

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS (MoEF)

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

VOLUME – I (EXECUTIVE SUMMARY)

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VOLUME – VI	MAPS

JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
JUNE 2014

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15. Delhi Sewerage Master Plan - 2031

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This Sewerage Master Plan is prepared in collaborative effort of Delhi Jal Board and AECOM-WAPCOS Team.

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**PROCEEDINGS OF STAKEHOLDER
WORKSHOPS FOR DEVELOPING
SEWERAGE MASTER PLAN
FOR DELHI, 2031**

PROCEEDINGS OF STAKEHOLDER WORKSHOPS FOR DEVELOPING SEWERAGE MASTER PLAN FOR DELHI, 2031

Delhi Jal Board (DJB), constituted under Delhi Jal Board Act 1998, is responsible for production and distribution of drinking water as also for collection, treatment, and disposal of waste water/sewage in the Capital. DJB intended to develop a Master Plan for Sewerage System of unsewered areas of Delhi to meet the Sewerage Infrastructure demand for the year 2031; carry out Feasibility Study and create all data in GIS platform for hydraulic modeling and approach for Management Information System.

In view of Sewerage Master Plan works, stakeholder workshops were held in order to a holistic Master Plan. The CEO of DJB initiated key workshop under the chairmanship of Chief Secretary, Govt. of NCT of Delhi. The key notes and outcomes of the workshops were accounted & analyzed to prepare the Master Plan.

DJB officials meeting on 5th August 2011 – Chaired by the then Chief Executive Officer (CEO), Delhi Jal Board

The workshop was chaired by Shri Ramesh Negi, the then CEO, Delhi Jal Board (DJB). He had mentioned that Delhi needs a sustainable sanitation plan in terms of drainage and sewerage. Sewage Management is the most complex issue faced today. Other related issues are ground water recharge and preservation of water bodies. Our approach should also include development of decentralized wastewater systems and using the treated water for various non-potable uses. For success of sewerage system, it is equally important to have a proper drainage system.

He also suggested that existing data and already planned schemes by DJB may be correlated with the Sewerage Master Plan in order to have a holistic approach of planning and management. He also raised the concern of drying up of water bodies once entire Delhi is sewerage. He suggested re-cycle and re-use of the tertiary treated effluent for recharging of these water bodies. In areas where there is no water and sewerage infrastructure available while laying of sewerage lines in those areas, the consideration shall be kept for the laying of water network lines also.

The presentation on pilot study for Yamuna Vihar area was given by AECOM explaining Approach & Methodology adopted for carrying out the hydraulic modeling, feasibility, optimization of sewerage schemes. The similar methodology was to be adopted for formulation of subsequent schemes.

Stakeholders meeting on 16th September 2011 – Chaired by Chief Secretary, Govt. of NCT of Delhi

Shri P.K. Tripathi, the then Chief Secretary, (Govt. of Delhi) expressed that it is quite challenging to provide basic amenities like water supply and sewerage systems in NCTD as largest intense of growth in a country lies within its cities. He had mentioned that Delhi is capable of higher level technology and advancement but at the same time it is dependent on its neighboring states for fulfilling its water requirements.

He had provided valuable suggestions for preparing Sewerage Master Plan of NCT Delhi. The master plan should take into account reuse of treated waste water. The unauthorized colonies in Delhi don't have access to sewerage system. The biggest challenge is to treat the sewage flowing in the city before it enters the River Yamuna. The neighboring states claim that Delhi is releasing untreated and poor quality of water into River Yamuna as a result of which downstream states to the river are getting affected. So it becomes necessary to ensure that River Yamuna is clean before it travels downstream Delhi. By doing this we can demand for more water from our neighboring states.

Subsequent to the challenges addressed regarding Sewerage Master Plan, he had mentioned about problems of drainage are acute in Delhi and it is very essential to develop a Drainage Master Plan. To

prepare this Master Plan, the data generated from Delhi's Geospatial Mapping Project can be used. He also mentioned that we all should aim at making Delhi the best and the greenest capital city of the world.

Shri Ramesh Negi, the then CEO, DJB, reiterated the importance of the project and invited the technical experts to point out their apprehensions regarding the engineering solutions presented that fruitfully contribute to the success of the project.

The presentation kicked off with basic engineering principles and introduction to Sewerage Master Plan by Alex Kwan, Executive Vice President of AECOM. He had discussed the scope of project, AECOM's Approach & Methodology, and gave an indication towards the need of investment to fulfill prioritization of projects coming from Sewerage Master Plan.

Subsequently, the presentation was followed by Technical Experts on Sewerage Master Plan work and Pilot Study Project of Yamuna Vihar area. The following points were discussed, addressed and were advised to be incorporated while preparing Sewerage Master Plan:

- The Topographical survey for preparation Sewerage Master Plan should be w.r.t ground reality. The point is addressed by technical experts and mentioned all the details carried out while doing actual ground survey.
- There shall be correlation of NCR Planning Board's Master Plan for Delhi and the ongoing SMP-2031. The same has been taken into account for preparation of Sewerage Master Plan.
- The rate of Water supply is different in different areas of the city, however master plan has been prepared based on CPHEEO guidelines for sewage generation for different types of buildings.
- The emphasis should be given to fully utilize the capacity of existing sewerage assets. The sewerage schemes of different catchments have been proposed while integrating with existing sewerage lines, pumping stations, proposed interceptor lines & capacities of existing WWTP's.
- In UK, the energy saving is done by transporting sewage to a single WWTP and then treated to the highest level of technology. However, the topography of Delhi is not supporting the centralized treatment for disposal. Therefore, decentralization has to be considered by providing various treatment plants with respect to different catchments.
- Integration of un-sewered areas with Interceptor Sewers (IS). The schemes for nearly all un-sewered areas of interceptor sewer lines are planned by integration and full utilization of infrastructure that comes up during in Interceptor Sewer Project.
- The prioritization of projects for stipulated investment should be done for schematic planning and implementation.

