hand pumps were collected and tested. The ground water samples were collected around the existing and proposed STPs.

River water samples were obtained from both the rivers. Presently the sewage is directly going to river at several places. Therefore care was taken to collect one sample from upstream area of sewage disposal and one water sample from down stream area of disposal location. The sampling locations are shown in Figure 5.14 and are listed in Tables 5.22 and Table 5.23.

Table 5.22 Ground Water Sampling Locations

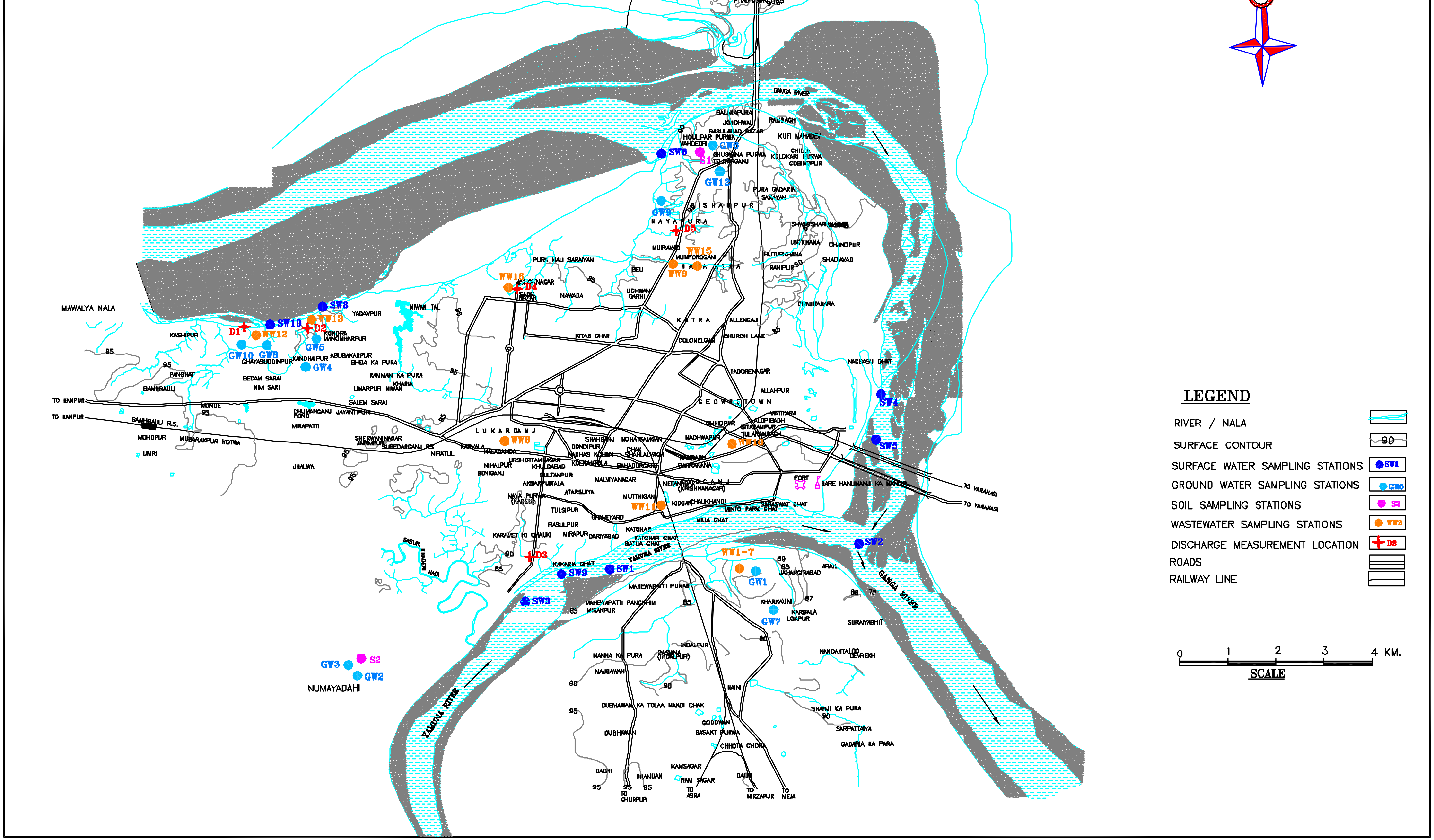
Sample Code	Location	Nearest Project Component
GW1	Bore Well at Naini	Existing Naini STP
GW7	Dug Well at Kharkauni	
GW2	Dug well at Dahi Village	Proposed Numaya Dahi STP
GW3	Hand Pump at Numaya Village	
GW4	Hand Pump at Kandhaipur	Proposed Kodara STP
GW5	Hand Pump at Kodara	
GW6	Rasoolabad (supply water)	Proposed Rajapur STP
GW9	Hand Pump at Naya Purwa	
GW8	Hand Pump near Ponghat Nala temple	Proposed Ponghat STP
GW10	Ghayasuddinpur (supply water)	

Table 5.23 Surface Water Sampling Locations

Sample Code	Location
SW1	Yamuna, down stream (near railway bridge)
SW2	Sangam
SW3	Yamuna, up stream (before Ghaghar Nala)
SW4	Ganga, up stream (before downfall of Mori Nala)
SW5	Ganga down stream (after downfall of Mori Nala)
SW6	Ganga near downfall of Rasoolabad nala
SW7	Yamuna, near Bisona village
SW8	Ganga, near down fall of Kodara Nala
SW9	Yamuna, near downfall of Ghaghar Nala
SW10	Ganga, near downfall of Ponghat Nala

ALLAHABAD CITY

FIGURE 5.10 LOCATION OF SAMPLING STATIONS



Collection Methodology

Samples collected from both type of sources were grab samples. The physico-chemical quality of water samples were characterised by adopting the relevant parts of IS: 3025, "Standard Methods for Water Analysis" and the methods prescribed under IS: 10500. Evaluation of parameters like odour; taste, temperature, pH, dissolved oxygen and alkalinity were carried out at the sampling stations immediately after collection of samples with the help of Field Analysis Kits. Parameters like colour turbidity, hardness, etc. were analysed in the field laboratory at Allahabad. For analysis of other parameters, the samples were brought to the Laboratory in New Delhi, after addition of proper preservatives. The metallic constituents like Arsenic, Mercury, Lead, Cadmium, Chromium, Copper, Zinc, Selenium, Iron and Manganese were analysed with Atomic Absorption Spectroscope after proper concentration and/or chelation, complexation and extraction of the metallic contaminants with suitable solvents. Mineral oil was determined by Gas Chromatographic Method.

Analytical Results

The detailed physico-chemical characteristics of surface and ground water samples are given in Appendix A5.15 and the summary of the test results is presented in Table 5.24 To facilitate comparison with drinking water standards, Test Characteristics for drinking Water, IS 10500: 1991, has been included along with summarized data of test results. The major parameters of test results such as pH, DO, BOD, TSS and total coliform are graphically shown in Figure 5.15 and Figure 5.16 for surface and ground water, respectively.

Table 5.24 Summarized Data of Water Test Results

Parameters	Unit	Permissible limit Standard as per IS: 10500	Test Results range of	
			Ground Water	Surface Water
pH		6.5-8.5	7.5-8.2	7.3-8.1
Total hardness	mg/l	600	124-1432	120-204
Iron	mg/l	1.0	0.09-0.3	0.10-2.98
Dissolved solid	mg/l	2,000	250-1764	243-532
Sulphate	mg/l	400	12-150	10-34
Nitrate	mg/l	100	6.2-11.5	5.8-8.7
Alkalinity	mg/l	600	128-508	128-424
Total coliform	MPN/100 ml	Nil	02-07	07-16

Surface Water Quality

Salient features of the physico-chemical characteristics of the surface water sample collected from Ganga and Yamuna rivers.

- As expected, test characteristics with respect to physical parameters like odour and turbidity does not exceed the permissible limits for drinking water.

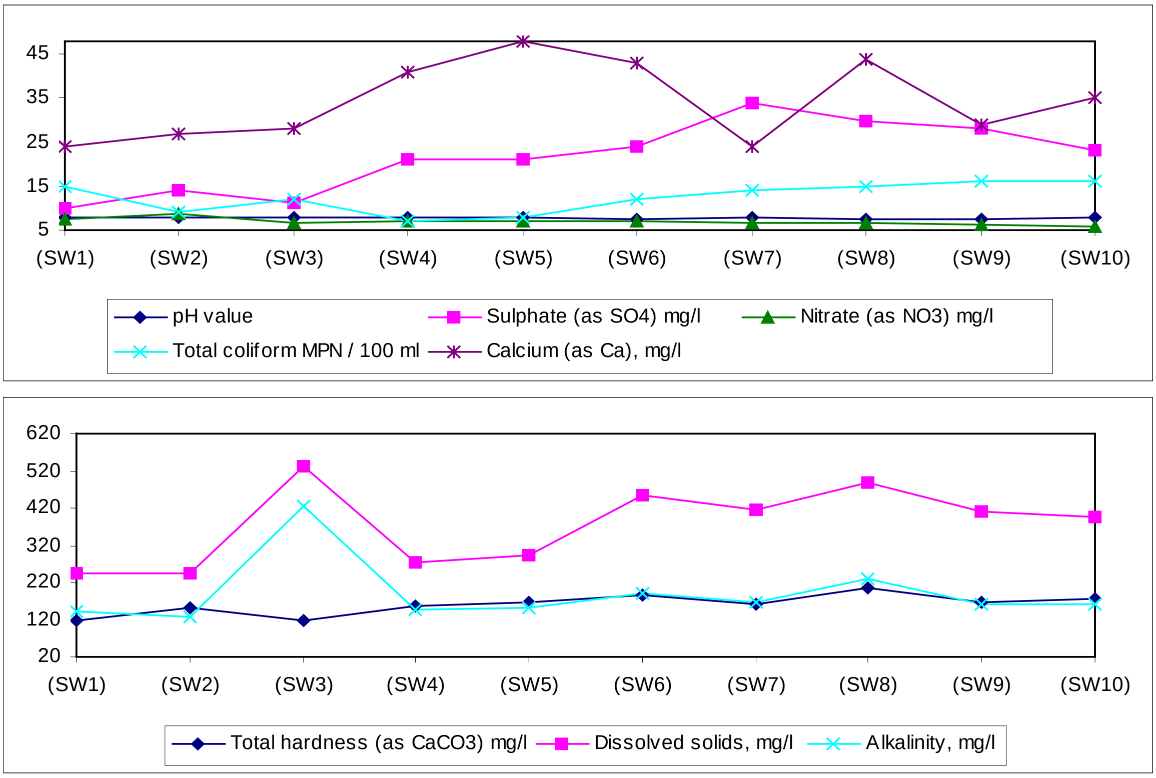


Figure 5.15 Surface Water Test Results

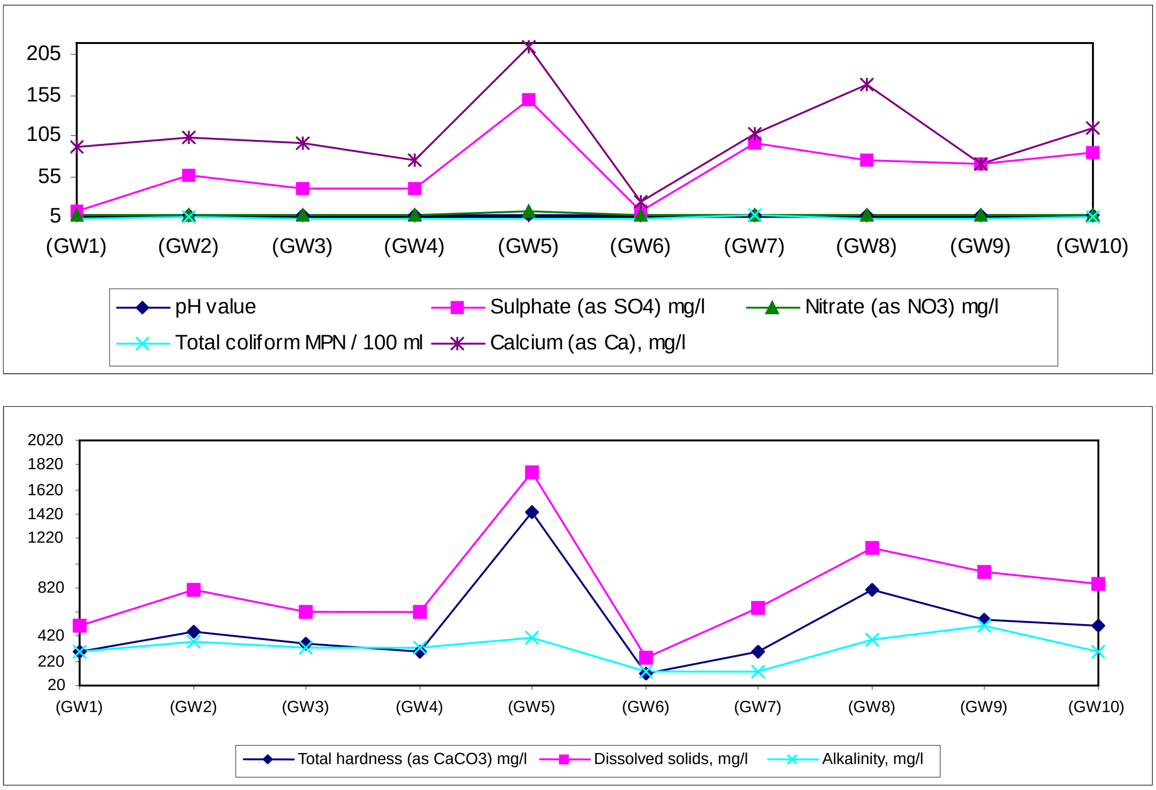


Figure 5.16 Graphs Showing Ground Water Test Results

- The observed pH values of 7.3 to 8.1 are well within the desirable range of 6.5 to 8.5 units.
- Total hardness, as $CaCO_3$ was observed in the range between 120 to 204 mg/l, which is well within the desirable limit of 300 mg/l.
- It was observed that most of the samples contain iron between 0.10 and 2.98 mg/l that is within the permissible limits except for samples from Yamuna River near Bisona and near Ghaghar Nala and a sample from the near Ponghat Nala where it slightly increases the permissible limits.
- Concentration of total dissolve solid was observed in the range between 243 and 532 mg/I, and is well within the permissible limit of 500 mg/l.

