from sewer charge	Optional Sources: Revenue from treated water sales	Optional Sources: Revenue from sludge sales	Amount to be borne by state transfer	Revenue from sewer charge	Optional Sources: Revenue from treated water sales	Optional Sources: Revenue from sludge sales	Amount to be borne by State Transfer
Million Rs./year											
Existing	177.4	8.9	168.5	9.8	3.9	13.7	150.0	15.0	3.9	13.7	144.8
100%	177.4	17.8	159.6					30.0	3.9	13.7	129.8
400%	177.4	44.5	132.9					75.1	3.9	13.7	84.7
950%	177.4	93.5	83.9					157.8	3.9	13.7	2.0
Conditions		Exiting sewer collection rate		1) 5% increase of sewer charge 2) 5 % increase of collection rate 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)				1) Increase in bill collection rate to 90 % 2) Increase in connection rate to 80 % in sewered area 3) New revenue sources (sales of sludge as fertilizer and treated water for irrigation)			

Note:

City	Existing Collection Rate of Bills	Existing Charge Level (Rs./Bill/ Year)	Affordability to Pay based on the income level: 1.5 % of average annual income per HH (Rs. per annum)
Lucknow:	80%	573	2,775
Kanpur:	50%	1,221	1,648
Allahabad:	56%	265	1,964
Varanasi	78%	112	1,889

Case-2		Case-1	
Estimated percentage of house connection in the sewer area	40%	charge	0.05
Estimated percentage of household in the sewered area	24%	collection	0.05
Estimated percentage of bill collected household out of total households in sewer area	48% in 2015		
Proposed collection rate	90% fixed		
Proposed connection rate	90% fixed		

Assuming the connection rate of 90 % in sewer area and the bill collection rate of 90 %, the amount to be borne by the State transfer will be reduced from Rs.168 million to Rs.144 million.

In this case, if the charge level is increased by 100 % (2 times of the existing charge level of Rs.112/HH per annum, in other words, if the charge level is revised to Rs.224/HH per annum), the amount to be borne by the state transfer will be reduced to Rs.129 million.

Furthermore, if the charge level is increased by 950 % (10.5 times of the existing charge level, in other words, if the charge level is revised to Rs. 1176/HH per annum), the revenue and O&M cost will be balanced. Even at this charge level, the revised charge will be within the affordability to pay for sanitation (Rs. 1,889/HH per annum).

From this viewpoint, a revision of the charge level is recommended by means of not only the revision of the existing tariff system but also the reassessment of the Annual Rental Value of properties since the charge level is closely linked with the Annual Rental Value of properties. However, extreme increase of sewer charge is not a realistic measure and therefore not all the O&M cost could recover from user charge. Government subsidy would be required for the project.

(4) Recommendations

To improve financial feasibility of the project, following measures are recommended:

1. Improvement of billing and bill collection, consisting of:

   - Increase in tax net
   - Reassessment of property values and annual rental value
   - Reduction of process time per bill
   - Increase in productivity by introducing incentive schemes

2. Utilisation of by-products, consisting of:
   - Treated water for irrigation
   - Generated sludge as fertiliser

3. Finding of government subsidy or other financial source for operation and maintenance cost

4.5.9 Stakeholder Meeting for Varanasi Project

(1) Objective of the Stakeholder Meeting

In accordance with the JICA guideline of Environmental and Social Considerations, a stakeholder meeting was held for the purpose of informing the feasibility study (F/S) project for Varanasi city to the stakeholders and public. The objective of stakeholder meeting was to encourage the recipient governments to take appropriate considerations of environmental and social factors in the project.

The meeting was organised by Department of Urban Development, Government of UP, and under this, Varanasi Nagar Nigam, UP Jal Nigam, Varanasi Jal Sansthan had the responsibility to hold the meeting in collaboration with the JICA Study Team. The organiser in consultation with JICA Study Team decided the range of stakeholders to be invited to the meeting and following stakeholders were selected:

- Elected Public Representatives
- Ministries and Govt. Agencies
- Project Affected People

- Officers of UP State Government and State Undertakings
- International Organisations and Donors
- NGOs
- Well-Informed Persons / Experts
- Media

(2) Pre-Meeting

Before stakeholder meeting, pre-meeting was held at Chiraigaon Block Office, where 30 villagers including Block Heads and Village Heads participated. Chiraigaon and Harahua are near the area of proposed STP site and some villagers could be affected due to land acquisition. The objective of the pre-meeting was to inform the contents of the project, especially STP and receive the comments / questions from villagers. Some of them raised the problem due to the existing Dinapur STP and their apprehension that the same might happen at Sathwa area also. It was explained that rehabilitation / renovation of Dinapur STP is included in the project and new technology to be adopted in Sathwa STP will not cause any problems.