Draft Master Plan Presentation on 27th September, 2013 – Chaired by Chief Executive Officer (CEO), Delhi Jal Board

Technical Experts of Consultant's team presented the Draft Master Plan wherein following points were discussed and addressed on Sewerage Master Plan:

- Formulation of DMP considering outcomes of various stakeholders meeting/ workshops.
- Holistic Draft Master Plan was presented showcasing Techno-feasible delineation of sewerage system of NCT of Delhi in Twelve (12) Drainage Zones.
- Sewerage schemes for each Drainage Zone were explained in detail representing proposed infrastructure comprising sewerage network, waste water pumping stations, waste water treatment plants and associated structures.

- Various technical concerns regarding sewerage schemes, Feasibility Study, Prioritization and Cost Estimates were discussed and agreed.
- The delineation of sewerage system of Delhi in Twelve Drainage Zones were agreed and approved.
- CEO advised to plan the proposed sewerage infrastructure in phased manner.
- Consultant's team was advised to develop Phase wise implementation schedule along with investment plan for stipulated design year to be incorporated in Final Master Plan.

Final Master Plan Presentation on 29th April, 2014 – Chaired by Chief Executive Officer (CEO), Delhi Jal Board

Final Sewerage Master Plan incorporating suggested inputs as advised on Draft Master Plan was presented. The key salient features included representation of all sewerage schemes, proposed sewerage infrastructure along with locations, prioritization of projects, Phase wise Implementation Schedule and Investment Plan. The key representation also included consolidated overall map reflecting proposed schemes as per Group of Colonies (GOCs) under SMP. The presentation ended agreeing all the ramifications of SMP.

EXECUTIVE SUMMARY

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Introduction

NCT Delhi has an expanding population that has grown by more than 300% since 1971 when it stood at 4.066 million, increasing to the current level of around 20 million. As per Census 2011, Delhi had a population of 16.753 Million and as per the Delhi Master Plan 2021, the population of Delhi is projected to be 23 Million. Presently, approximately 50% of Delhi is not connected with sewerage system as shown in **Figure 1**. The wastewater services in next twenty years are likely to worsen drastically unless remedial measures are taken today.