Ground Water Quality

The analytical results of the ground water samples collected during field survey have been summarized in Table 5.24. The critical review of detailed analytical results is as follows:

- The pH value indicates that ground water in the area is mildly alkaline in nature
- Mostly the ground water is soft except for village Kodara and Ponghat which is localized in nature
- Iron in ground water is within desirable limits
- Total mineral is within permissible limits
- Sulphates, nitrates, etc. are within permissible limits

Quantification of Sewage

The discharge of five existing natural drains has been measured using the velocity area method at the tail end i.e. just before they fall down into Ganga River / Yamuna River. Two discharge readings were taken at each location, one during the anticipated peak discharge period (7 a.m.–9 a.m.) and the second during the anticipated lean discharge period (12:00 a.m.- 02 a.m.),

The instruments used for measurement were 'V' notch plate (90^{o} angle) / flow meter (Propeller type current meter).

Places, where the flow was low and it was possible to fix up the 'V' notch plate the measurements were undertaken using 'V' notch. Where the flow was heavy the current meter was used. The area velocity method has been used to evaluate the flow rates. The location wise observed flow rates of the sewage at 5 locations are given in Table 5.25 and shown in Figure 5.14.

Table 5.25 Location of Wastewater Discharge Measurement

Location Code	Name of nala/ sewerage	Location	Equipment used	Discharge (l/min)	
				Peak	Lean
D1	Ponghat Nala	Ghayasuddinpur (near temple)	'V' notch	404	147
D2	Kodara Nala	Kodara (near left of temple)	Current meter	1,449	1,113
D3	Ghaghar nala	At Karamat ki Chowki (near road crossing)	Current meter	71,280	21,960
D4	Mumfordganj Nala	At Mumfordganj (near Pumping station)	'V' notch	-	1,449
D5	Sadar bazaar Nala	At Sadar bazaar (near big culvert/ bridge)	Current meter	-	6,400

Discharge Measurement with 'v' notch at Ponghat Nala, Allahabad

Migratory Birds- Chaha & Surkhabn
Ganga River at Rasoolabad (near Rajapur), Allahabad

Migratory Birds (Chaha) Caught for Food
by Medicine Induced Flightlessness in
Ganga River near Rasoolabad (near Rajapur), Allahabad

Fishing in Yamuna River near Ghaghar Nala, Allahabad

Waste water Test Results

Sixteen wastewater samples were collected and analysed. Seven samples were collected from various units of the existing Naini STP to adjudge the functioning of the plant. Nine samples were collected from various Nalas / Pumping Stations to estimate the quality of waste water which will flow to the proposed STPs. Locations of sampling stations are shown in Figure 5.14. The test results for raw sewage are given in Table 5.26.

Table 5.26 Wastewater Test Results of Allahabad

Location		Type	Date of sampling	pH	Temp (°C)	BOD, mg/l	COD, mg/l	TSS, mg/l	VSS, mg/l	SO_4, mg/l	Target STP
Sewerage pumping stations	**Lukerganj**	**C**	**4-5.11.04**	6.8	29	89	208	25	9	56	Numaya Dahi
	Mumfordganj	**C**	**4-5.11.04**	7.1	28	85	198	33	12	25	Rajapur
	Alopibagh	**C**	**4-5.11.04**	7	29	108	202	132	49	53	Rajapur
	Gaughat	**C**	**4-5.11.04**	7.2	26	127	263	83	56	54	Naini
Out fall of drain/ nala	**Ponghat**	**C**	**4-5.11.04**	7.5	28	86	215	65	45	26	Ponghat
	Kodara	**C**	**4-5.11.04**	7.2	27	119	254	149	76	45	Kodara
	Ghaghar	**C**	**4-5.11.04**	7	27	93	247	95	65	35	Numaya Dahi
Drain/ Nala	**Mumfordganj**	**G**	**5.11.04**	7.2	28	88	204	86	42	51	Rajapur
	Sadar bazaar	**G**	**5.11.04**	7.1	29	98	167	136	30	27	Rajapur

Note : ***C = Composite*** ***G = Grab***

(6) Municipal Water Supply

The status of water supply as in 2003 is presented in Table 5.27.

Table 5.27 Water Supply Status in Allahabad

Year		**2003**	**2015**	**2033**
Population served by municipal system		1,049,800	1,404,700	1,932,850
Demand (UPJN estimates)	mld	210	290	402
Water supply treatment capacity				
Existing	mld	130	130	140
Proposed	mld		10	
Total	**mld**	**130**	**140**	**140**
Water Sources				
Municipal-river	mld	80	140	140
Municipal-wells	mld	137	137	137
Private	mld	54	54	54
Other	mld			
Total	**mld**	**271**	**331**	**331**

From the above table it is evident that groundwater is the main source of drinking water in the town. The main surface water source is the Yamuna River. Intake of water from the river in 2003 was 80 mld. The raw water intake is located at Karelibagh and from here the water is sent to the treatment works located at Khusrobagh.

(7) Wastewater Generation

General

The estimates of present water supply and wastewater generation from Allahabad town based on 2003 population data are given in Table 5.28.

TABLE 5.28 Quantity of Water Supply and Wastewater Generation in Allahabad (2003)

Sr	**Item**	**Unit**	**Amount**
1	Population in sewer service area	No.	308,304
2	Population connected to sewer	No.	200,494
3	Waste water return rate per capita	lpcd	205
4	Total waste water generated	Mld	226
5	Amount intercepted	mld	111
6	Existing treatment capacity	mld	60

From the above table, it is anticipated that the total domestic wastewater load is about 226 mld against an installed treatment capacity of 60 mld. The amount of wastewater collected and diverted to treatment is on average 66 mld. Remaining wastewater is discharged to Ganga and Yamuna Rivers through open drains.

(8) Soil Quality

In the study area, thick clay layer occurs on the top surface, with a thickness ranging between 10- 15 m. Thick sandy horizon occurs beneath the top clay layer having sufficiently large thickness.
The soil in this area, i.e., Doab has three distinct types. Sandy soil is found along the banks of the rivers, clay is found in the depressions and loam, a mixture of sand and clay that is usually a rich and rather dark soil, the less fertile variety.

Near the proposed STP sites of Ponghat and Kodara in Sulem Sarai area, erosion of soil along the riverbank especially during flood period has been recognized and is shown in the following photograph.

Soil Erosion along Right Bank of Ganga between Ponghat and Kodara Nala, Allahabad

Soil Sampling Location

Soil samples were collected from two locations and analysed. The samples were collected from agricultural field; locations have been marked in Figure 5.14.

Methodology of Sample collection & Analysis

Soil samples from cultivated agricultural fields were collected by digging a pit of 50 cm depth at the appropriate location with the help of a spade and a `Khurpi' (small digging tool). The excavated soil from each location was mixed thoroughly and about 2 kgs of mixed sample was collected by `Cone & Quartering method'. The sample was packed in a polyethylene bag, sealed and brought to the laboratory.

After drawing a part of the sample for testing moisture content, the remaining samples were air dried for a few days. For chemical characteristics, air-dried samples were ground in an agate mortar with the help of a wooden hammer and passed through a 2-mm (10-mesh) sieve. The coarser materials were rejected and the sieved material was sampled by the standard `cone and quartering' method.

Characterisation of soil samples was performed by adopting methods prescribed under relevant parts of IS: 2720, "*Indian Standard* Methods of Test for Soils".

Results of Soil Analysis

The detailed analytical results of soil samples have been given in Appendix A5.16 and summarized in Table 5.29.

Table 5.29 Summary of Soil Test Result

Sr.	Parameters	Unit	Range of test results
1	pH		7.9 – 8.0
2	Type		Silty clay
3	Bulk density	gm/cm	1.2 – 1.28
4	Conductivity	μmhos/cm	390.5 – 371.6
5	Water holding capacity	% by mass	47.7 – 49.54
6	Organic matter	% by mass	1.08 – 1.16

(9) Land Use

The proposed project involves construction of 4 STPs and 2 SPS for which land acquisition is required. The area required for the proposed STP's are given in Table 5.30.

Table 5.30 Area Required for STPs and SPSs

Sr.	Location	Approximate Area (ha.)	Present Land Use	Reference Appendix
1.	Numaya Dahi STP	75.8	Agriculture	A5.23
2.	Ponghat STP	19.3	Uncultivated land	A5.24
3.	Kodara STP	12.1	Sand quarrying + Agriculture	A5.25
4.	Rajapur STP	25	Flood Plain	A5.26
5.	Ghaghar nala SPS	0.2	Waste land, within the natural channel of the nala.	A5.27
6.	Sasur Khaderi PS	0.56	Designated agricultural land, not being cultivated	A5.28
7.	Mumfordganj SPS	0.95	Designated agricultural land, not being cultivated	A5.29
8.	Effluent Channel from Numaya Dahi STP to outfall at Bisona	3.7	Agriculture	A5.30
9.	Morigate SPS	0.56	Defence land	-
Total		**138.17**		

Land area requirement for the proposed trunk sewers and rising mains is 9.12 ha. All of the area required for this purpose lies in the right of way of the existing PWD and Nagar Nigam roads.

(10) Noise Environment

Background noise levels were measured at different locations specially near the sites of existing and proposed STPs and pumping station, with the help of automatic sound level meter. The detailed results are given in Appendix A5.17 and summarized in Table 5.31. The monitoring stations are shown in Figure 5.14.

Table 5.31 Summary of Noise Level Monitored Data

Code No.	Location	Range of noise levels [Leq in dB(A)]		
		Day time	Night time	Average
N1	Numaya Dahi (dist B)	45.8	41.1	44.0
N2	Sulem Sarai (dist E)	56.3	48.4	53.4
N3	Near DM. Office (civil lines) (dist D)	72.4	54.5	65.7
	Permissible level	**55**	**45**	

Perusal of the above table shows that the noise levels at Numaya Dahi village are well within the permissible limits for both day and night time, where as the noise levels at Sulem Sarai and near DM office are higher than the desirable level for residential area but below the permissible level of commercial and industrial area, respectively.

5.4.3 Biological Environment

(1) Terrestrial Environment

1) Agriculture

The main harvests of the area are the Kharif (autumn), the Rabi (spring) and the Zaid (hot weather). The zaid harvest occupies an insignificant area as compared with Kharif and Rabi. Melons, vegetables and spices constitute the major crops of the zaid harvest.

Season wise principal chief crops of this area are given in Table 5.32.

Table 5.32 Season Wise Principal Chief Crops

Seasons	Crops
Kharif	Bajra (Pennisetum typhoides), Jowar (Sorghum vulgase), Maize (Zea mays)
Rabi	Wheat (Triticum aestivum), Barley (Hordeum vulgase), Gram (Cicer arietinum), Pea (Pisum sativum)

The other food crops, such as Arhar, Masur, Mung, Moth, Urad, Kodon, Mandua, Sawan, etc. Mustard, Castor and Tobacco are the main food crop also grown in this area. Sugarcane is an important Kharif cash crop.

Fruits and vegetable plantations also occupy a sizable area of the city and form an important proportion of the zaid crops. Mangoes, Guavas, Citrus fruits, Ber and Melons are the main fruits grown in and around the city area. Lobia (*vigna catjang*), Guar (*Cyamopsis tetragonoloba*), Mung (*Phaseolus radiatus*), Sanai (*Crotalaria juncea*) and Dhaincha (*sesbania cannabina*) are some of the major green manure crops sown in the sub urban area. Rotation of crops and mixed cultivation practice are also common features of local agricultural practice.

2) Flora

Because of its fertile soil, suitable topography and suitable climatic conditions, the main land use in the project area is agriculture. The deciduous forests, which covered the area long ago, were cleared up for colonization. However, under the social forestry schemes both sides of the roads have been covered by natural land vegetation like Albizia lebbeck, Ficus infectoria, Ficus glomerata, etc. In the heart of the city, the existence of natural growth of flora is almost nil. Trees like Peepal, Neem and Bargad can be seen sparsely. The main city still preserves a few old natural gardens/parks viz. Khusro Bagh, Azab Park, Elephant Park, etc. These parks are well covered with thick vegetation like Mangifera indica, Dalbergia sisoo, Ficus benghalenis, Ficus glomerata, Ficus religiosa, Tamarindus indica, Azadiracata indica, Psidium guajava, etc. A consolidated list of flora present in and around Allahabad city is given in Appendix A5.18.