(3) Stakeholder Meeting

Based on the guideline, a stakeholder meeting was held at Varanasi. The details are as below:

- Date: 14th September 2004
- Venue: Senate Hall of Banaras Hindu University
- Participants: 139 participants from various stakeholders

The key issues raised by participants and reactions of the organisers/JICA Study Team are as below:

Question	Answer
All the area being developed by Development Authority should be included in the project.	The development area of the city is considered in the project.
As seen in Dinapur, drinking water / ground water and crops are affected due to STP, and odour of sludge is also a problem. It is necessary to make it clear how to treat these issues.	The contamination is caused by faecal coliform, which is not treated in Dinapur STP. The rehabilitation / renovation of Dinapur STP is included in the project, so that the same could not happen further.
The electricity produced by biogas be also delivered to villagers.	The power, which would be generated, is for the STP on priority. If excess power is available then it could be distributed.
If the sludge with many chemicals like Zinc, Cobalt, Nickel etc. are used as manure, chemical balance of the field will be affected. The provision to monitor the sludge and treated water quality is necessary.	Regular monitoring is proposed in our project. If required, the sludge could be mixed with such other ingredients so that the manure could be utilised without any problem and even then if these harmful elements are found more than the standards, it will be disposed off through land filling.
The transparency of finance is also required	This is very important. The strengthening of institution is proposed and if it is done, the transparency will be achieved.

Comments from participants:

- Corporators were not involved in the planning stage, even though they know the city very well. It seems that there is no transparency and public participation so far.
- The area where the farming is less can be taken as proposed STP site, so that people could not be affected.
- After implementation of the project, the responsibility of operation and management should be provided to only one agency in place of dividing the work so that its responsibility should

be clear.

- The project is good, but the project is very big and its steps are not clear. There is lack of transparency. It needs highly qualified and skilled persons, which will increase the budget. And without this the plan will not work successfully.
- The STP should be installed far from the city area.
- Participation of Nagar Nigam and Jal Sansthan is also required because ground water and management of sewage is the main work of the project.

The answers to the comments are attached in Volume IV-4, Part VI.

The minutes of meeting, participants' list, comments from participants and answers from the organisers were made available to the public at the offices of VNN, UPJN and VJS. The same are also available to the public in JICA Study Team's Homepage.

5

PILOT PROJECT FOR SANITARY IMPROVEMENT OF MANIKARNIKA GHAT

5. PILOT PROJECT FOR SANITARY IMPROVEMENT OF MANIKARNIKA GHAT

5.1 INTRODUCTION

Ghat Improvement in Varanasi is an important component of the Study on Water Quality Management Plan of Ganga River Basin. As a first step, a Pilot Project for improvement of a selected ghat of Varanasi was to be undertaken as a part of the Study. The objective of the Pilot Project is to improve the sanitary conditions of the ghat and to abate water pollution from non-point sources such as open defecation, cattle wallowing, throwing of un-burnt or half-burnt dead bodies, etc. In this pilot project, the construction or renovation of the facilities such as public toilets, crematoria, garbage disposal, changing rooms, etc. were to be included as Project Components. This Project was to be carried out on a pilot basis to be used as a replicable model for improvement project for other ghats subsequently.

The following steps were taken to implement the Project in order to select appropriate components of the facility and to formulate sustainable operation and maintenance (O&M) plan.

Step 1 Survey
Step 2 Identification of project
Step 3 Conceptual design
Step 4 Basic design
Step 5 Formulation of operation and maintenance and public awareness plan
Step 6 Detailed design
Step 7 Construction (Implementation)
Step 8 Handing-over of facilities
Step 9 Utilisation
Step 10 Evaluation of usage and impact

5.2 PROJECT COMPONENTS

After several discussions with the local stakeholders on several alternatives of improvement plans, Manikarnika Ghat was selected and agreed by the local stakeholders for the pilot project. Then the selection of Manikarnika Ghat as a pilot project was formally requested to JICA by the Varanasi Nagar Nigam and agreed by the Steering Committee of the Study on 14th July 2003.