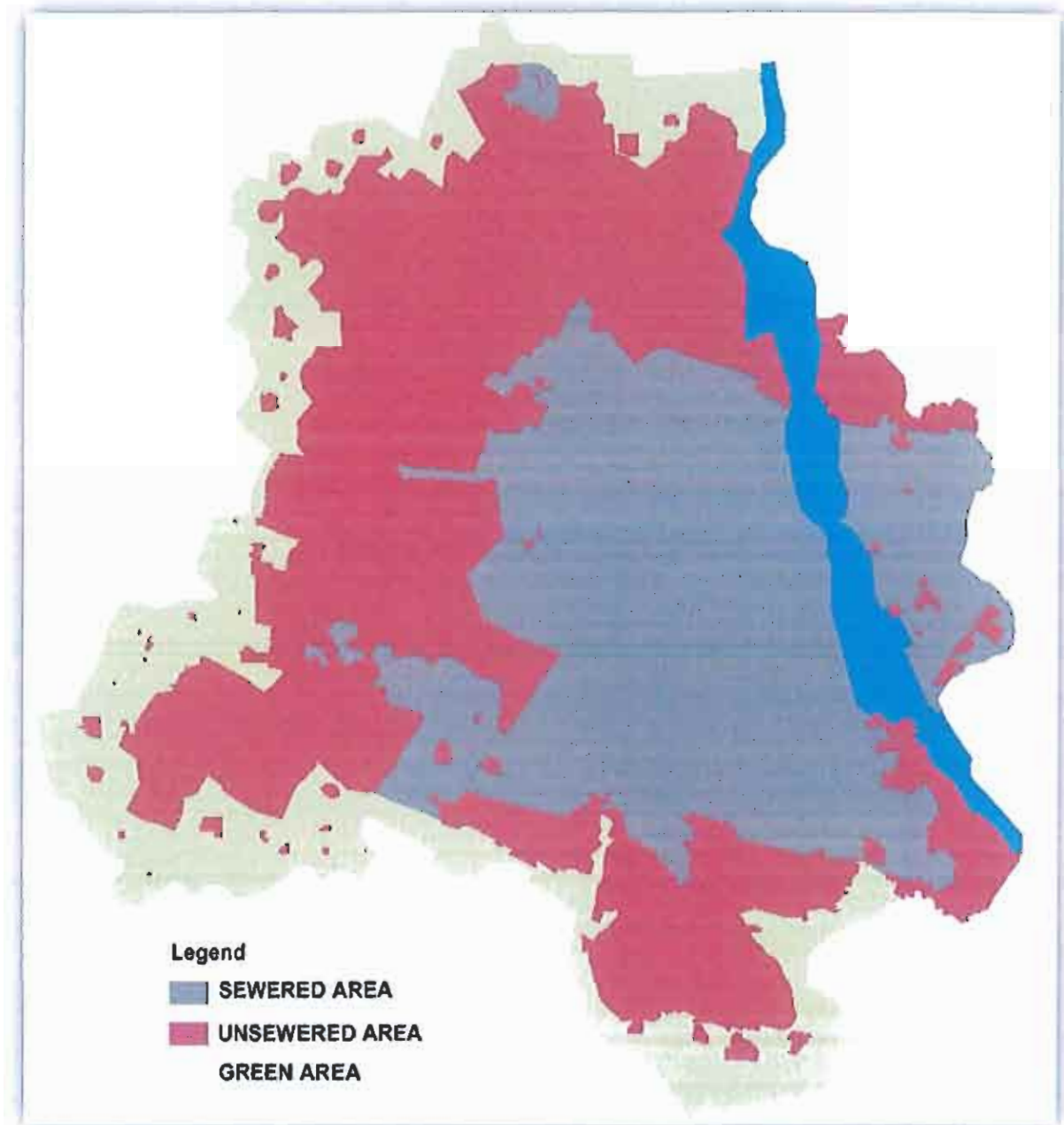


Figure 1: Sewered & Unsewered area of NCT of Delhi

For unsewered areas of Delhi, DJB intended to develop a holistic, integrated and sustainable Master Plan for design horizon of 2031 has been prepared. This master plan shall ensure that the comprehensive, technically and financially viable plans (CAPEX & OPEX) are in place for the implementation of sewerage works in unsewered areas of Delhi by integrating with existing network and sewerage infrastructure so as to bring the latter to their optimum utilization state.

The sewerage master plan for design year 2031 (SMP-2031) has been developed by AECOM with huge sewerage network of around 10,000 Km. Unsewered areas of Delhi has complex situation with congestion and lesser space left for laying the sewerage utility. In view of this, trenchless technology methods such as Microtunnelling and HDD have been proposed for laying new networks as appropriate. As an immediate measures a techno-feasible option has also been convened which is to trap the sewage flowing in the drains from un-sewered areas by implementing Interceptor Sewer system. This shall cut off untreated sewage contamination in the drains towards river Yamuna. This shall be a short term immediate relief for the betterment of sanitation condition and hence quality of river Yamuna. The master planner, AECOM with inputs of DJB has wisely taken up the proposed infrastructure in the SMP-2031 by integrating with these proposed interceptor sewers. The proposed sewerage schemes under SMP-2031 shall be implemented in various phases as per intended priority over next few years.

Ramifications of SMP will ensure that the comprehensive, techno-economical plans are in place for the implementation of sewerage development and improvement works. Ramifications will also upgrade the sewerage infrastructure leading to improved sanitation conditions and also enhance the water quality in river Yamuna.

Objectives of the Project

Following are the broad objectives of the project for effective implementation and operations of wastewater services:

- Development of holistic, integrated, sustainable and techno-feasible Sewerage Master Plan.
- Integration of various ongoing sewerage projects with overall sewerage schemes proposed under Master Plan.
- Topographical Survey and its GIS Integration, Feasibility study, Detailed Cost Estimates / Tender Documents for proposed sewerage schemes.

Key activities

The key activities carried out for preparation of Sewerage Master Plan are represented below:

Topographical Survey

As envisaged in Master Planning scope, Intensive survey and investigation work has been carried out for all unsewered colonies / areas.

- Identified Bench Marks
- Captured levels at 30m center to center and contour maps generated.
- Captured all the relevant features with required attributes from Total Station.

GIS Integration

- All survey data with captured attributes converted and Integrated in GIS format.
- Final GIS data is in Shape file format with its defined projection

Hydraulic Modelling and Feasibility Study

Bentley SewerGEMS Sanitary software used for the hydraulic modelling works using GIS Shape files. Correlation of field data with design works to achieve cost effective and feasible solutions. Sewerage network models have been built for unsewered areas. Various alternatives were considered for its feasibility and onward planning. Subsequently, optimization of sewerage network was carried out.

Estimation Works

Cost Estimates for all Sewerage Schemes have been prepared as per latest Delhi Schedule of Rate and DJB's Planning approved rates.

Master Planning for Unsewered Areas of Delhi

Presently Delhi is divided into six (6) drainage zones as shown in *Figure 2* below, namely Rithala, Keshopur, Okhla, Shahdara, Coronation Pillar and Outer Delhi.

Keshopur, Okhla, Rithala, South of Shahdara and Coronation Pillar drainage zones are majorly sewered with pockets of unsewered colonies. The North of Shahdara and Outer Delhi extending from Narela, Bawana in North, Najafgarh in West to Bhati Kalan & Dera Mandi in South, are predominantly unsewered.