Vegetational structure at the 4 proposed STP sites is as follows:

(i) Numaya Dahi:

The area is situated in rural locality. Towards Numaya & Dahi villages, a few trees are present. Among these Mango, Sisam, Neem etc. are predominant species. Within the site area about 10-20 trees of Mango, Neem, and Kikar species are present. The site view and the floral composition can be seen in photographs (presented later in this Chapter).

(ii) Rajapur STP:

The site is located adjacent to defense area at Rasoolabad. It is the open flood plain of Ganga river. There is no tree or any type of vegetation present in this land. Adjoining the proposed site of STP Pakar and Neem trees are present along nala near Mandir and Masjid, while near the defense area, the site is covered with Kikar (*Prosopis juliflora*). The actual view of the site is shown in photographs (presented later in this Chapter). Only two layers of vegetation can be seen in this area viz. trees and shrubs. The height of the trees is mostly in the range of 3-4 meters.

(iii) Ponghat and Kodara STP:

The proposed sites lie along the right bank of a branch of the Ganga river. Sulem Sarai area has rich vegetational growth in comparison to the main city. The flora mainly consists of Karanj, Aam, Eucalyptus, Kathal, Neem, Bargad, etc.

Diversity in plant species in almost every category such as tree, shrub, herb, grass can be seen along the highway and open places. Pipal and Neem trees are often found near temples and ponds. Plantations of orchards and groves of Mango, Guavas, Bananas and Mahua are common. The Allahabad guava is of national fame. Some old trees of Pipal Bargad, Imli and Mango, which exist even today, belong to the Sher Shah Suri period.

The most common shrubs are those of Babul (Acacia arabica), Ber (Ziziphus Jujuba), Kikar (Acacia nilotica) and Katira (sterculia urens). Some tall grasses like Munj (Saccharum munja) are seen growing for a long stretch along the roadside and wasteland and highway. The other grasses are Sarpat and Kans. Some of the herbs growing along the roadside and wasteland are Madar (*Calatropis procera*), dhatura (*Datura metal*), Croton (*Croton bonplandianum*), Duddhi (*Euphorbia hirta*), Latzeera (*Achyranthus aspera*), etc.

3) Fauna

In the Ganga-Yamuna Doab, rich diversity and density of avifauna is observed. The variety of avifauna can be easily seen in the ancient parks and along the banks of Ganga River and Yamuna River. Apart from the common birds, migratory birds such as Surkhab & Chaha can be recognized during the winter season (between November to February). The ideal location of these migratory birds is along the wide stretch of Ganga near Rasoolabad, as shown in photographs. A list of fauna in the urban and sub urban area is given in Appendix A5.19.

Animal Husbandry

The domestic animals of the area are of an inferior quality. Cattle, Buffalo, Sheep, Goats, Horses, Donkey and Pigs are the main domestic animals reared in the city area.

(2) Aquatic Environment

A study of the fast deteriorating aquatic ecosystem in Allahabad region is of great importance as rapid industrialization and the various religious Melas annually submits the waters to unusual pollution stress.

1) Hydrophytes

Most of the ponds which are not in regular use show luxuriant growth of Eichhornia, Trapa, Wolffia vallisneria, Nymphea, scirpus, Azolla, Salvinia, Lemna, Nelumbo, Hydrilla, etc. The aquatic plants are important in maintaining the balance of the ecosystem. A list of aquatic flora commonly found is presented in Appendix A5.20.

2) Fauna

Fishes and tortoise among the vertebrates are the most common species can be seen as aquatic fauna in these two rivers. A list of fishes available in this region is given in Appendix A5.21.

5.4.4 Socio-Cultural Environment

(1) Demography

As per the Census 2001 the total population of the city is 1.018 million. The male population constitutes 55.29% while the remaining is female. The sex ratio is 888 females for every 1000 males. It is thus evident that there is gross deficit of the female species. The Schedule Cast population constitutes 12.5% of total population. The population of people having less than 6 years of age in the city is 107211 (10.5% of total population). The Schedule Tribe population in the city is negligible (495). The details of population based on Census 2001 of Allahabad city are given in Table 5.33 and same is depicted in Figure 5.17.

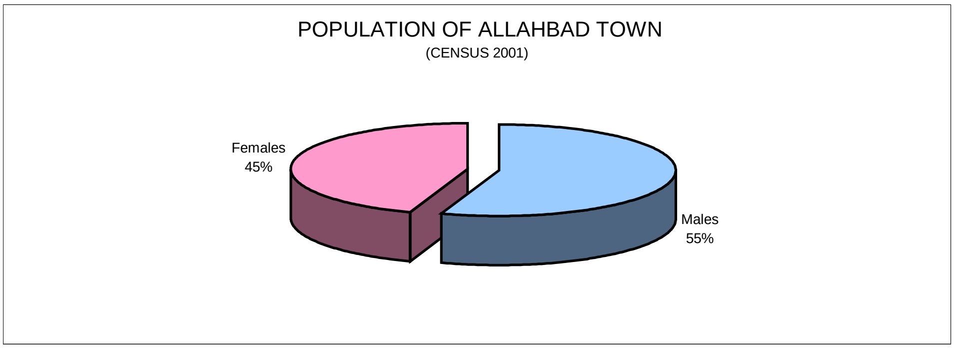
Table 5.33 Details of Population in Allahabad (As Per Census 2001)

Description	Persons
No. of households	157,829
Total population	1,018,092
Total Males	562,864
Total Females	455,228
Total population (age <06 years)	107,211
Total males (age <06 years)	56,415
Total females (age <06 years)	50,796
Total scheduled caste	127,459
Male scheduled caste	70,201

Description	Persons
Female scheduled caste	57,258
Total scheduled tribes	495
Male scheduled tribes	310
Female scheduled tribes	185

There are 157,829 households in the city, which suggest occupancy of 6.7 persons in each household. In other words the size of family in the city is on average 6 to 7.

There is consistent growth in total population of the district from 1,931 onwards. The growth rate as well is swelling every year. Majority of the population is Hindi speaking. Around 82% of population comprises of Hindu and 13% are Muslim.



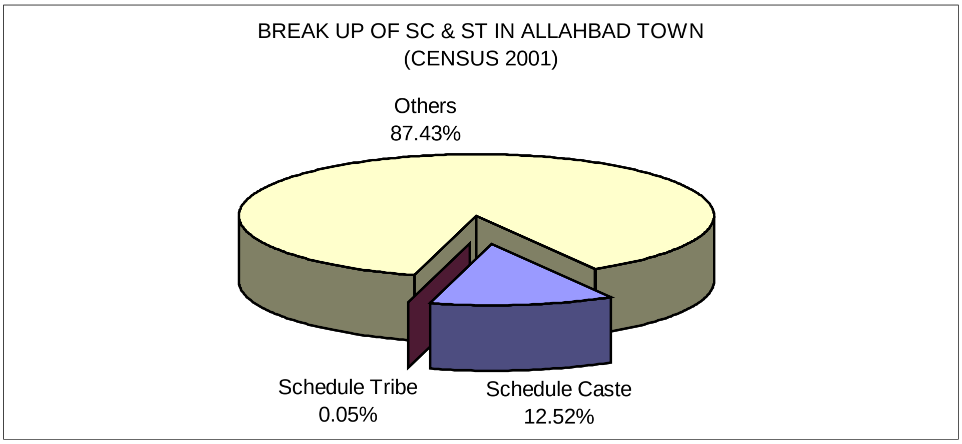
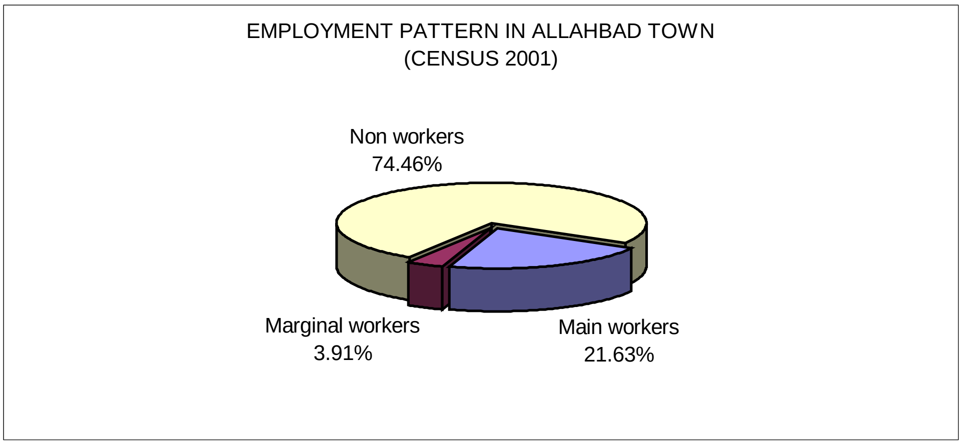


Figure 5.17 Population Details (1/2)



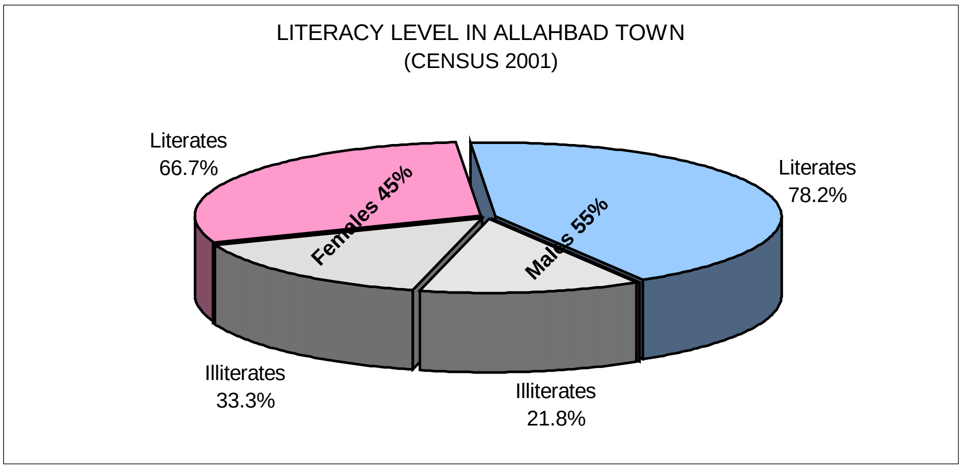


Figure 5.18 Population Details (2/2)

Data regarding literacy levels is given in Appendix A5.22.

5.4.5 Pollution

(1) Solid Waste

The city of Allahabad lacks a planned solid waste management system, or at least the implementation of such a system. Consequently, a vast amount of solid waste finds its way into the sewers and surface drains, chocking them. The solid waste packed in plastic bags was found in most of the existing sewers reviewed under the present study. These plastic bags are causing severe operational problems at all the existing Pumping Stations also, where they choke up the screens very fast.

Hence, for effective operation of the sewerage system proposed under the Master Plan, concurrent implementation of solid waste management system is an absolute must.

(2) Domestic Waste Waters

The lack of required infrastructure in Allahabad, for sewage collection and treatment has resulted in heavy pollution load on the Ganga River and Yamuna River.

The pollution load being exerted onto rivers, can be estimated as follows:

1) The discharge for the nalas in Allahabad as calculated by UP Jal Nigam (210 mld) in 1998 can be increased by 10% to assess the discharge (231 mld) in 2002. This factor is applied keeping in view the increase in population and increased commercial/industrial activities.

2) The quantity of sewage being treated in the existing Naini STP is deducted from the total quantity of sewage as calculated in step 1 above to estimate the pollution load of raw sewage of the city. The average values of BOD and SS as observed at the inlet of STP during last 3 years are taken into account as representative characteristics of raw sewage of the city because raw sewage from the major portion of the city comes to this point after proper equalization at Gaughat pumping station.

3) The average values of BOD and SS of treated sewage are used to calculate the pollution load being exerted by the treated sewage.

The results are presented in Table 5.34.

Table 5.34 Current Pollution Load from Allahabad

Category of Sewage	Discharge mld	BOD mg/l	SS mg/l	BOD Load t/day	SS Load t/day
Untreated	171	97.32	335.55	16.642	57.379
Treated	60	27.45	59.32	1.647	3.559
TOTAL	**231**			**18.3**	**60.9**

Source : CPCB

The estimated figures for wastewater generated in 2003, as reported in the CPCB report tally closely with the figures estimated in the M/P. As per the M/P, total wastewater generated in Allahabad works out to 226 mld. If this figure is taken for calculation of pollution load, and the BOD and SS figures as reported in the above table for treated and untreated wastewater are retained, the pollution load figures work out to 17.8 t/day in terms of BOD and 59.3 t/day in terms of SS.