A working group comprising the local stakeholders related to Manikarnika Ghat was formulated to discuss the contents of the pilot project. Through several workshops and stakeholder interviews the design of the proposed facilities was decided and agreed by the working group. However, in the course of construction, the facility design was modified and finalised according to site conditions and considering the reasonable demands of the stakeholders. The proposed project consists of the following works (Figure 5.1):

1) Construction of changing room at Janana Ghat
2) Renovation of raised cremation platform
3) Renovation of ground cremation platform
4) Renovation of Chakra Pushkarni Manikarnika Kund
5) Construction of Heritage Corner
6) Repaving of Ramlila Maidan Ground
7) Renovation of Birla Dharmshala building as waiting room with lockers
8) Renovation of existing public toilet
9) Provision of dustbins
10) Provision of sign boards
11) Provision of pump for de-silting
12) Construction of Mural in Heritage Corner

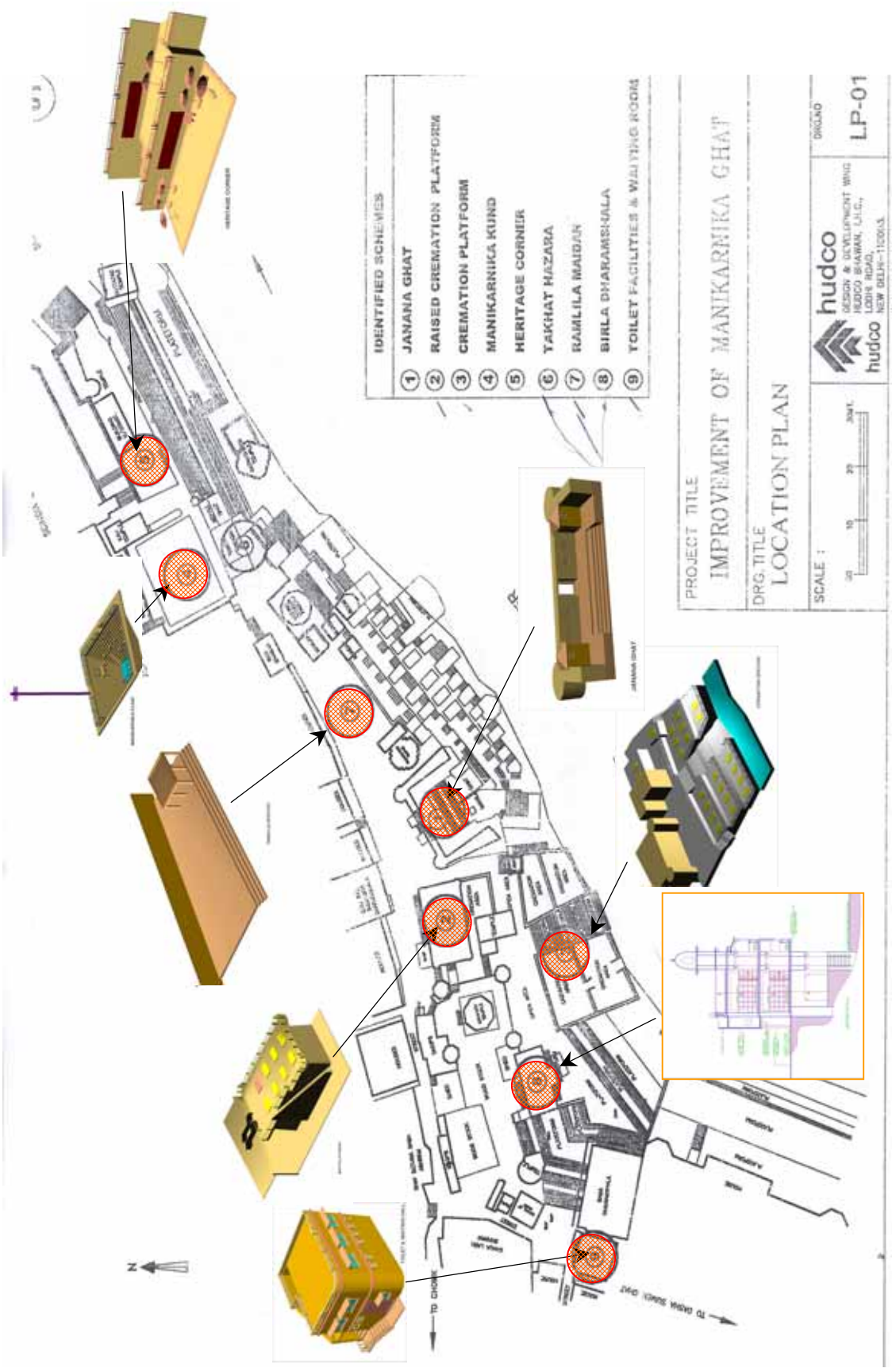


Figure 5.1 Pilot Project Components

The improvement works started at the beginning of May, 2004 but the work had to be suspended from June to September because of submergence of the sites due to floods. The improvement works were resumed after rainy season and completed in March 2005.

5.3 OPERATION AND MAINTENANCE PLAN FOR PROPOSED FACILITY

(1) Management Concept

JICA Study Team conducted a study to understand the present system of O & M at the Ghat and also to ascertain the appropriate institutional system that could adequately manage the facilities and ensure its structural maintenance besides cleanliness and hygiene. As a result of study it was decided to establish a Community-based Organisation (CBO) to look after day-to-day care of the facilities, and to work in co-ordination and collaboration with Nagar Nigam, Varanasi.

In the stakeholder workshop on 27th April 2004, operation and maintenance of the proposed facilities was discussed and the followings decisions were taken to which all the stakeholders agreed:

- CBO (Community-based Organisation) will be created for O&M on regular basis.
- All possibilities of fund generations for O&M of proposed facilities and ghat area from user groups will be explored and worked out.