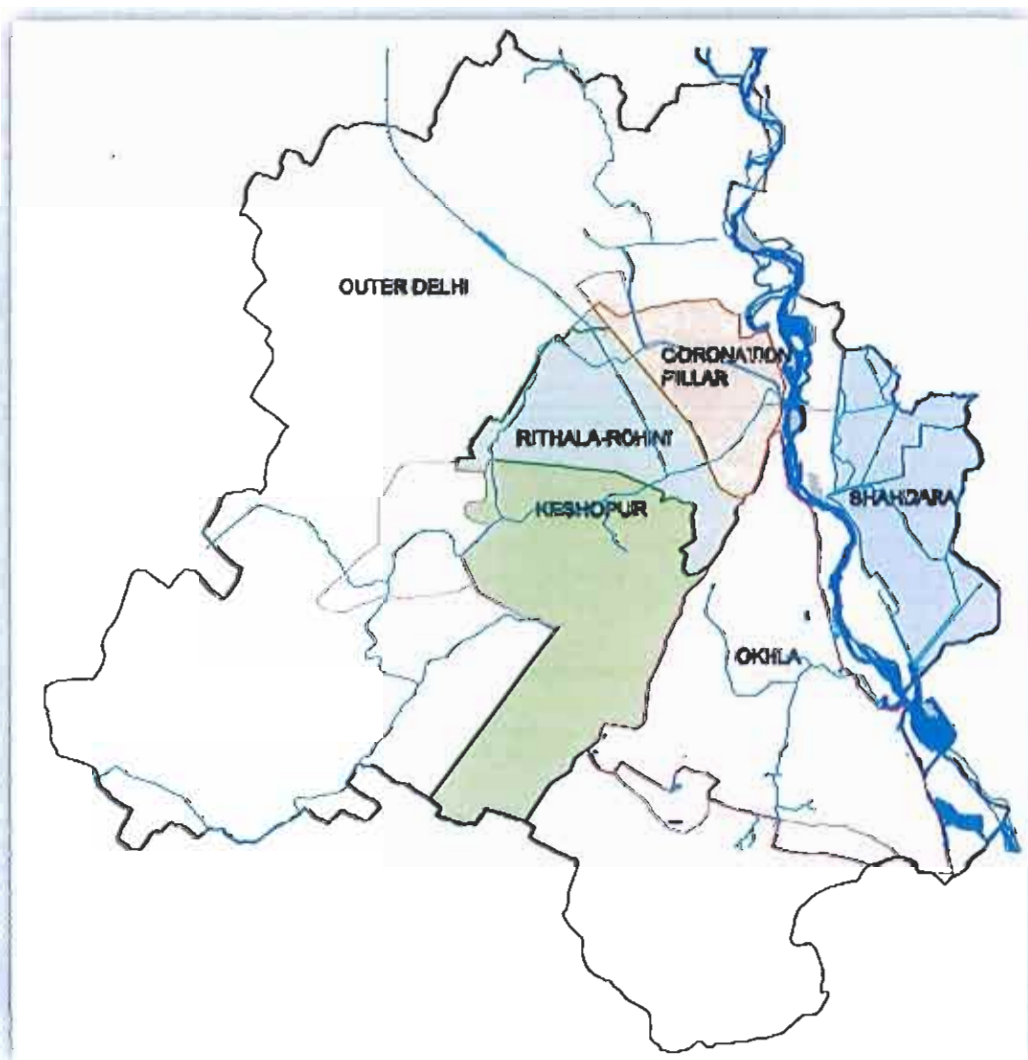


Figure 2: Six Drainage Zones of Delhi

Proposed Drainage and Sub-Drainage Zones

The demarcation/delineation of various drainage zones and sub-drainage zones has been carried out based on the existing six (6) major drainage zones and certain zoning criteria/constraints, which have been described further. The boundaries of proposed drainage zones are delineated on the following criteria/constraints:

- Topography of NCT of Delhi
- Natural boundaries like river Yamuna, canals/drains and habitation pattern
- Major Highways and Railways
- Utilization of existing sewer network, WWPSs, pumping mains, WWTPs
- Future sewage generation from the catchments
- Permissible depth of outfall sewer, length of main/trunk sewer and pumping main etc.

Similarly, the boundaries of sub drainage zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs, pumping mains and the direction of gravity flow of sewage to arrive at the most economical and practically (on-site) feasible sewer network alignment. The proposed sub drainage zones have been formulated considering the following criteria/constraints:

- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTPs and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPSs/ WWTP
- Hydraulic analysis and condition assessment of existing sewerage assets
- Feasibility implications
- Delineation based on contours of respective sub-drainage zone

Based on the above described physical constraints and zoning criteria, the whole NCT of Delhi has been delineated into 12 (twelve) drainage zones excluding Cantonment and Airport area. The proposed drainage zones are further delineated into various WWTP and sub drainage zones as shown in **Figure 3 & Figure 4** below:

- Shahdara Drainage Zone (SHD)
- Okhla Drainage Zone (OKH)
- Keshopur Drainage Zone (KSP)
- Rohini- Rithala Drainage Zone (RR)
- Coronation Pillar Drainage (COR)
- Dwarka Drainage Zone (DWK)
- Najafgarh Drainage Zone (NJF)
- Nilothi Drainage Zone (NLT)
- Narela Drainage Zone (NRL)
- South Delhi Drainage Zone (SD)
- Outer South Delhi Drainage Zone (OSD)
- Kanjhawala-Bawana (KB)