Table 5.35 Current Pollution Load from Allahabad based on Discharge as Calculated in the M/P

Category of Sewage	Discharge mld	BOD mg/l	SS mg/l	BOD Load t/day	SS Load t/day
Untreated	166	97.32	335.55	16.16	55.7
Treated	60	27.45	59.32	1.64	3.56
TOTAL	**226**			**17.8**	**59.3**

5.5 IMPACT IDENTIFICATION – CONSTRUCTION AND OPERATION PHASE

5.5.1 General

The basic purpose of Environmental Impact Assessment (EIA) is its use as a planning tool so that the environmental considerations are incorporated in initial stages of project planning and the cost of environmental protection measures are treated as an integral component of the total project cost. The EIA is a procedure for bringing out the potential effects of development projects on environmental systems and it identifies the possible positive and negative impacts to the environment from the project. The EIA methodology involves superimposition of the expected impacts, from different activities forming part of the proposed project, over the baseline environmental status. This superimposition will enable the impacts on each of the parameters to be objectively assessed.

This Section identifies likely environmental impacts, both beneficial and adverse, of the proposed project components. General discussions and site-specific impacts that are predicted to be generated by major components of the project are also presented in this section. They are further summarized in tabular form together with the related mitigation measures presented later in this Chapter.

The impact of the proposed project may be grouped into two categories namely (1) construction phase impacts (2) operation phase impacts. The impacts during construction will be short lived while the impacts during operation phase would be long term. The impacts are positive as well as negative. However, positive impacts far outweigh the negative impacts, a majority of which are temporary and restricted to the construction phase. The great benefit of the system will be realized only after its commissioning.

(1) Environmental Parameters Likely to be Affected

The potential impacts resulting from the construction activities will be those common to large civil engineering projects and as stated above, are likely to be temporary. These impacts would affect the following environmental parameters:

1) Air quality
2) Noise and vibration,
3) Water environment
4) Land use
5) Land acquisition
6) Soil quality
7) Socio-Cultural environment
8) Ecology
9) Traffic
10) Public health

11) Worker's health

(2) Activities During the Construction Phase

During the construction phase, the following activities are likely to contribute significant environmental impacts:

- Site preparation (fencing, grading & clearing of site)
- Excavation (levelling of ground, digging of foundations, pilling, etc.)
- Construction of connecting roads; SPS, Sewage Treatment Plant and gravity sewers/rising mains, etc.
- Construction of campus, i.e., Temporary site office, maintenance workshops, facilities and other infrastructure to support all these activities and also workers camps
- Transportation and disposal of earth materials and construction spoils
- Soil compaction
- Employment of people

All these activities will have impact on environmental parameters as identified in the preceding section.

Several types of negative impacts upon environment may be caused during construction phase, primarily due to negligent practices. Appropriate techniques and responsible supervision is needed to avoid/ minimize/ mitigate these adverse impacts.

(3) Activities During Operation Phase

The major project activities which are likely to impact the environment when the project is operational are:

- Energy requirement
- Operation of DG sets in pumping stations
- Operation of pumps and related equipments in the pumping stations
- O&M of STPs
- Treated effluent discharge from the STPs
- Sludge disposal from the STPs

Figure 5.19 gives a visual representation of the parameters affecting the environment during construction/operation phase.

Phases	Construction Phase							Operation Phase					
Parameter	Site Preparation	Excavation	Construction	Constru. Camps	Transportation and Disposal of Earth	Soil Compaction	Employment of People	Energy Utilisation	DG Operation	Pump / Motor O&M	Treatment Plant O&M	Treated Effluent Disposal	Sludge Disposal
Air Quality	■	■	■		■	■			■	■	■		
Noise/Vibration	■	■	■		■	■		■	■	■	■		
Water Env.	■	■	■	■							■	■	
Land use	■	■	■	■	■		■					■	■
Land Acquisition			■										
Soil Quality	■	■	■	■	■	■						■	■
Socio-Cultural Env.			■	■			■	■			■	■	
Ecology	■		■									■	■
Traffic	■	■	■								■	■	
Public Health		■	■	■	■	■					■	■	■
Worker Health		■	■	■						■	■		■

Figure 5.19 Impact Identification Matrix

5.5.2 Impacts during the Construction Phase

(1) Positive Impacts of the Project during the Construction Phase

Positive impacts of the project will not be perceptible during the construction phase, when most of the impacts are usually adverse, though of short duration and temporary. The tremendous beneficial impacts of the project will be realised only in the operation phase of the Project.

The positive impact of the construction phase of the Project would be the potential for employment of local population during construction stage, and the associated increase in trade and business, which would have a positive impact on the economy and the population, as long as it lasts.

(2) Environmental Impacts

The project consists of four major types of activities:

- Upgradation / Rehabilitation measures for the existing sewers and Pumping Stations
- Construction of new sewers
- Construction of new Pumping Stations
- Construction of new STPs

The project components are discussed in detail in Chapters 1, 2, 3 and 4 of this report and are summarized in earlier part of this Chapter.

The construction activities for new works would consist of the usual earthworks, civil construction and E&M installation and commissioning. However, for the upgradation / rehabilitation of existing sewers, activities like temporary diversion of existing sewer lines into surface water drains will also have to be carried out.

The construction impacts are related to a considerable extent to the phasing of works. In general, the impacts are more intense during the first phase of works because the land use of the sites changes radically. Thereafter, when extension works are executed, some of the construction impacts affect the area again, but the nature of these impacts does not change.

The impacts of these construction stage activities on the various environmental parameters listed in the preceding section are examined hereafter.

(3) Air Quality

An increase in ambient SPM (Suspended Particulate Matters), carbon mono-oxide, hydrocarbons and NOx is likely during the construction phase due to:

- Vehicle exhausts from construction machinery and from light and heavy vehicles for transportation of pipes and construction material like cement, etc.
- Use of portable diesel generators and other fuel fired machinery.
- Emission from hot mix plant for road construction.

An increase in SPM is likely due to dust generated as a result of vehicular movement on unpaved roads and the concrete preparation units. Dust will also be generated during excavation operations.

Of all the project sites, two sites namely, Numaya Dahi STP site and Sasur Khaderi Pumping Station site, are located away from the urban area. Other sites are located near or within the urban areas and hence, the impact on air quality in these latter sites is of greater concern. However, as stated earlier, these impacts are of temporary nature, lasting only for the construction period.

Secondary impacts of rise in air pollution, in general, would be observed on the flora at Numaya Dahi site. Agricultural production may be affected to a minor extent due to dust deposition and gaseous emissions. Another secondary impact due to rise in dust levels will be on the health of workers which may lead to a tertiary impact on the economic output of the labour force.

(4) Noise Quality

Noise levels in the vicinity of any construction activity rise due to plying of transport vehicles and use of portable generators, mechanical machinery such as cranes, riveting machines, hammering etc. These activities will occur round the clock and the noise pollution thus created may affect human habitations, particularly during the nighttime.

The magnitude of rise in noise levels will be greater at Numaya Dahi STP and Sasur Khaderi SPS sites. However, as there is no habitation within 500 m of the proposed sites, the natural attenuation of noise levels will take place in the ambient environment and not cause any major impact on the nearest villages. As regards the other sites, viz. sites for Rajapur, Ponghat and Kodara STPs and site for Ghaghar Nala SPS, these are in close vicinity of inhabited areas. Again, of these sites, the STP sites are along the riverbank. Hence, the anticipated impact will be localized, only towards the southern & eastern boundaries.

The increase in noise levels will thus be a major concern at the Ghaghar Nala SPS site, which is located in the urbanized area of the city and close to habitation. The primary impact of noise level would be mainly on workers operating high noise generating machines if appropriate control measures are not adopted. Increase of noise level at night may produce disturbances, causing sleeplessness in people in the vicinity of the site in case construction activity is extended into the night hours.

Various site preparation and construction activities will generate increased noise levels due to operation of mechanical equipment. Construction activities are expected to produce noise levels in the range of 80–95 dB(A). Table 5.36 presents international standards for noise from different construction equipment.

Table 5.36 International Standards for Noise of Construction Equipment

Equipment	**Noise level dB(A) at 2 m**	**Equipment**	**Noise level dB(A) at 2 m**
Air compressor	74 – 87	Front end loader	72 – 84
Backhole	72 – 93	Grader	80 – 93
Bulldozer	80	Jack hammer	81 – 98
Concrete mixer	74 – 88	Paver	86 – 88
Concrete pump	81 – 84	Roller	73 – 75
Concrete vibrator	76	Craper	80 – 93
Crane	75 – 77	Tamper	74 – 77
Crane with ball	75 – 87	Welding generator	71 – 82
Dump truck	72 – 84		

The construction equipment such as jack hammers, excavators, pay loaders, generators and concrete mixers will have noise levels above working environmental limits. Workers operating these machines may be affected if equivalent 8 hour exposure is more than the prescribed safety limits. Exposures to impulses of impact noise should not exceed 140 dB(A) and peak acoustic pressure. Exposure to 10,000 impulses of 120 dB(A) is permissible per day.

Noise likely to be generated near the construction site will be in the range of 90 – 105 dB(A) when all equipment are working together and simultaneously. This seems to be a remote possibility. Hence, the noise levels are likely to be between 80 dB(A) and 90 dB(A) in an 8 hour shift.

(5) Water Environment

1) Resource

- The natural existing drainage pattern at the project sites may change due to a change in the existing profile and slope of the land.
- Substantial amount of water would be required at the time of construction for water tightness tests, curing of concrete, flushing and washing of pipes, etc. This will affect the local communities if the urban water supply sources are used for these purposes.

2) Quality

The natural water bodies / drainage channels of the project area are likely to be affected in the following ways:

- By wastewater from construction activities – This would mostly contain suspended impurities. Other pollutants, which may find their way to it, are likely to be in insignificant concentrations and may be safely disregarded.
- Due to wastewater disposal from the workers camp and sullage generated from construction sites.

If adequate arrangements are not made to ensure proper drainage of wastewater from the construction sites, such waters may form stagnant pools, which might promote breeding of mosquitoes and create generally unsanitary conditions.

- Due to the diversion of sewer lines during the desilting / rehabilitation / replacement works to be carried out for the existing sewers.

However, as these nalas carry considerable raw sewage as on date, the relative increase would not be alarming, provided rehabilitation is taken up in stages, is well planned and there are no time over-runs during construction.

The above wastes are likely to be discharged to the nearby surface drains and would hence temporarily increase the pollution load of these drains / nalas.

(6) Land Use Profile

Acquisition of land is involved for the construction of all new works under the project and for expansion of the existing Mumfordganj and Morigate pumping stations. Site-specific discussion is presented herein:

- For Numaya Dahi STP the land proposed to be procured, lies amongst agricultural fields and is currently being cultivated. Hence, the land use for this site will change from agriculture (productive) to commercial (less productive).
- The land within the sites earmarked for Ponghat and Kodara STPs is designated as agricultural land. However, the land is not being cultivated at present.

- The land identified for the Rajapur STP lies between two water channels, which are sub-branches of the southern branch of the Ganga, and is very low lying (R.L. between 78.00 and 80.00). This land is a part of the stretch where migratory birds like Surkhab and Chaha are found during the winter season (November to February).
- The land identified for Sasur Khaderi PS is also designated agricultural land. However, it is not being cultivated at present. Construction of the PS will change the land use from agricultural (productive) to Commercial (Less productive).
- The land area to be acquired for Ghaghar Nala PS lies within the channel way of the Ghaghar Nala. Hence, non-usable land is being reclaimed for commercial use.
- The land area for Morigate PS belongs to the Defense Ministry, Government of India. It is not being used for any purpose at present.

(7) Land Acquisition

Land is to be acquired for the following project components:

- 4 STPs at Numaya Dahi, Rajapur, Kodara & Ponghat
- 2 new SPS at Ghaghar Nala & Sasur Khaderi Sites
- Expansion of existing Morigate and Mumfordganj SPS

Area requirements are summarized in Table 5.30.

Revenue (Khasra) maps for the above sites were obtained and respective Patwaries (revenue officer) were requested to mark the project sites on these maps. The resettlement is avoided by selecting appropriate sites without displacement of villages and sites for the STPs and SPSs will be acquired in agricultural, un-cultivated land, flood plain and san quarrying.