- Though focus will be on community based approach of O&M, and process will be initiated in this regard, but, as long as CBO is not organised, Nagar Nigam will take full responsibility of O&M of the proposed facilities and Manikarnika Ghat area.

(2) Existing Sanitary Conditions

The main problems with regard to hygiene and sanitation conditions at the Ghat were:

- Unhygienic conditions due to open defecation and urination at the Ghat area.
- Improper arrangement of cleanliness and sanitation at the Ghat area.
- Deposits of garbage and water logging at several places. Lack of proper and regular arrangements of garbage disposal.
- Continuous movements of stray cattle.
- Highly polluted cremation area.
- Improper toilet facilities.
- Encroachments (due to wood stocking, animal keeping, illegal vendors, extension of shops, etc.) at several places.
- No dustbins.
- Low awareness level with regard to sanitation and hygiene.
- Lack of a system of supervision, monitoring and checking on regular basis.

(3) Existing Facilities at Manikarnika Ghat and their Operation and Maintenance

The existing facilities at ghat and their operation and maintenance agencies are as following:

Facilities/Important Places	Maintenance Agency
Manikarnika Kund	Kashi Tirth Purohit Samiti
Takht Hazara	Local Pandas
Ramlila Ground	Ramlila Committee
Cremation Site	Family members of Dom Raja
Toilets	O & M by Sulabh International
Birla Dharmshala	Nagar Nigam
Hygiene and Sanitation	Nagar Nigam Varanasi

(4) Target Group

The target groups of this Study include:

- Various stakeholders especially service providers of the ghat area like wood sellers, shopkeepers, tirth purohits, pandas, mahapatras, boatmen, barbers, members of the Dom community.
- Guest House owners, Dharmshala owners, local school principals, temple trustees, Nagar Nigam officials especially Municipal Commissioner, Mahant of the Satua Baba Ashram, Dom Raja, etc.
- Mourners, pilgrims, tourists — national and internationals, tourist guides etc.
- Prominent people/social workers of the city, reputed NGOs and Clubs like Rotary, Lions, etc.
- Political leaders, Corporators of Manikarnika Ghat area and other local leaders, keeping in mind the importance of political will.