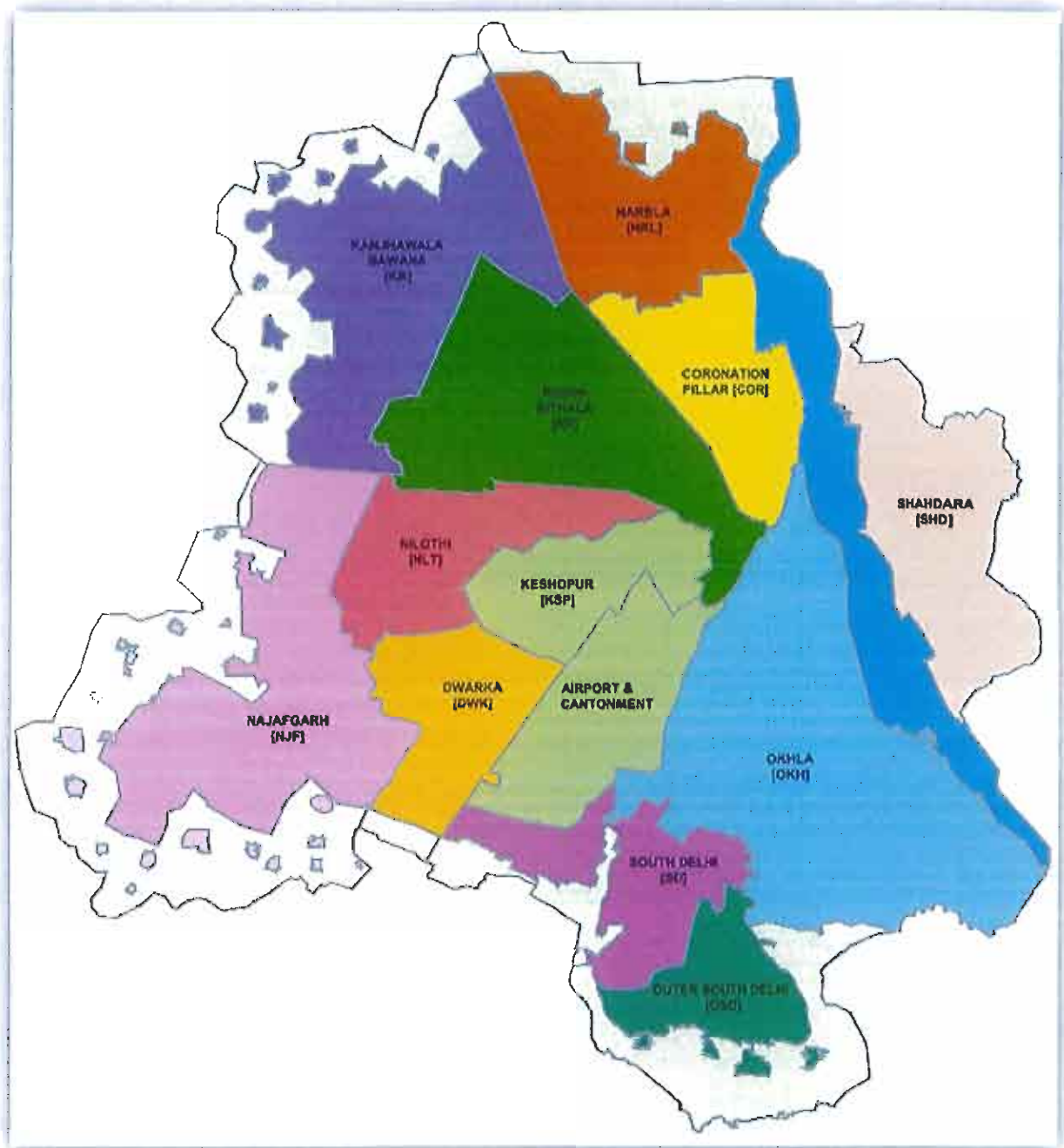


Figure 3: Proposed Drainage Zones – NCT Delhi

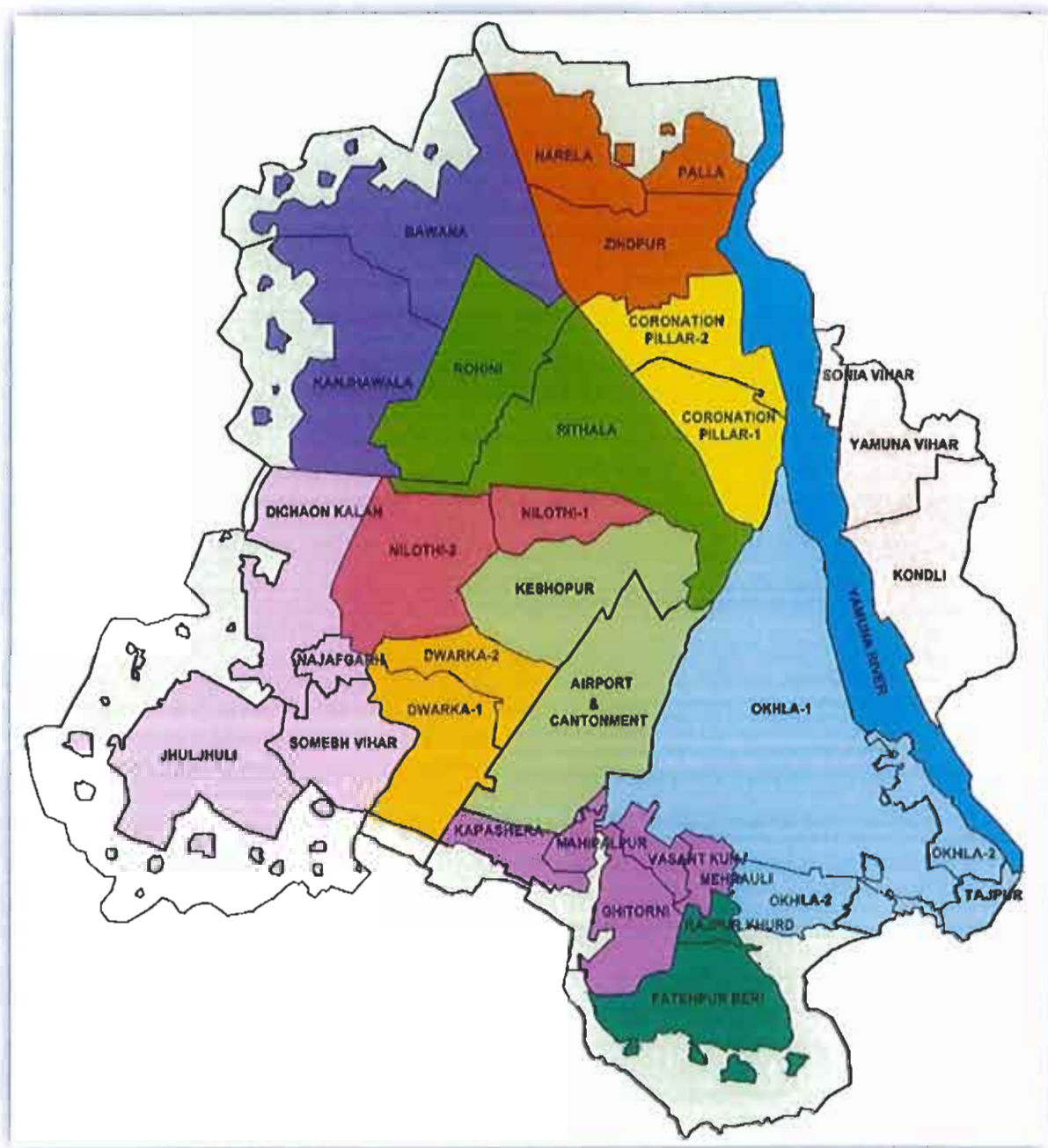


Figure 4: Proposed Sub-Drainage Zones – NCT Delhi

The following **Table 1** describes in detail the proposed delineated zones and sub zones. Each sub zone has been delineated based upon the wastewater generation from the sub zone and existing/proposed WWTP/WWPS capacity.