	Land use	**Name of village**	**No. of land owners affected**
Numaya Dahi	Agricultural land	Sayyedapur	64
		Numaya	25
		Dahi	4
		Korendha	35
Rajapur	Flood plain	Mohendori Kacchar	22
Kodara	Sand quarrying + agriculture	Manoharpur	19
Ponghat	Uncultivated land	Kashipur	66
Ghaghar Nala	Waste land, within the natural channel of the nala	Sadiyapur	3
Sasur Khaderi	Agricultural land, not being cultivated	Bajupur	2
Mumfordganj	Designated agricultural land, not being cultivated	Beli Upparhar	6

These maps have been digitized and are presented in Figure 5.20 to 5.26 as per the following details:

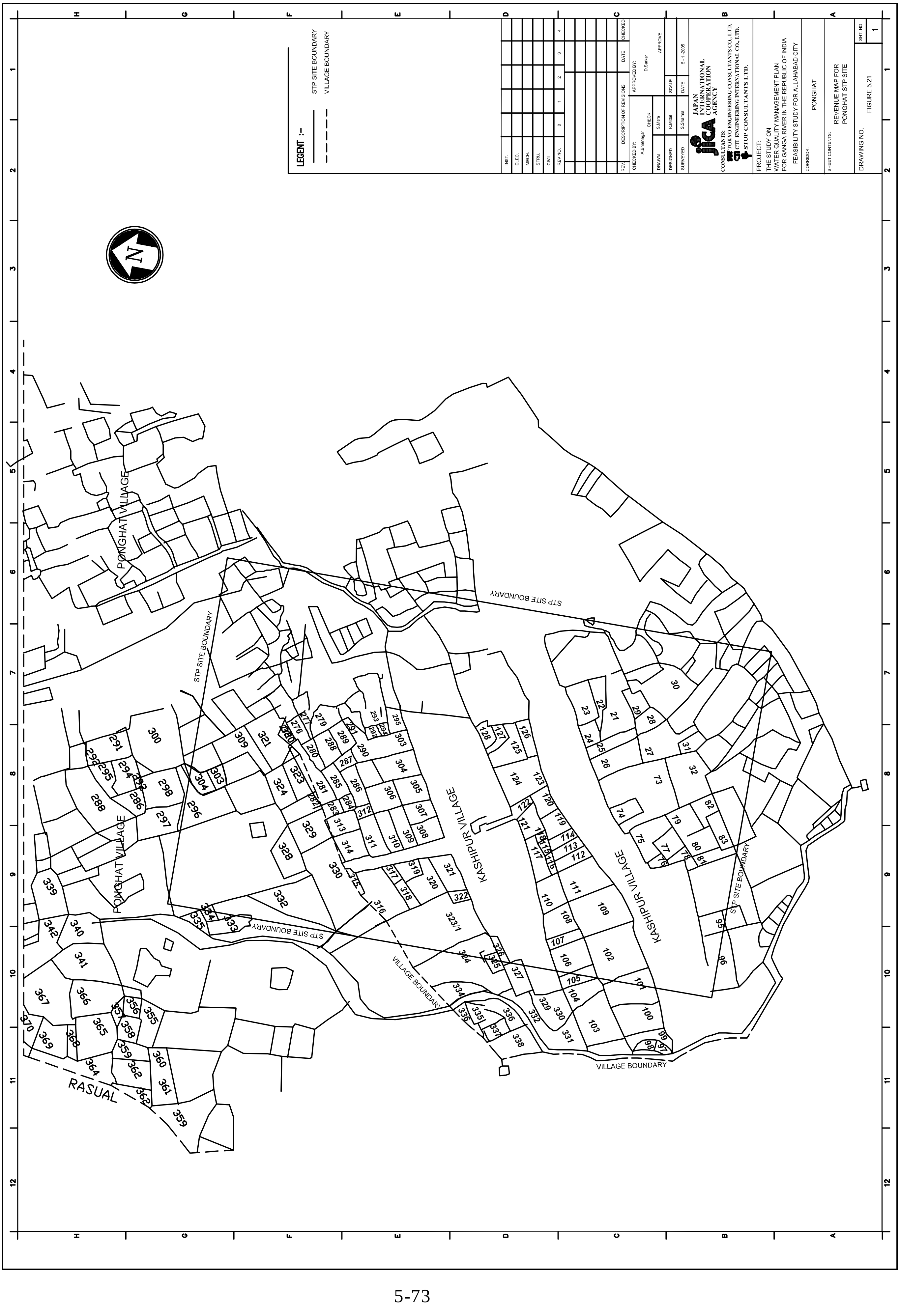
- Figure 5.20 - For Numaya Dahi STP
- Figure 5.21 - For Ponghat STP
- Figure 5.22 - For Kodara STP
- Figure 5.23 - For Rajapur STP
- Figure 5.24 - For Ghaghar Nala SPS
- Figure 5.25 - For Sasur Khaderi SPS
- Figure 5.26 - For Mumforganj SPS

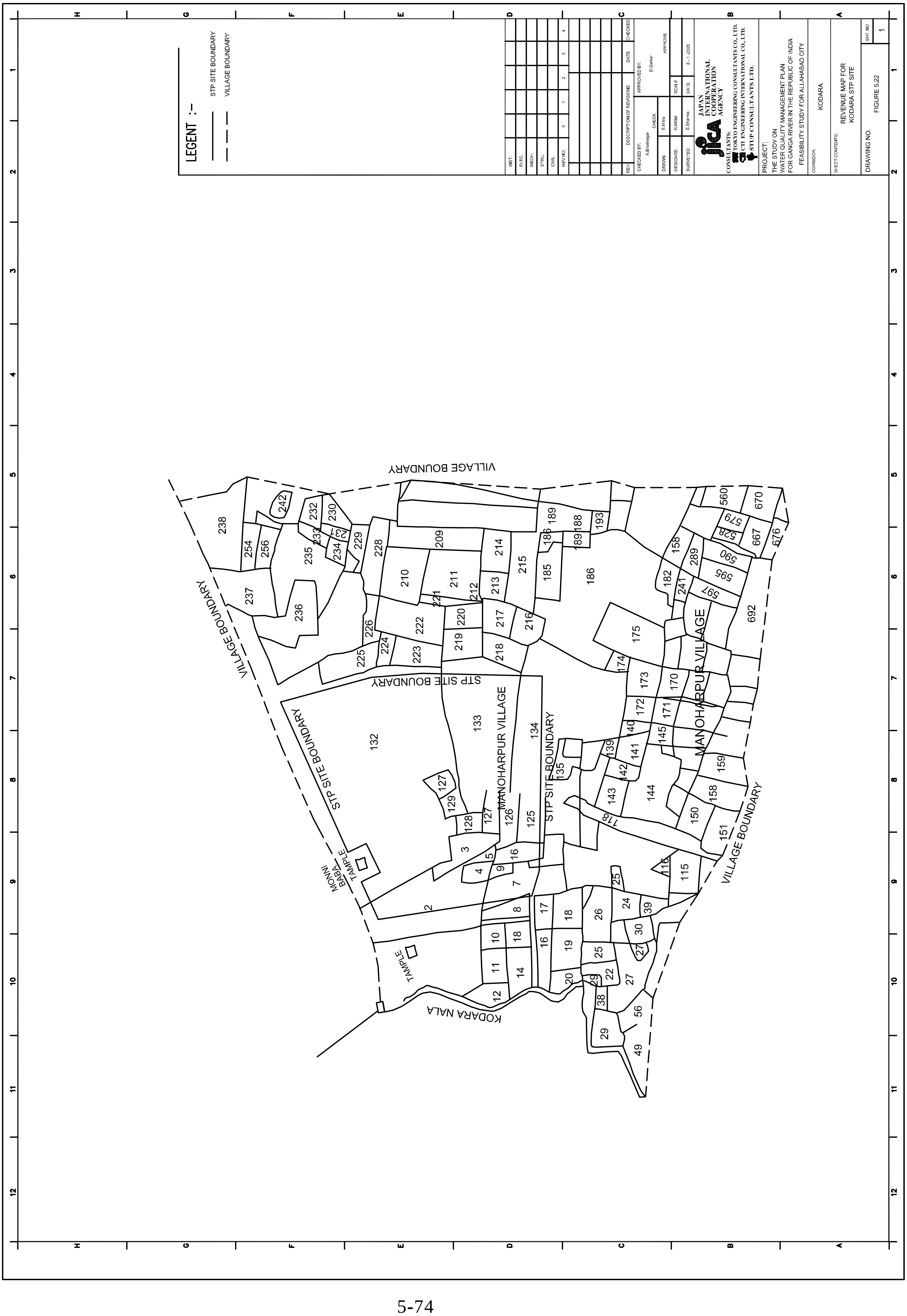
A list of the people whose land would have to be acquired is presented in Appendix A5.23 to 5.30 as per the following details:

- Appendix A5.23 - For Numaya Dahi STP
- Appendix A5.24 - For Ponghat STP
- Appendix A5.25 - For Kodara STP
- Appendix A5.26 - For Rajapur STP
- Appendix A5.27 - For Ghaghar Nala SPS
- Appendix A5.28 - For Sasur Khaderi SPS
- Appendix A5.29 - For Mumforganj SPS
- Appendix A5.30 - For treated effluent channel from Numaya Dahi STP to Yamuna

Land acquisition costs have been included in project implementation costs.


LEGENT :-
STP SITE BOUNDARY
VILLAGE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
CONSULTANTS:
TOKYO ENGINEERING CONSULTANTS CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
STUP CONSULTANTS LTD.
PROJECT:
THE STUDY ON
WATER QUALITY MANAGEMENT PLAN
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
CORRIDOR:
NUMAYA DAHI
SHEET CONTENTS:
REVENUE MAP FOR
NUMAYA DAHI STP SITE
DRAWING NO.
FIGURE 5.20
TO ALLAHABAD
TO BISONA
SAYYEDPUR VILLAGE
KARENDHA VILLAGE
NUMAYA VILLAGE
DAHI VILLAGE
VILLAGE BOUNDARY


LEGENT :-
STP SITE BOUNDARY
VILLAGE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
PONGHAT
REVENUE MAP FOR PONGHAT STP SITE
FIGURE 5.21
PONGHAT VILLAGE
KASHIPUR VILLAGE
STP SITE BOUNDARY
VILLAGE BOUNDARY
RASUAL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STP SITE BOUNDARY
VILLAGE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
CONSULTANTS:
TOKYO ENGINEERING CONSULTANTS CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
STUP CONSULTANTS LTD.
PROJECT:
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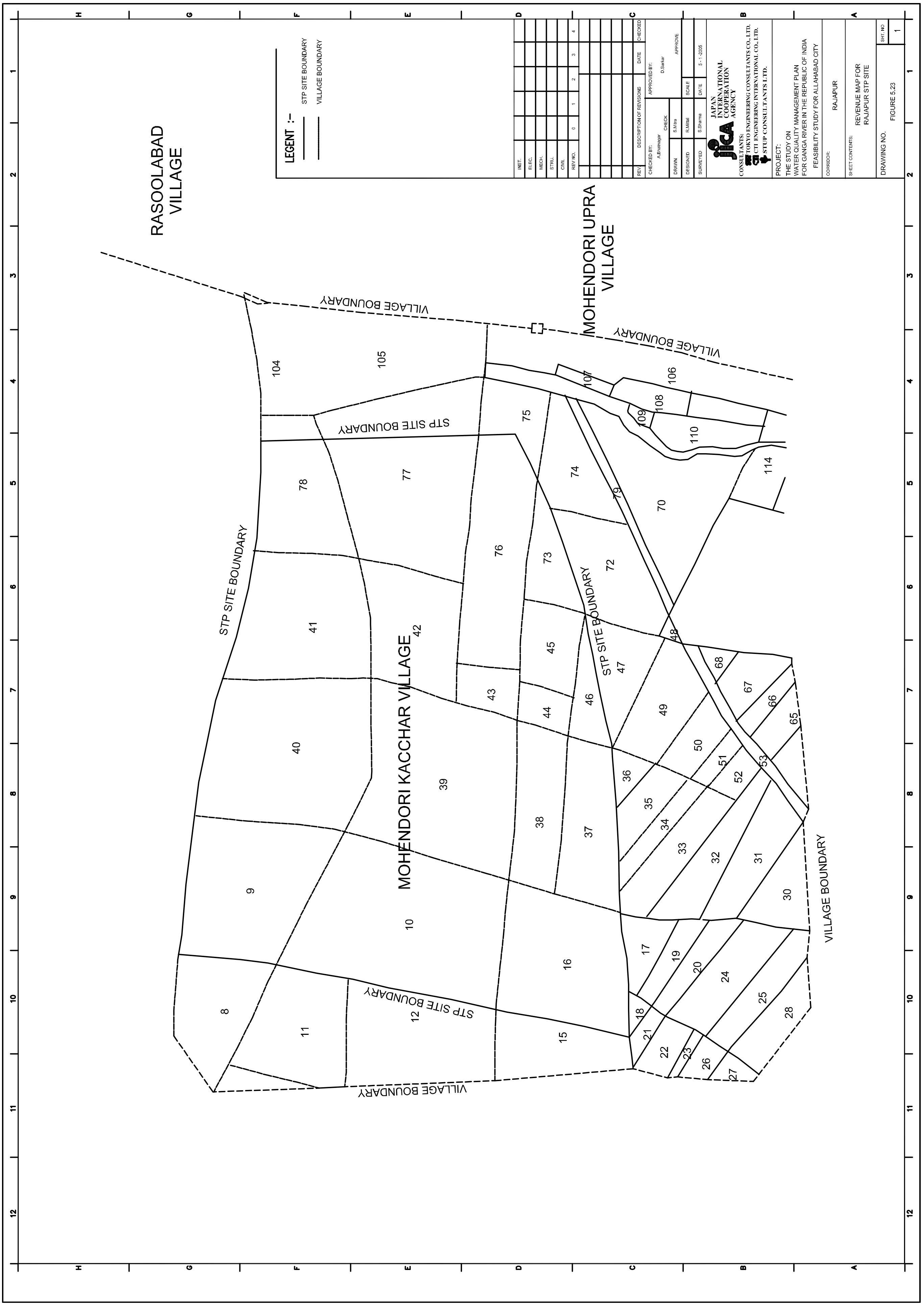
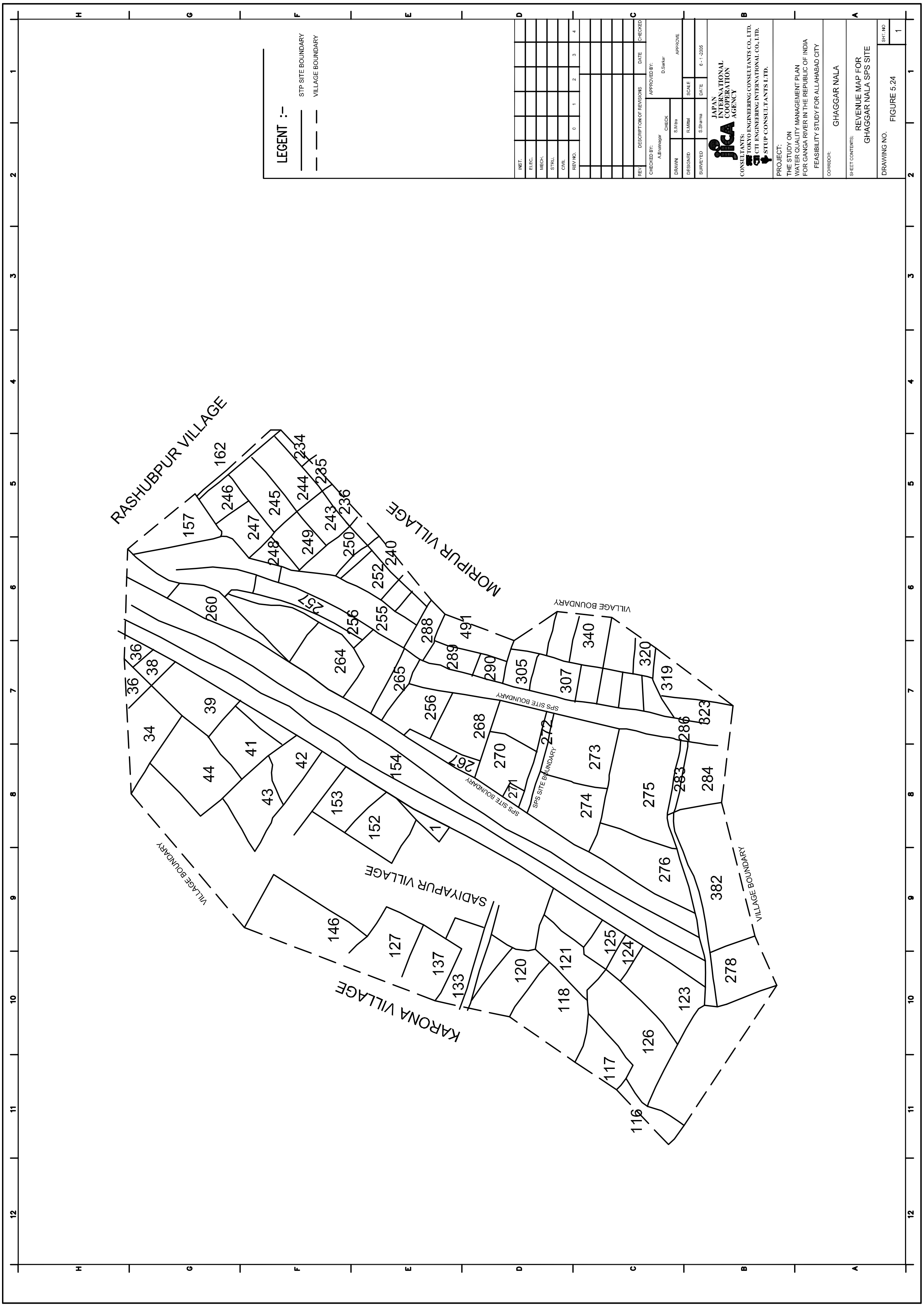
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
CORRIDOR:
KODARA
SHEET CONTENTS:
REVENUE MAP FOR
KODARA STP SITE
DRAWING NO.
FIGURE 5.22
SHT. NO
1
VILLAGE BOUNDARY
STP SITE BOUNDARY
MANOHARPUR VILLAGE
MONNI BABA TAMPLE
TAMPLE
KODARA NALA