(5) CBO Formation- Institutional Structure

A ghat based CBO was formed after due deliberations at the Stakeholders meeting. A two tier organisational system (i) The Working Committee, and (ii) The Advisory Committee has also been constituted. This locally based institutional organisation, however, will be monitored and supervised by the Varanasi Nagar Nigam, thus, making the institutional structure three tiers. This organisation was registered as a CBO (*"Manikarnika Tourism Development and Management Committee (Manikarnika Tirth Vikas and Prabhandan Samity)"*).

(6) Major Aims and Responsibilities of CBO

The aim of the CBO is to ensure effective, prompt and sustainable operation and maintenance of the developed facilities along with maintenance of sanitary and hygienic conditions of the entire ghat area. The byelaws of the CBO have been prepared after due deliberation in the Stakeholders meeting.

The following are responsibilities of CBO:

- Prompt and effective cleanliness round the clock.
- To arrange timely collection and disposal of solid waste /garbage.
- To prevent open defecation and urination.
- To stop roaming of stray animals.
- To organise awareness programmes with regard to usage of public toilets and thereby stopping open defecation and urination in the ghat area.
- Structural maintenance and effective operation of all facilities.
- Security of facilities such as temporary shade, heritage corner, high-mass light at heritage corner, murals at heritage site, water pump, roofing of Takht Hazara, office, etc.
- Timely collection of funds, proper utilisation of funds, and proper maintenance of accounts of the income and expenditure, etc.
- To ensure coordination with Nagar Nigam.
- To organise regular monthly meetings of the CBO members.

It was proposed that the Working Committee in consultation with the Advisory Committee shall do the management of the CBO. Different stakeholder groups have accepted the proposal to contribute some amount from their earnings on daily/monthly basis. The General Secretary and the Treasurer of the CBO will jointly do the money transaction.

(7) Staff and Office Requirement

For the effective operation and maintenance of the CBO one-room office at the central place has been provided by one stakeholder. A two member staff for the CBO office has been engaged on contract basis. The office has also been equipped with audio system.

(8) Public Participation and Awareness Programme

An elaborate PP/PA programme has been proposed which is based on the existing levels of hygiene awareness and public participation in maintaining and managing the existing facilities in the ghat area. The following are proposed for immediate awareness programmes.

1) Display boards, largely visual, to cater to the large number of illiterate people, at the end of lanes which open to the ghat area where facility location is identified and where usage of facility is encouraged
2) Placing sign boards in front of the facilities for correct usage and dissuading wrong practices
3) Display boards promoting practice of good hygiene and sanitation
4) Display boards indicating actions punishable by law
5) Display boards against open defecation and garbage dumping on ghat
6) Visual show events against pollution
7) Voluntary pressure groups (comprising of aware shop keepers, priests, doms and other stakeholders) for persistent persuasion to the residents and visitors to maintain cleanliness at the ghat, not to damage it and for proper use of the facilities
8) Police patrolling to punish law breakers

5.4 CONCLUSIONS OF PILOT PROJECT

5.4.1 Handing Over

The works of the Pilot Project were successfully completed and the CBO was formed. A handing over ceremony was held by JICA together with Nagar Nigam and Manikarnika Ghat CBO members on 24th March 2005 in Heritage Corner, Manikarnika Ghat.

At the end of the handing over ceremony, JICA representative and Municipal Commissioner signed the handover and takeover documents and exchanged with each other. Also a key of CBO office was handed over formally to its members.

5.4.2 Rapid Evaluation of Pilot Project

A rapid evaluation was conducted during and after the construction by JICA Study Team to assess the design of constructed facilities and their usage. The following table describes major findings and recommendations.