Table 1: Proposed Drainage Zones – NCT Delhi

Sl. No.	Drainage Zone	Sub Drainage Zone
Zone 1	Shahdara (SHD)	Yamuna Vihar (YV)
		Sonia Vihar (SV)
		Kondli (KN)
Zone 2	Okhla (OKH)	Okhla (OK)
		Tajpur (TP)
Zone 3	Keshopur (KSP)	Keshopur (KP)
Zone 4	ROHINI-RITHALA (RR)	Rithala (RT)
		Rohini (RH)
Zone 5	CORONATION PILLAR (COR)	Coronation Pillar (CP-1)
		Coronation Pillar (CP-2)
Zone 6	DWARKA (DWK)	Dwarka (DK-1)
		Dwarka (DK-2)
Zone 7	NAJAFGARH (NJF)	Najafgarh (NJ)
		Jhuljhuli (JH)
		Dhikaon kalan (DK)
		Somesh Vihar (SV)
Zone 8	NILOTHI (NLT)	Nilothi (NT-1)
		Nilothi (NT-2)
Zone 9	NARELA (NRL)	Narela (NR)
		Palla (PL)
		Zindpur (ZP)
Zone 10	SOUTH DELHI (SD)	Mahrauli (MH)
		Vasantkunj (VK)
		Ghitorni (GH)
		Mahipalpur (MP)
		Kapashera (KH)
Zone 11	OUTER SOUTH DELHI (OSD)	Fatehpurberi and Chandanhola (FC)
		Rajpur Khurd (RK)
Zone 12	KANJHAWALA-BAWANA (KB)	Kanjhawala (KJ)
		Bawana (BW)

Zone Wise Wastewater Generation

The zones have been primarily delineated based on the wastewater generation from each zone/sub zone, the capacity of existing WWTP/s & WWPS/s and land availability for any additional WWTP/WWPS, if required.

The population of NCT Delhi has been projected using DDA's zones and census data, and distribution of projected population is done by correlating the proposed Drainage Zones with DDA Zone map as shown in **Figure 5**. **Table 2** below describes the quantum of wastewater generation from each drainage zone.