RASOOLABAD VILLAGE
MOHENDORI UPRA VILLAGE
MOHENDORI KACCHAR VILLAGE
VILLAGE BOUNDARY
STP SITE BOUNDARY
LEGENT :-
STP SITE BOUNDARY
VILLAGE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
PROJECT:
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
RAJAPUR
REVENUE MAP FOR RAJAPUR STP SITE
DRAWING NO.
FIGURE 5.23


LEGENT :-
STP SITE BOUNDARY
VILLAGE BOUNDARY
RASHUBPUR VILLAGE
MORIPUR VILLAGE
SADIYAPUR VILLAGE
KARONA VILLAGE
SPS SITE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
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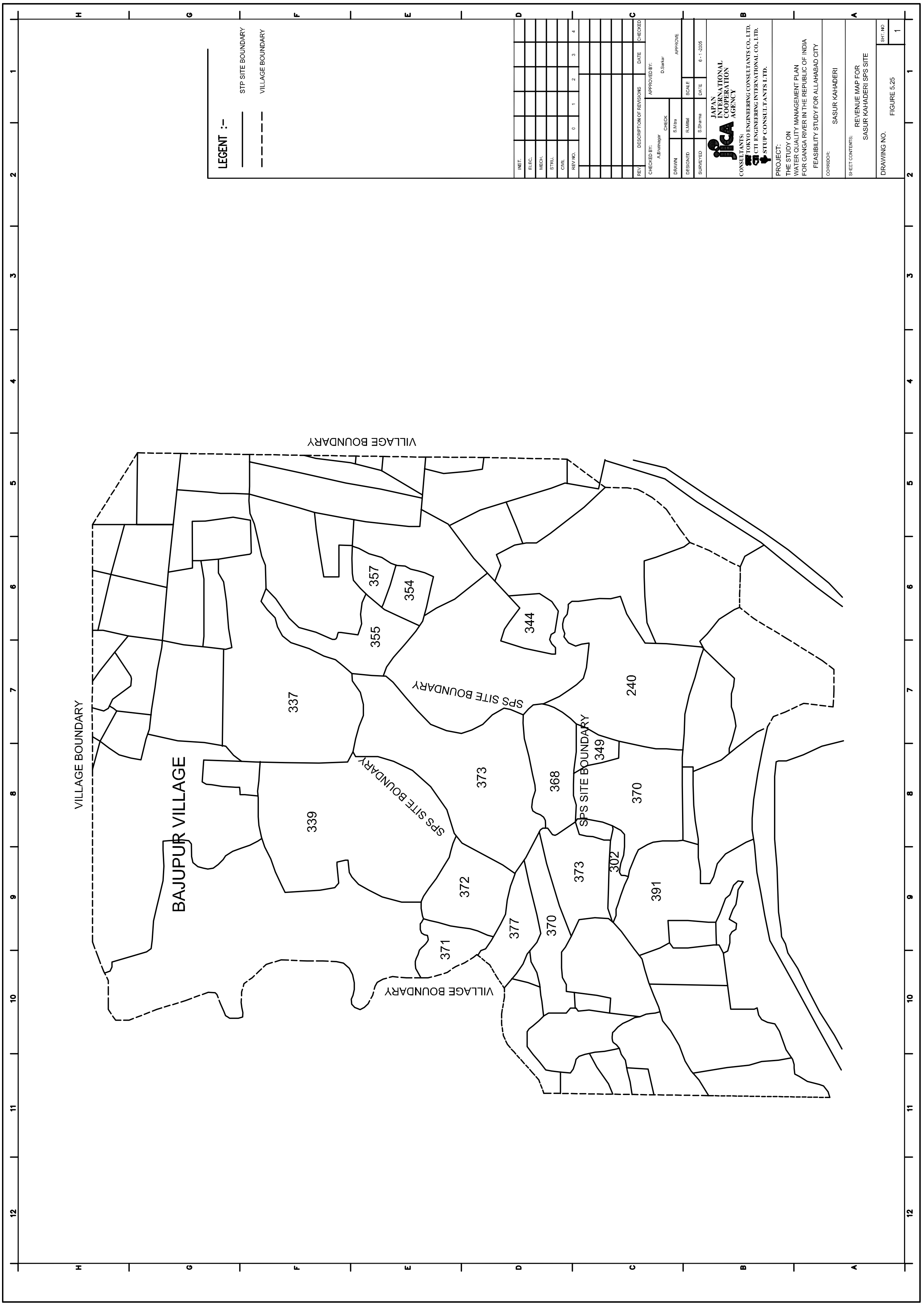
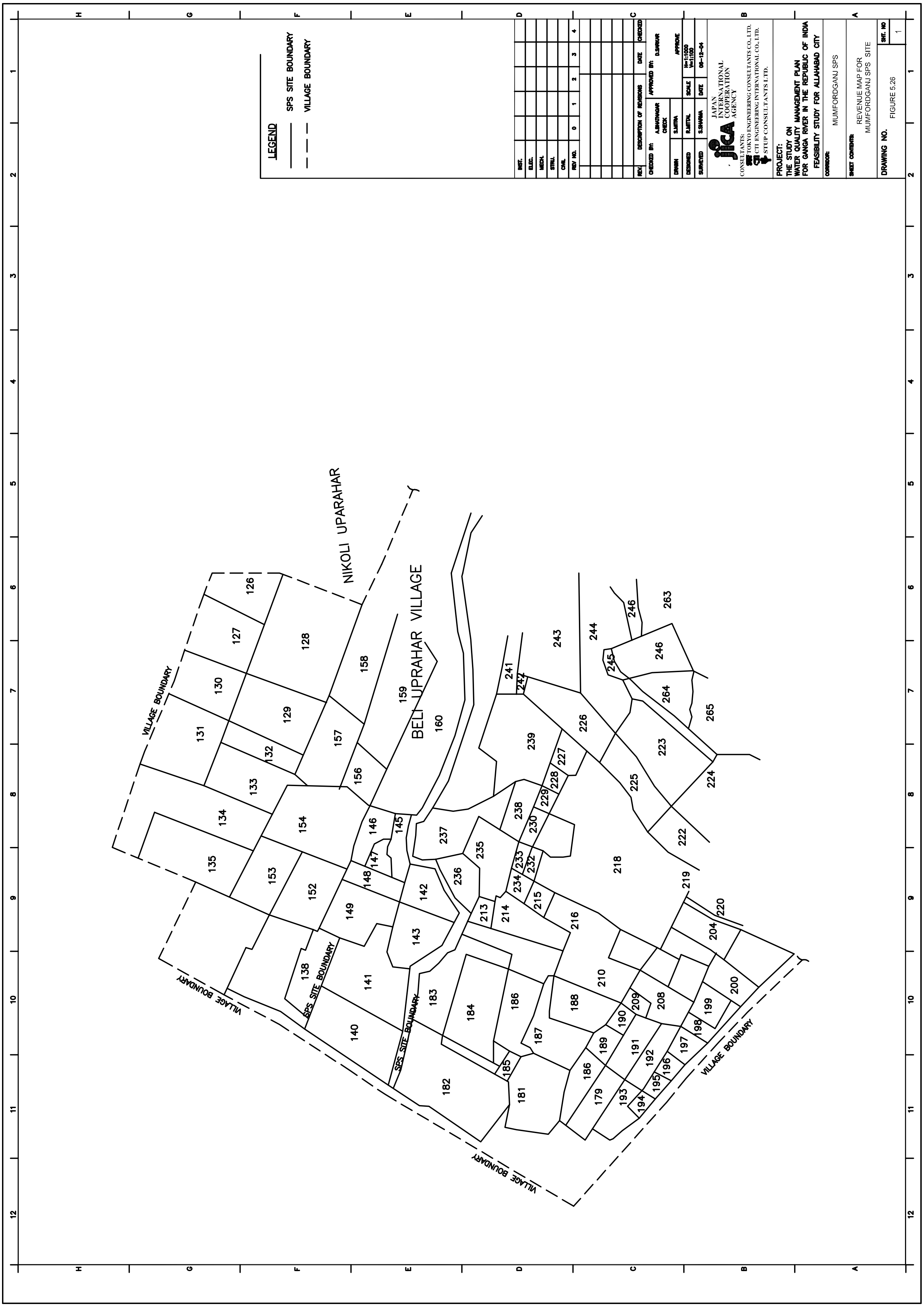
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
GHAGGAR NALA
REVENUE MAP FOR
GHAGGAR NALA SPS SITE
DRAWING NO.
FIGURE 5.24


LEGENT :-
STP SITE BOUNDARY
VILLAGE BOUNDARY
INST.
ELEC.
MECH.
STRU.
CIVIL
REV NO.
0
1
2
3
4
REV.
DESCRIPTION OF REVISIONS
DATE
CHECKED
CHECKED BY:
A.Bhatnagar
CHECK
APPROVED BY:
D.Sarkar
APPROVE
DRAWN
S.Mitra
DESIGNED
R.Mittal
SCALE
SURVEYED
S.Sharma
DATE
6 - 1 -2005
JAPAN INTERNATIONAL COOPERATION AGENCY
CONSULTANTS:
TOKYO ENGINEERING CONSULTANTS CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
STUP CONSULTANTS LTD.
PROJECT:
THE STUDY ON
WATER QUALITY MANAGEMENT PLAN
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
CORRIDOR:
SASUR KAHADERI
SHEET CONTENTS:
REVENUE MAP FOR
SASUR KAHADERI SPS SITE
DRAWING NO.
FIGURE 5.25
SHT. NO
1
VILLAGE BOUNDARY
BAJUPUR VILLAGE
SPS SITE BOUNDARY
357
354
355
344
337
240
349
373
368
370
339
372
302
391
371
377


LEGEND
SPS SITE BOUNDARY
VILLAGE BOUNDARY
NIKOLI UPARAHAR
BELI UPRAHAR VILLAGE
VILLAGE BOUNDARY
SPS SITE BOUNDARY
JAPAN INTERNATIONAL COOPERATION AGENCY
PROJECT:
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR ALLAHABAD CITY
MUMFORDGANJ SPS
REVENUE MAP FOR MUMFORDGANJ SPS SITE
DRAWING NO.
FIGURE 5.26

(8) Soil Quality

During laying the sewers and construction of STPs / PS, top soil will be displaced and permanent loss of top soil may occur if it is not stored and replaced. The excavated material needs to be disposed of in low lying areas and top soil should be preserved to avoid permanent loss of top soil. Once excavation is completed and overburden is disposed of in an environmentally safe manner, the soil quality will get restored. The impact will be of temporary duration. Soil compaction along the trenches where sewer lines are laid should be carefully done in order to avoid future settlement. Excavation should be avoided during rainy season in order to avoid landslides resulting in house collapse.