Sr.	Facility	Evaluation and Recommendation
1.	Changing room at Janana Ghat	• This will be mainly used in flood season when changing rooms located in the lower area are submerged in flood season. During the visit of Study Team in dry season, nobody seemed to using the changing room. • Urination was still rampant in the Janana Ghat area and unhygienic condition is not so improved. • The usage shall be encouraged through Janana Ghat priests and CBO. • Awareness on improvement of hygienic condition should be raised through public awareness and participation campaign, etc.
2.	Raised cremation platform	• This will be mainly used during the flood season when lower ground cremation is submerged. The visit by the Study Team was in dry season so it was not being used. However, the facility is well constructed and was not found any problem to include. It is for sure that it will be used during flood season. The Dom (cremation) community has ensured proper maintenance of the facilities.
3.	Ground cremation platform	• The ground cremation was used as it was. It seemed that maintenance of the facility was improved and the cleanliness of the cremation area was much improved. The Dom (cremation) community has ensured proper maintenance.
4.	Chakra Pushkarni Manikarnika Kund	• The Kund was well decorated when the Study Team visited and it seemed that the cleanliness has improved.
5.	Heritage Corner	• This was most well constructed and attracted attention of the visitors. • Wondering and staling of animals and urination in the area were stopped and the area was kept clean. • It seemed the corner gave a good demonstration of the heritage of Manikarnika Ghat to visitors as designed.
6.	Birla Dharmshala building as waiting room with lockers	• The building was well renovated and kept clean. • It is required that the usage of locker and waiting room shall be encouraged and managed by CBO.
7.	Public toilet	• The toilet was well renovated with appropriate ventilation, flushing water tank, reservoir and washing place. • The facility should be well maintained by Sulabh International.
8.	Dustbins	• Dustbins were installed. • These should be appropriately maintained by CBO and Nagar Nigam.
9.	Mural in Heritage Corner	• The theme and design of the mural was appropriate and it attracted attention of the visitors.

This is a result of the rapid evaluation of constructed facilities just after the completion of the project. The JICA Study Team felt that further evaluation may be required after the facilities will be used for some time to obtain more accumulated operation and maintenance data.

The JICA Study Team assisted to form a Community-based Organisation (CBO) for operation and maintenance of the facilities constructed. As a result, a CBO was established for Manikarnika Ghat. However, the management of the CBO has not yet been matured just after the completion of the facilities. Further monitoring of the CBO and assistance to it shall be considered to ensure sustainability of the facilities constructed. To form a successful organisation, active involvement of CBO members and chairmanship of Nagar Nigam are indispensable.

5.4.3 Socio-environmental Impact

The following are socio-environmental impacts or benefits identified. These would be gradually recognised by the public.

- The implementation of the pilot project will give a face-lift to the entire Manikarnika Ghat area, where numerous devotees and tourists from abroad visit, apart from its impact on people performing the cremation and other religious rites.

- The facilities constructed will improve the sanitary and environmental conditions and create a positive socio environmental impact on the users.

- The project will provide protection, sustainability and longevity to the area with respect to intense usage through various seasonal and behavioural conditions of the river.

- The project will beautify and revitalise the Ghat area, keeping the heritage, visual scenario and aura intact.

- The Project will help in enhancement of the archaeological and architectural values with a view to promote user-friendly pilgrimage and tourism.

- The materials adopted for physical upliftment of spaces/buildings are modern application of indigenous/locally available materials that would merge with the existing colour and texture.

- The project will help in sensitising and educating the locals, stakeholders and local bodies for taking up further improvement plans for other ghats as well.

6

CONCLUSIONS AND RECOMMENDATIONS

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

- ✓ Stretches of the Ganga, Yamuna and Gomti rivers where five class-I cities in UP state are situated are severely polluted in water quality. The five cities are Lucknow, Kanpur Allahabad, Varanasi and Agra. Water quality improvement program is being implemented for Agra under the Yamuna Action Plan Phase II. Water quality improvement program is also being implemented for the remaining four cities under either Ganga Action Plan Phase II or Gomti Action Plan Phase II. The above plans aim at stopping the sewage from flowing into the rivers and after implementation, they will be effective to a large extent in resuming the water quality of the rivers for bathing purposes.

- ✓ The Government of India has planned the study of Water Quality Management Plan for Ganga river. The purpose of the study is to first analyse water quality deterioration mechanism in the rivers more broadly and technically and, based on the mechanism, estimate the measures that are required not only in the immediate future but also for long term, i.e., up to 2030.

- ✓ The study results reveal that if the domestic sewage in the four cities is intercepted, diverted and treated, the water quality will be resumed to bathing standards. Interception, diversion and treatment of sewage is essential in the upstream towns also, although their sizes are comparatively small, in order to maintain the water quality along the stretches of the Ganga, Yamuna and Gomti rivers, including the four cities.