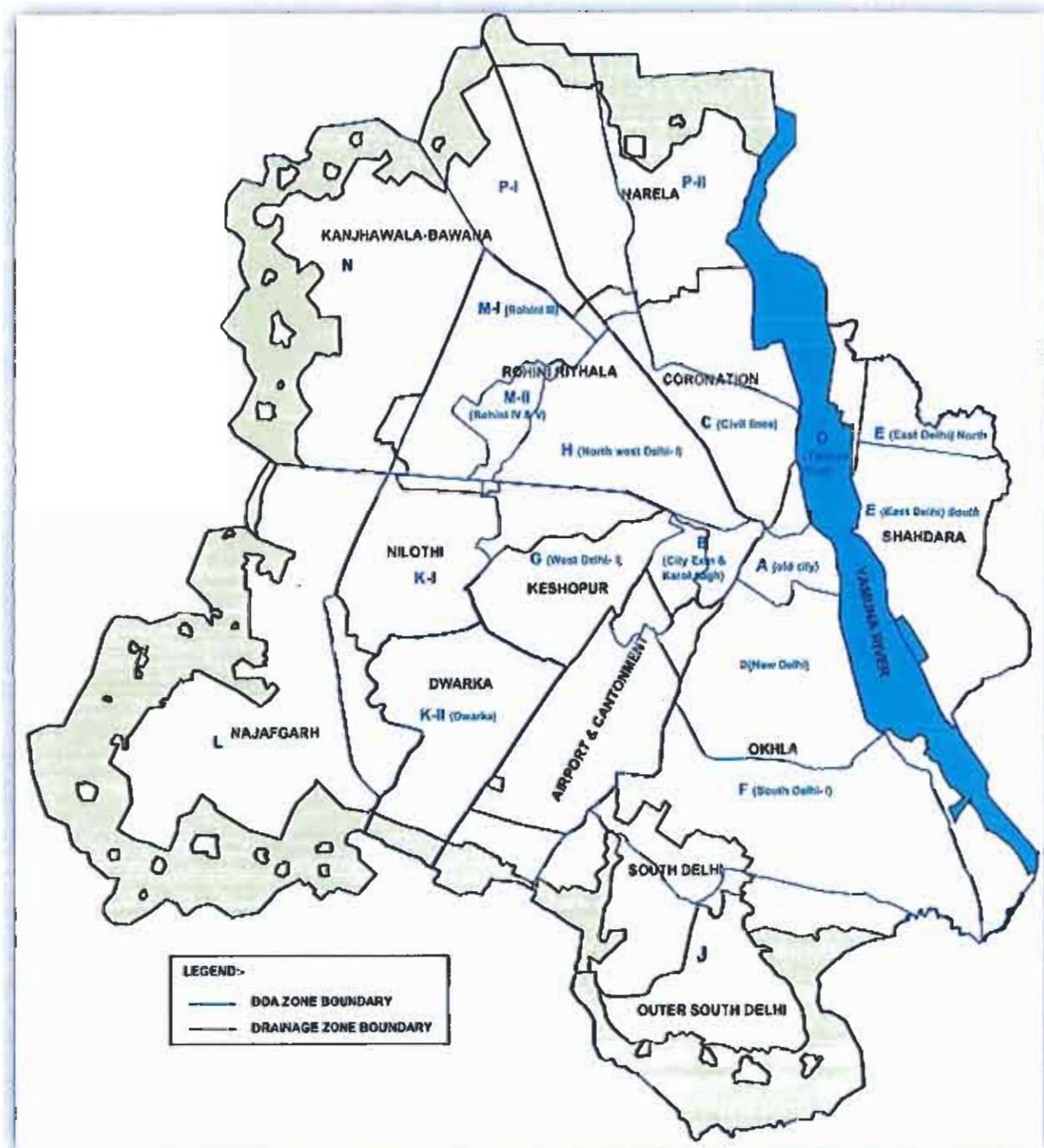


Figure 5: Drainage Zone and DDA Zone Boundary

Table 2: Zone wise Estimated Wastewater Generation of NCT of Delhi

Sl. No.	Drainage Zone	Waste Water Generation (MGD)		
		2011	2021	2031
1	Shahdara	110.0	126.0	142
2	Okhla	137.0	162.0	187
3	South Delhi	23.0	34.0	40.4
4	Outer South Delhi	10.0	20.0	49.2
5	Narela	26.0	42.7	59.3
6	Coronation	55.0	67.5	79.9
7	Najafgarh	43.0	65.3	87.5
8	Nilothi	45.0	52.8	60.66
9	Kanjhawala-Bawana	35.5	69.6	103.6
10	Rohini-Rithala	95.0	107.5	120
11	Dwarka	38.4	49.2	60
12	Keshopur	62.0	67.0	72
TOTAL (MGD)		679.9	863.4	1,061.6

Note: The wastewater generation as shown in the table includes estimation of sewage generation for sewerage areas based on zonal PPH, existing plant capacities, their utilization and integration with sewage generation from unsewered areas.

Zone Wise Proposed Sewerage Schemes

Sewerage Schemes for various zones have been prepared considering the following aspects:

- Existing Sewerage Infrastructure
- Proposed Sewerage Infrastructure under various projects
- Development Plans for a particular area
- Population projections and amount of waste water generation
- Land availability for proposed sewerage infrastructure
- Site feasibility

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Additional Sewage Treatment Capacity Requirements

The feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in a phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

At present there are 34 Wastewater Treatment Plants (WWTPs) at 21 different locations, equipped to treat 2700.03 MLD (594.72 MGD) of sewage with utilization of around 57%. Capacity of WWTP varies from (0.66 MGD) to (170 MGD). The Wastewater Treatment Plants in the city are 1–45 years old in age. Old age of WWTPs has resulted in loss of treatment efficiency. Due to network deficiencies, there is an overflow from sewers into storm water drains. **Table 3** below represents design capacity of existing WWTPs and their present utilization efficiency based on the quantum of treated sewage by individual WWTP.

Based on already completed study and anticipated flows from already sewered areas, DJB anticipates to increase the wastewater treatment capacity to (731.9 MGD). The details are presented in **Table 3** below:

Table 3: Waste Water Treatment Capacity Present and Being Implemented in Delhi

Sl. No.	Location	Present Sewage Treatment Capacity	Under Construction / Proposed	Total Sewage Treatment Capacity after augmentation
		(MGD)	(MGD)	(MGD)
1	Okhla *	170		170
2	Keshopur	72		72
3	Coronation Pillar	40	40**	80
4	Rithala	80		80
5	Kondli	90		90
6	Vasant Kunj	5		5
7	Yamuna Vihar	20	25*	45
8	Ghitorni	5		5
9	Dwarka (Pappan Kalan)	20	20*	40
10	Narela	10		10
11	Najafgarh	5		5
12	Mehrauli	5		5
13	Delhi Gate	2.2		2.2
14	Sen Nursing Home	2.2		2.2
15	Rohini	15		15
16	Nilothi	40	20*	60
17	Timarpur	6		6
18	Rural Villages (Kapashera)	5		5
19	CWG Village	1		1
20	Molarband	0.66		0.66
21	Bakkarwala	0.66		0.66

Sl. No.	Location	Present Sewage Treatment Capacity	Under Construction / Proposed	Total Sewage Treatment Capacity after augmentation
		(MGD)	(MGD)	(MGD)
22	Chilla	NIL	9*	9
23	Delhi Gate Phase-II	NIL	15*	15
24	Delhi Cantt.	NIL	8**	8
Sub- Total (MGD)		594.72	137	731.72
Waste Water Treatment Capacity in Delhi as per SMP-2031 Table 4 (MGD)				374
Total Waste Water Treatment Capacity after implementation of SMP-2031(MGD)				1105.72
<i>*WWTP under Construction</i>				
<i>**WWTP already proposed</i>				
<i>#Okhla Tertiary Treatment Plant of capacity 2.2 MGD is under Construction</i>				

The above details pertaining to upcoming infrastructure have been taken into consideration while proposing new infrastructure under Sewerage Master Plan (SMP)-2031 study. Detail of proposed WWTPs under SMP along with phasing has been represented in **Table 4**:

Table 4: Details and Phasing for proposed WWTPs

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP Location	Existing/ UC/ Planned by DJB WWTP Capacity (MGD)	Proposed WWTP Under SMP-2031		
					As per Present Habitation Occupancy		As per DDA-2021
					Phase-I MGD	Phase-II MGD	Phase-III MGD
1	SHAH DARA	KN	Kondli	90			
		YV	Yamuna Vihar	45			
		SV	Sonia Vihar		7		
2	OKHLA	OK	Okhla	170			
		TP	Tajpur		10	7	
3	SOUTH DELHI	MH	Mehrauli	5			
		KH	Kapashera	5			6.4
		VK	Vasant Kunj	5			
		GH	Ghitorni	5		9	
		MH	Mahipalpur		3	2	
4	OUTER SOUTH DELHI	FC	Fatehpurberi and Chandanhola		5	5	29.2
		RK	Rajpurkhurd		5	5	
5	NARELA	NR	Narela	10			10
		PL	Palla		6		