Digging and backfilling of trench for laying sewer lines may render topsoil loose. Soils of the construction area may be contaminated by wastewaters. This contamination will be due to:

- Through alteration of chemical make-up of the soils, increased acidity/alkalinity
- Pressure of pathogens and other organic material in the excavated material

These impacts will be minor and limited to the construction phase only. No major impact on soil quality is anticipated.

(9) Socio-cultural Environment

The proposed sites for construction of project works do not have any national monuments / national parks / reserve forests.
The only exception is the Kodara STP site where a small temple of local significance (Mouni Baba Temple) and an adjacent well lie near the proposed STP site. This aspect has been studied and carefully considered while designing the layout of the STP. The boundary of the STP has been drawn up such that the temple and the well lie outside the proposed STP campus. Additionally, the site boundary has been pushed back from the ridge line to provide adequate walking access to the temple.

The land identified for the Rajapur STP is a part of the stretch where migratory birds like Surkhab and Chaha are found during the winter season (November to February).

The construction activity will provide employment opportunities to the local population. After completion of the construction work, the temporary residences of labours may not be demolished and squatter colonies may spring up.

(10) Ecology

None of the project sites involve any forestland / ecologically sensitive areas. Thus, there will be no significant impact on the ecology of the area. A few trees of locally common species exist at Numaya Dahi and Kodara STP sites. However, their loss will not be significant, as provision has been made for an 8m wide green belt along all STP boundaries.

(11) Traffic

The traffic will have to be diverted during sewer laying, as much of the roads will be occupied for sewerage work. Traffic congestion will be experienced on the roads connected to the sewerage sites. The impact will be temporary and of short duration.

(12) Public Health

During sewer laying, any accumulated water due to rains will be pumped out of the trench and will flow into the surrounding area, forming stagnant water pools that might lead to breeding of mosquitoes, a cause for malaria and other diseases etc. The stagnant pools may also be formed due to flow of wastewater from temporary labour colonies. Considerable amount of solid wastes, packing material, etc. are likely to be generated at the construction sites. These need to be disposed off at the earliest otherwise they may aggravate the already unsatisfactory situation of solid waste disposal in the city. The dust generated in the atmosphere may give discomfort to respiration systems of the labourers and the nearby residents, especially those with respiratory disorders. Thus public health may be adversely affected, but the impact will not be serious and will be of a temporary nature.

5.5.3 Impacts during the Operation Phase

(1) General

The operation phase of the Sewerage Project will include collection of sewage from individual service connections and its conveyance through branch and trunk sewers to sewage treatment plants. It also includes the operation of sewage treatment plants and sewage pumping stations. The predicted impacts of these activities are discussed below.

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, pumping and sewerage conveyance system 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 adequate sewer cleaning and evacuating machines
- Provision of generator sets at pumping stations
- Provision of diesel for the generator sets
- All spare parts should be readily available in case of emergency
- Provision of standby units of pumps at each station
- Provision of adequate maintenance staff with accessories
- Regular training of system staff, skilled technicians and craftsman
- Proper operating budgets and attractive salaries

Having gone through the measurement and assessment of all parameters that may affect the environment, the possible impacts as could be predictably assessed are summarized in subsequent paragraphs.

(2) Beneficial Impacts of the Project during the Operation Phase

Concurrent implementation of the project for construction of branch and lateral sewers is necessary for full beneficial impacts of the project to be realised. This measure will reduce the flow of domestic waste into the open drains.

The rehabilitation and extension of sewerage and the treatment of all the sewage /produced in the city will improve the quality of life and the life style of the people. Better sanitation facilities mean better health conditions, and a cleaner environment. The risk of contagious diseases can be minimised and to an extent even mitigated. Sewering the city would reduce the chances of contamination of the groundwater and the water supply pipelines leading also to reduced incidence of diseases, improved health, and economic well being of the community.

Perhaps the most significant benefit would be an improvement in the water quality of the Ganga and Yamuna. At present, out of the estimated 226 mld wastewater being generated in the city only 60 mld (i.e. 26%) is being treated in the lone STP located at Naini. The quality of underground water of the city would also be benefited due to reduced pollution loads in the unlined Nalas.

Also, as the discharge of sewage wastewater into the nalas stops, the overall aesthetics of the city will improve which will have a positive impact on the economics of tourism industry.

Presently, in the semi-urban areas of Allahabad, untreated sewage flowing in the Nalas is used for irrigation. Sewering the city will first eliminate any wastewater flow in these nalas with consequent stoppage of use of untreated wastewater for growing crops in the area.

The treated wastewater from Numaya Dahi and Ponghat STPs has the potential to be used for irrigation after all the required discharge parameters are met. The treated wastewater reuse would provide an additional water source, which would be continuous throughout the year. This would enable farmers in the area to cultivate their land, which presently depends on monsoon for irrigation, for more than one crop. This however, needs a detailed study including the types of crops that can be grown and also the soil characteristics and water retaining capacities etc., to prevent formation of sink holes or other problems linked with treated sewage recycling. This reuse potential of wastewater in the area would trigger an all round increase in developmental activities with considerable impact on the life style of the population.

In sum, the overall impact of the project on the socio-economic environment is expected to be beneficial and positive.

(3) Environmental Impacts (Operation Phase)

Air Quality

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 smells may be present but to a lesser extent. However, the impact will be higher where the plant is very near to residential areas such as at the Kodara STP site. To mitigate this, the width of peripheral green belt at Kodara STP site has been increased to 15 m. Some possible deterioration in air quality is also likely from operation of DG sets. All required pollution prevention measures should be considered and implemented.

Noise Quality

Present noise levels near the proposed STP sites are generally within the desirable limits fixed by CPCB. The major source of noise is mainly vehicular activity. During the project operation period some rise in noise levels is possible due to operation of pumps / motors and Diesel Generating Sets. However, the impact is not foreseen to be significant at STP sites especially the Numaya Dahi and Ponghat sites as these STPs are based on Waste Stabilization Ponds (WSP) Technology, which involves very little E&M works. The noise levels at the other STP sites may be a little higher. However, sufficient attenuation would be achieved by providing a green curtain all around the STP campus.

Water Environment

The water resources in the project area would arguably be the biggest beneficiaries of the sanitation project.

The surface water drains would get cleaned up greatly improving the living conditions of the residents. This would also reduce the pollution load passing down into the underground water reserves.

As described earlier (Section 5.4.5 of this Chapter), the total pollution load from Allahabad on the Ganga and Yamuna in 2003, calculated on the basis of the estimated figures of 226 mld wastewater generation and 60 mld wastewater being treated, works out to 17.8 t/day of BOD and 59.3 t/day of SS. On implementation of this project, the entire wastewater generated would be treated. The effluent characteristics for all the new Sewage Treatment Plants have been fixed as BOD = 30 mg/l and SS = 50 mg/l. When these are achieved, the pollution load will reduce as shown in the Table below:

Table 5.37 Future Pollution Load from Allahabad

Category of Sewage	**Discharge mld**	**BOD mg/l**	**SS mg/l**	**BOD Load t/day**	**SS Load t/day**
New STPs	166.00	30	50	4.98	8.30
Naini STP	60.00	27.45	59.32	1.64	3.56
TOTAL	220.00			6.62	11.86

Hence, the pollution reduction achieved would be 63% in terms of BOD and 80% in terms of SS. The wastewater discharge values are unaltered to aid comparison.

Of the four STPs proposed in this project, two (Numaya Dahi and Ponghat) are based on the WSP technique. The untreated sewage retained in these ponds can seep underground and pollute the underground water reserves. Adequate precaution for this has been considered by providing an impermeable lining along the base and sides of all ponds.

- Treated Effluent Reuse and Disposal

(i) The effluent from the existing Naini STP does not meet the discharge standards with reference to the *Faecal Coli.* Hence, chlorination is proposed for disinfection of the effluent, a part of which is used for irrigation at present.

(ii) The three possible alternatives for effluent disposal from Numaya Dahi STP are discussed later in this Chapter. For the preferred option, the treated effluent from the Numaya Dahi STP is to be disposed into Yamuna River. The disposal point is upstream of the Karelibagh raw water intake, which draws 80 mld water from Yamuna River for supply to the Allahabad city. Hence, for design of this STP, WSP Technology, which is a low environmental risk technology, has been chosen. Moreover, the effluent will be conveyed to Bisona village via a 3.7 km long channel. The disposal point will thus be approx. 25 km upstream of the Karelibagh water intake and there would be sufficient time for dilution / absorption of this effluent in the river water.

The *Faecal Coli* level in the effluent has been designed to be less than 10,000 MPN / 100 ml and the effluent channel has been routed through agricultural fields, so that the treated wastewaters can be used for irrigation of the nearby fields.

(iii) **Ponghat STP** – Treated effluent from Ponghat STP will be discharged back into the Nala, downstream of the tapping point. This STP will also be based on the WSP technology and thus the effluent will be suitable for re-use as irrigation water in the fields adjoining the STP site.

Raw sewage flowing in the Ponghat Nala is at present used to irrigate the surrounding fields. The usual method adopted by the farmers for irrigation is by ponding the sewage, blocking the nala flow, and drawing the sewage by means of buckets.

Discharge of treated effluent into the nala will thus give a three-fold benefit:

- Farmers will get continuous and assured flow of safe irrigation water for their fields
- The health of farmers will be benefited as they will not come in direct contact with raw sewage
- Public health will improve due to stoppage of the unhealthy practice of irrigating crops with polluted wastewater

(iv) **Rajapur STP** – Treated effluent from the Rajapur STP will be discharged back to the Rajapur Nala, substantially reducing the pollution load on the downstream Rasoolabad Ghat.

(v) **Kodara STP** – Treated effluent from this STP will be discharged into the Ganga channel, which is receiving untreated sewage from the Kodara & Nehru Nalas at present. Hence, the pollution load on this stream and ultimately in the Ganga will come down.

(4) Sludge Disposal

Sludge disposal requirements will be minimum from the two STPs based on WSP technology viz. Numaya Dahi & Ponghat STPs as the anaerobic ponds are designed for desludging once in a year and the facultative and maturation ponds once in five years.

Digested and stabilized sludge from the Rajapur and Kodara STPs can be used as manure and sold as such to farmers. The scope for such practice exists, as there are large cultivated areas in the suburban areas.

On average, the sludge production will be to the tune of 120 kg/day from the Rajapur and Kodara Sewage Treatment Plants. It will be dried on the sludge drying beds. During the drying process, there will be a nuisance of insects around the sludge drying beds. It can be minimised by spraying insecticides in the area, also by proper maintenance of sludge drying beds, and proper drainage. The wet sludge should be raked often and the dried sludge removed frequently.

The dried sludge can be given or sold to farmers as manure if it can be handled properly by them. The value of sludge as an organic fertiliser has long been recognised and this offers reduced fertiliser cost to the farmer. Monitoring of the quality of the sludge is however required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials. Movement of sludge tankers from sewage treatment to agricultural land can create traffic problems and give rise to noise and odour nuisance. Mode of transport should be appropriate and routes chosen so as to minimize inconvenience to the public. Odour control is also required. It is preferable to use enclosed tankers for transporting sludge.

Besides the use of sludge as fertilizer, the dry sludge can also be disposed of in specified landfill sites. In general the two options are applied. Co-disposal of sludge with municipal waste in designated landfills is acceptable.

When carrying out the detailed design of the treatment plant, a sludge disposal plan must be prepared whose objectives are: (i) to identify the land where the sludge can be disposed of, (ii) to define the frequency of land application and (iii) the quantity of sludge to be applied each time. The area where the sludge will have to be stored must also be defined. The sludge disposal plan should also take into account the type of crops and the soil characteristics.