- ✓ The costs of proposed sewerage schemes up to the year 2030 are large, amounting to 28.2 billion Rupees for Lucknow, 23.5 billion Rupees for Kanpur, 8.9 billion Rupees for Allahabad, and 12.1 billion Rupees for Varanasi. So the sewerage components have been divided into two stages for the implementation.

- ✓ The first stage is targeted up to the year 2015. The major facilities for this stage consist of interception, diversion and treatment of sewage, cost of which should be borne by the Central Government through the National River Conservation Directorate (NRCD) of Ministry of Environment and Forests (MoEF), and the State Government. The second stage facilities consisting of mainly secondary sewers, branch sewers and house connections, are not under the jurisdiction of MoEF but of the Ministry of Urban Development of the Govt. of India.

- ✓ The sewerage priority projects to be implemented immediately have been identified in the first stage works, with the aim of reducing the pollution load in the river. The costs of priority projects are 3.3 billion Rupees for Lucknow, 3.9 billion Rupees for Kanpur, 2.7 billion Rupees for Allahabad and 4.1 billion Rupees for Varanasi.

- ✓ The proposed treatment process is mainly either waste stabilisation pond where enough land is available or UASB plus appropriate post treatment (aerated lagoons (AL)) where enough land is not available. These processes are proposed so as to have the least disruption under the prevailing conditions of the Study area like insufficient power supply. It is noted that under the current insufficient power supply condition and operation and maintenance technology, these treatment processes are the best option.

- ✓ At present, the expected quality of treated water has not been attained technically because necessary expertise/know-how has not yet been accumulated in the area of operation and maintenance. Further, power supply is important and should be supplied continuously for proper function of the sewerage facilities. The uninterrupted power supply is essential due to very flat terrain of all the four cities even though we have proposed less energy-intensive facilities.

- ✓ The area of more serious concern is financial and institutional issue. So far no organisation is willing to take over operation and maintenance (O&M). Legally the responsibility of O&M rests with urban local bodies, i.e., in the study area, the Municipal Corporations (Nagar Nigam). In this context, institutional development programme (IDP) including organisation and institutional development, capacity building and financial strengthening measures has been proposed in the study as a prerequisite for the implementation of the project.

- ✓ There are several opinions from stakeholders concerning operation and maintenance. Therefore, the proposed IDP will require strong will and deep involvement of decision-makers of the Municipal Corporations and the State Government.

- ✓ Another objective of IDP is setting up unified single agency for sewerage. Currently many agencies are engaged on sewerage works (UP Jal Nigam, Jal Sansthans, Municipal Corporations, Development Authorities etc.) with a very little coordination.

- ✓ Besides sewerage components, non-sewerage components have also been included in the study in which CTC (Community Toilet Complexes) and Constructed Dhobi Ghats (commercial washing or laundry places) have been planned. The former are planned for improving sanitary condition of slum communities. The latter are planned for aesthetical improvement by relocating traditional washing places along the river to the inland area.

- ✓ The planning for non-sewerage components is based on demand-based approach rather than on supply-based approach to reflect user's needs to site selection, design, size etc. For this purpose, the study team has conducted sample survey and reflected the results in the planning.

- ✓ In the development of the above concept, lessons learned through pilot project implementation to improve sanitary condition of Manikarnika Ghat in Varanasi have been very helpful. It was intended to understand the Indian culture and society and utilise the knowledge for study planning. The site selected for the pilot project is religiously very important for the Hindus. Right from the stage of site selection to the completion of pilot project, several stakeholders meetings were organised. The JICA study team also assisted in formulating a Community-Based Organisation (CBO) for operation and maintenance of the facilities constructed in the pilot project.

- ✓ For the success of the sewerage and non-sewerage projects, particularly during the operation and maintenance phase, cooperation is essential from every stakeholder. To achieve this, public participation and public awareness programme (PP/PA) has been proposed.

- ✓ Stakeholder meetings were organised by the proponent under the study according to the JICA Environmental and Social Consideration Guideline, which was effective from April 1st of 2004. (1) All of the future projects should be examined and evaluated in accordance with this Guideline. (2) All of the future projects should be categorised as class A to C at the stage of preliminary study. However, it is applied partially to on-going development study as of 1st of April. Considering importance of the project, it was tried at the final stage of the study and the study has incorporated various comments raised in the stakeholder meetings. Therefore, environmental and social considerations, hopefully, will become a practical tool for the project formulation.