(5) Socio-cultural Environment

A permanent beneficial impact is foreseen on the socio-cultural environment due to cleaning of nalas. Improvement of water quality at the Sangam would benefit lakhs of pilgrims.

(6) Health

An improvement in the quality of water flowing in the surface drains will reduce the risk of water-borne epidemics and related diseases.

Even though the sewage treatment plant will be useful in improving the health of the general public, it may not be so in regard to the health of the workers who are operating the plant. In the operation phase of the sewage treatment plant, care needs to be taken for the workers' health. The workers may suffer from epidemic diseases, malaria and respiratory diseases. The impact on their health would be adverse and significant. The workers should be provided with safety equipment for safe handling of the sewage treatment plant - sewage and sludge - and must be instructed in its use. This will eliminate any possibility of adverse health effects on the workers during plant operations. Adequate medical help should also be provided.

Similarly, the farmers will also have to be protected against infection, and special equipment, especially to handle the screenings, grit and sludge, should be made available and they should be educated on how to wear it.

Sewage sickness can be encountered in the use of raw or settled sewage but this negative effect is considerably reduced when an appropriate treatment (as lagoons) is proposed for irrigation re-use. The risk of consumption of raw vegetables irrigated with sewage is not excluded and it is therefore suggested that special cropping patterns of B Type (for cereal, industrial and fodder crops, etc.) be developed after detailed study. In all cases it is assumed that the existing situation will improve as compared to the present situation where raw sewage is used for irrigation.

5.6 ANALYSIS OF ALTERNATIVES

An environmental analysis has been carried out for the various project alternatives to ensure the following:

1) Environmental constraints regarding water quality, air quality, ecological disturbance, sludge disposal, public health are minimized.
2) Social impacts are reduced and careful management is needed to do so. The acceptance of the project by the community is required in order to allow its smooth implementation and prevent negative reactions from local residents.
3) The technical approach addresses the above constraints simultaneously while aiming at reducing both capital and operating costs.

The various alternatives examined are:

- Alternative sewage treatment technologies
- Alternative sites for the Numaya Dahi and Rajapur STPs
- Alternatives for effluent disposal from Numaya Dahi STP

5.6.1 With and Without Proposed Project

With and without project scenarios are compared in the following table. The water quality is evaluated at the confluence of Ganga and Yamuna Rivers, Sangam.

Table 5.38 Comparison of With and Without Project in Year 2015

	Without Project (incl. sanctioned)	**With Project**
Estimated wastewater discharged in 2015	240.5 mld	240.5 mld
Treatment capacity in 2015	89 mld	239 mld
Diversion to other basin in 2015	0 mld	0 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)
Bathing environment for bathing	Raw wastewater is discharged in the Ganga and Yamuna, which is causing unhygienic condition for bathing.	All raw wastewater except District F and G will be intercepted before entering the Ganga and Yamuna, and treated. The bathing environment will be improved.
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	Bacteria pollution because of no disinfection facility	Chlorination or maturation pond will be applied to all existing and proposed STP. Bacterial pollution will be reduced.

Note: 1) The dry flow of the Ganga Rover 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 are implemented (with the project scenario), 97 % of the wastewater discharged will be intercepted and treated in 2015 while if the project are 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 increased to 4.3 mg/l without the project and 2.8 mg/l with the project.

5.6.2 Alternative Treatment Technologies

The various treatment technologies considered for Allahabad include:

- Waste Stabilisation Ponds
- Aerated Lagoons
- UASB + Post-treatment with aerated lagoons
- UASB + Post-treatment with mechanical aeration followed by solids separation
- Conventional Activated Sludge

These treatment technologies are usually, in a techno-economic analysis, compared on the basis of the following general parameters:

- Suitability to meet discharge standards
- Capital costs
- O&M costs
- Power requirement
- Land requirement
- Treated effluent discharge
- Sludge disposal requirements
- Resource recovery in terms of re-use of methane gas

The present project discharge standards are :

1) BOD – 30 mg/l
2) SS – 50 mg/l
3) Faecal Coli -10,000 MPN/100 ml

Regarding the above parameters, their related importance in the comparison of alternative sewage treatment technologies for the present project has been decided in view of the following site constraints:

1) Power Constraint: - Power outages are very common in Allahabad and can reach a maximum of 8 hrs a day. Hence, a technology with a high dependency on power for effective and reliable treatment of wastewater would generally not be desirable.
2) Land Constraint: - The main city is densely populated and offers few choices for locating the sewage treatment facilities. A large part of the town is under the Cantonment Board's administration. Although land is available in this part of the town, obtaining it for sewage treatment facilities involves administrative delays. Hence, the STPs have to be perforce located at the riverfronts. This entails building high (8-10m) bunds for flood protection and consequently huge capital costs. Hence, land area minimisation is a major consideration in selection of the treatment technologies.

Other site-specific constraints are discussed below separately for each STP site:

(1) Numaya Dahi STP

The major points of consideration for this site are:

1) 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.
2) The site is surrounded by agricultural land and hence, the treated effluent can be used for irrigation.
3) 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 from where Yamuna water is abstracted for supply of potable water to the main city, after conventional treatment. Hence, the slightest increase in pollution levels could have a major impact on the health of the city's residents.
4) 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, the suitability of the various treatment technologies is evaluated for this site and presented in Table 5.39.

Table 5.39 Comparisons of Treatment Technologies

Parameter \ Technology	WSP	Conventional ASP	Aerated Lagoon + Maturation Ponds	UASB + Post-Treatment by Lagoons	UASB + Conventional Aeration	Fluidised Aerated Bio-Reactor (FAB)
Achieving discharge standards	Suitable	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Suitable	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Post-treatment required in terms of disinfection by chlorine or maturation ponds
Reuse of treated effluent for irrigation	Suitable	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Suitable	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Post-treatment required in terms of disinfection by chlorine or maturation ponds	Post-treatment required in terms of disinfection by chlorine or maturation ponds
Power Requirement	Least	High	High	Medium	High	High
Environmental Risk*	Least	High	Medium	Medium	High	High
Air Quality	Some odour problems if ponds not operated properly.	Minimum odour	Medium odour	Medium odour	Minimum odour	Minimum odour
Land Requirement	Highest	High	High	Medium	Medium	Low
Maintenance Requirement	Least	High	Low	Low	Low	High
Sludge Disposal Requirement	Least	High	Low	Medium	Medium	High

* *Measured in terms of loss of treatment efficiency due to long and frequent power cuts.*

From Table 5.39, WSP emerges as the environmentally most reliable technology for Numaya Dahi STP.

(2) Ponghat STP

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

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

Referring to the comparison presented in Table 5.39, 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.

(3) Kodara STP

This site is surrounded on the northern side by a river stream, which is a southern channel of 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, it has to be disposed into the river stream flowing nearby.

Hence, for this site UASB followed by suitable post-treatment would be a better environmental solution than aerobic technologies like ASP and FAB in view of the frequent and long power cuts in Allahabad.

(4) Rajapur STP

Two sites were considered in the M/P for locating this STP; both are on low-lying areas. Flood protection measures would mean a very high bund (8-10m) enclosing the STP site. Hence, for the site, footprint technologies, minimising the land requirements, would be preferable. However, this requirement would have to be balanced with the requirement of low power consumption and high process reliability in face of frequent and long power cuts. From an environmental point of view hence, WSP is the best solution in case the required land is available. Else, UASB followed by a suitable post treatment can be adopted.

5.6.3 Alternatives for STP Sites

(1) Numaya Dahi STP

The two alternative sites considered for Numaya Dahi STP are shown in following photos. Their comparison is presented in Table 5.40.

Numaya Dahi STP Alternative I

Numaya Dahi STP Alternative II

Table 5.40 Analysis of Alternative Sites for the Numaya Dahi STP

Issues	Alternative I	Alternative II
NATURAL PARAMETERS		
Soil Quality	• As a result of plant construction, top soil will be affected	• As a result of plant construction, top soil will be affected
Air Quality	• No major habitation nearby, hence, odor impact not significant	• No major habitation nearby, hence, odor impact not significant
Receiving Water Quality	• Discharge of treated effluent into the Yamuna at Bisona possible which is approx. 25 km upstream of the Raw Water Intake	• **Discharge of treated effluent into nearby Sasur Khaderi river or into the Yamuna not desirable, as it is too near, on the upstream side, of the Raw Water Intake**
Ecologically Sensitive Area	• No significant ecological issue involved	• No significant ecological issue involved
SOCIO-CULTURAL PARAMETERS		
Land Use Pattern	• Change in land-use pattern expected from agricultural (productive) to commercial (less productive)	• Change in land-use pattern expected from agricultural (productive) to commercial (less productive)
Socio-Economic Condition	• Positive impact on socio-economic condition due to increase in employment opportunities during construction	• Positive impact on socio-economic condition due to increase in employment opportunities during construction
Public Health	• Overall positive impact on public health • Proper housekeeping and maintenance of the plant required to offset problems of mosquito breeding and odour nuisances	• Overall positive impact on public health • Proper housekeeping and maintenance of the plant required to offset problems of mosquito breeding and odour nuisances
Land Availability	• Land availability not a constraint	• **A number of High Tension lines passing through the proposed site**
Treatment Technology	• Possible to provide ponds	• Possible to provide ponds
Reuse -Irrigation potential of Treated Sewage	• Irrigation re-use possible due to agricultural land in the vicinity	• Irrigation re-use possible due to agricultural land in the vicinity
Conclusion	**Recommended**	**Not recommended**

Treated Effluent Channel Routing

Three alternatives routes considered for discharge of treated effluent into the Yamuna were as follows:

1) STP Site to Karendha Village (Alt. 1)
2) STP Site via Fish pond beyond Dahi village to Yamuna (Alt. 2)
3) STP Site to Yamuna at Bisona Village (Alt. 3)

The three alternatives are compared in Table 5.41.

Table 5.41 Comparison of Alternative Routes for Treated Effluent Channel from Numaya Dahi to Yamuna River

Sr.	Environmental Issue	Alternative 1	Alternative 2	Alternative 3
1.	Re-use of Effluent for Irrigation	Possible	Possible	Possible
2.	Probability of re-contamination of treated effluent	Low	High, as raw sewage of adjoining villages is being discharged untreated into the fish pond	Low
3.	Capital Cost	Lowest	**Highest**	High
4.	Approx. distance, along the river stream from the Karelibagh raw water intake	**5 km, Not sufficient distance available for dispersion & dilution of effluent into the river waters**	>30 km Sufficient distance available for dispersion & dilution of effluent into the river waters	25 km Sufficient distance available for dispersion & dilution of effluent into the river waters
	Conclusion	**Not recommended**	**Not recommended**	**Recommended**

(2) Rajapur STP

The two alternative sites are shown in following photos and their comparison presented in Table 5.42.

Rajapur STP site – Alternative I

Rajapur STP site – Alternative II

Table 5.42 Analysis of Alternative Sites for the Rajapur STP

Issues	Alternative I	Alternative II
NATURAL PARAMETERS		
Soil Quality	• As a result of plant construction, top soil will be affected	• As a result of plant construction, top soil will be affected
Air Quality	• Located near a residential colony hence, odor impact significant	• Located near a residential colony hence, odor impact significant
Receiving Water Quality	• Discharge of treated effluent back into the Nala, which ultimately joins a southern channel of Ganga River. As all Nalas downstream of the treated effluent outfall into the Nala are being tapped, the effluent will not be re-polluted before joining Ganga River channel.	• Discharge of treated effluent back into the Nala, which ultimately joins a southern channel of Ganga River. A number of Nalas d/s of the site have to be tapped and brought back to the site by providing adequate pumping arrangements.
Ecologically Sensitive Area	• **The site is the winter habitat of a number of migratory birds.**	• The site is the winter habitat of a number of migratory birds.
SOCIO-CULTURAL PARAMETERS		
Land Use Pattern	• Land extremely low lying and prone to flooding, hence, not put to any use at present	• Land extremely low lying and prone to flooding, hence, not put to any use at present
Socio-Economic Condition	• Positive impact on socio-economic condition due to increase in employment opportunities during construction	• Positive impact on socio-economic condition due to increase in employment opportunities during construction
Public Health	• Overall positive impact on public health • Proper housekeeping and maintenance of the plant required to offset problems of mosquito breeding and odour nuisances	• Overall positive impact on public health • Proper housekeeping and maintenance of the plant required to offset problems of mosquito breeding and odour nuisances
Land Availability	• Land requirement to be minimised, in view of the discussion above	• Land requirement to be minimised, in view of the discussion above
Pumping	• **Tapping of nearby Nalas by gravity possible**	• Will involve installation of small pumping facilities for tapping the downstream Nalas namely, Nalas 11 A-D
Treatment Technology	• Technology minimising the land requirement preferable	Technology minimising the land requirement preferable
Reuse -Irrigation potential of Treated Sewage	• Irrigation re-use not possible as there is no cultivable land in the vicinity.	• Irrigation re-use not possible as there is no cultivable land in the vicinity.
Sludge Disposal	• Sludge will have to be transported to agricultural area.	• Sludge will have to be transported to agricultural area.
Conclusion	**Recommended in absence of a better alternative**	**Not recommended**