- ✓ The costs of all the feasibility study projects including sewerage and non-sewerage schemes, IDP and PP/PA are 3.7 billion Rupees for Lucknow, 4.2 billion Rupees for Kanpur, 3.0 billion Rupees for Allahabad and 4.8 billion Rupees for Varanasi.

- ✓ The Economic Internal Rate of Return (EIRR) of proposed projects works out to a minimum 5 %.

- ✓ The financial evaluation has revealed that only a part of the O&M cost of the proposed sewerage project can be recovered from user charges and the remaining O&M cost and the capital costs

cannot be recovered under existing financial conditions.

- ✓ The main objective of sewerage projects, which are public works, is to provide basic urban infrastructure for better living conditions to the residents by improving the environment and sanitary conditions. In general, it is very difficult to make such project financially viable with only revenue from user charges. Measures to improve financial viability of the proposed sewerage projects are proposed.

6.2 RECOMMENDATIONS

- ➢ One of the most valuable outcomes of the study has been the sewerage and non-sewerage Master Plan for the four target cities. However, it is very important that the Master Plan is sincerely adopted by all concerned in its letter and spirit and all the future developments must take place in accordance with the Master Plan proposals and no deviations are allowed. Otherwise, the purpose of the Master Plan will be defeated.

- ➢ The study included extensive surveys, analysis and input from many organisations and consultants for two years, covering extensive areas such as GIS database, water quality simulation model, town planning, facility planning, etc. During the study it was observed that, although some form of town planning is practiced, but it does not seem to function as a guiding tool. To achieve effective sewerage development, such guiding tool is required.

- ➢ Discharge of untreated industrial waste into the rivers must be controlled and monitored effectively.

- ➢ One significant assumption that has been made in the study is that water supply system will be developed properly and, large unaccounted-for water will be put under control. Necessary steps to achieve this must be taken on priority.

- ➢ Solid waste management in all the cities is found to be inadequate. Sewerage and drainage facilities are indiscriminately used as dumping grounds for solid wastes. This causes the sewerage system to become dysfunctional resulting into serious problems of unhygienic conditions in the cities as well as pollution of the rivers. It needs rectification. Indiscriminate throwing of solid wastes in the sewers and drains must be stopped. This requires extensive PP/PA and if necessary, stringent laws against this practice be enacted with provision of punishment for violation.

- ➢ Sewerage planning and implementation should be coordinated for the time being. Eventually both planning and implementation should be executed under a single organisation. In the study it is proposed that Jal Sansthan should be brought under the Municipal Corporation.

- ➢ According to the study results, the appropriate operational costs of sewerage facilities should be prepared and disbursed by the proponent.

- ➢ For implementation of IDP, strong intervention and will of the decision makers of both the Municipal Corporations and the State government is required. An Organisation for handling PP/PA must be created. Similarly, an organisation for handling environmental monitoring must also be created in Municipal Corporations.

- ➢ Land for the proposed treatment plants and pumping stations should be reserved and acquired based on further stakeholder meetings in consultation with the affected people by land acquisition.

- ➢ In addition to the trunk facilities, interception and diversion works and treatment plants proposed in the Master Plan and the feasibility study of the Priority Projects, it is simultaneously necessary to develop the facilities of secondary sewers and branch sewers and to connect them to the trunk

facilities so that the people get the benefit of the facilities as well as sufficient flow of sewage reaches the treatment plants to make them properly functional. Hence, the planning for the development of the secondary sewers and branch sewers must be initiated and implemented as necessary along with the implementation of the trunk facilities.

- The National River Conservation Plan of the Government of India envisages that 30% of the capital cost of the Projects should be borne by the State Governments, out of which 10% should be forthcoming from the local bodies. In the project cities, many of the areas have been developed by different State Agencies like UP State Housing Development Board (UPHDB) and Development Authorities as well as by private developers. These developers have been providing only the secondary sewerage facilities in the colonies excluding trunk facilities and sewage treatment. Hence, the Study Team recommends that some element of cost sharing by these developers towards the trunk and treatment facilities must be introduced.