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP Location	Existing/ UC/ Planned by DJB WWTP Capacity (MGD)	Proposed WWTP Under SMP-2031		
					As per Present Habitation Occupancy		As per DDA-2021
					Phase-I MGD	Phase-II MGD	Phase-III MGD
		ZP	Zindpur		10	5	18.3
6	CORONATION PILLAR	COR1	Coronation Ph I, II & III	40			
			Timarpur	6			
		COR2	Coronation Ph IV	40			
7	NAJAFGARH	NJF	Najafgarh	5			3
		DK	Tikri Kalan		2.7	2.0	7.3
			Mitrao		5.6	3.5	
			Dichao Kalan		5.6	4.0	
		JH	Kazipur		1.1	1.0	4.6
			Khera Dabar Extn		0.9	1.0	
			Shikarpur		0.6	0.5	
			Zafarpur		1.1	1.0	
			Samaspur Khalsa		2.2	1.0	
			Pandwala Kalan		2.2	1.0	
			Jhul Jhuli		2.8	1.0	
			Rawta Village		0.8	1.0	
		SV	Tajpur Khurd		8.0	4.0	5.1
			Goyala vihar		2.5	2.0	
			Badu Sarai		1.4	2.0	
8	NILOTHI	Nilothi-2	Nilothi	60			
			Bakkarwala	0.66			
9	KANJHAWALA-BAWANA	Bawana	Katewara		2.6	2	15
			Daryapur		1.7	2	
			Bawana Village		2.8	2	
			Sultanpur Dabbas		1	2	
			Pooth Khurd		3.8	2	
			Bankner		4.3	2	
			Bawana		9	2.8	
		Kanjhawala	Salahpur Majra		1	3	25.5
			Kanjhawala Village		6	5	
			Sawda Gaon		1.5	2	
			Ghewera		1.7	2.9	

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP Location	Existing/ UC/ Planned by DJB WWTP Capacity (MGD)	Proposed WWTP Under SMP-2031		
					As per Present Habitation Occupancy		As per DDA- 2021
					Phase-I MGD	Phase-II MGD	Phase-III MGD
10	ROHINI- RITHALA		Rithala	80			
			Rohini	15			25
11	DWARKA		Dwarka	40			20
12	KESHOPUR		Keshopur	72			
Sub-Total (MGD)				693.66	118.9	85.7	169.4
Total Proposed Waste Water Treatment Capacity (MGD)				374.0			

Note: WWTP capacities and phasing for design year include Existing/ Planned WWTP capacities and proposed capacities for un-sewered areas as per SMP-2031. The constraints for finalization of capacities and phasing of WWTPs depends on habitation, land availability, implementation of DDA Master Plan and policy level decisions.

A synopsis of each of the sewerage scheme for the 12 drainage zones is provided in **Table 5** below:

Table 5: Synopsis of the Sewerage Schemes for the Drainage Zones of NCT of Delhi

Drainage Zone	Proposed Scheme
Zone 1: Shahdara Drainage Zone (SHD)	The Sewerage Scheme of drainage zone is designed and planned with respect to the catchment of existing WWTP of Yamuna Vihar and Kondli. Planning also done using proposed interceptor sewer line and existing Wazirabad Road Sewer (WRS) line in drainage zone. A WWTP is proposed for Sonia Vihar catchment.
Zone 2: Okhla Drainage Zone (OKH)	The sewage generated from the unsewered catchment has been proposed to cater to existing Okhla WWTP and Molarband WWTP. Another WWTP has been proposed at Tajpur.
Zone 3: Keshopur Drainage Zone (KSP)	This drainage zone is mostly sewerage discharging sewage to the Keshopur WWTP via existing Pumping stations. The unsewered pockets are proposed to be integrated to the existing sewer lines discharging to existing WWTP.
Zone 4: Rohini-Rithala Drainage Zone (RR)	The sewage generated from unsewered pockets in Rohini Catchment has been proposed to cater to existing Rohini WWTP. The sewage generated from Rithala Catchment has been proposed to discharge to existing sewerage infrastructure.
Zone 5: Coronation Pillar Drainage (COR)	The entire unsewered catchment of Drainage Zone convey sewage to the proposed 111 MGD capacity WWPS and proposed sewer under Interceptor Sewer Project. The wastewater from 111 MGD pumping station will finally discharge to existing Coronation Pillar WWTP. Proposed

Drainage Zone	Proposed Scheme
	interceptor sewer has been utilized while integrating with proposed infrastructure.
Zone 6: Dwarka Drainage Zone (DWK)	The scheme for Dwarka Drainage Zone is proposed with integration to the existing sewerage Infrastructure.
Zone 7: Najafgarh Drainage Zone (NJF)	Integration of existing sewerage infrastructure is proposed for the unsewered areas. The remaining unsewered areas within the drainage zone has been planned & designed.
Zone 8: Nilothi Drainage Zone (NLT)	The Sewerage Scheme of drainage zone is designed and planned with respect to the catchment of existing WWTP of Nilothi. Proposed interceptor sewer has been utilized while integrating with proposed infrastructure.
Zone 9: Narela Drainage Zone (NRL)	The scheme has been proposed to divert flows from this zone to existing Narela WWTP of 10 MGD capacity. The sewage generated through unsewered catchment is planned to discharge to the proposed two WWTPs in the Sub Drainage Zone at Palla and Zindpur.
Zone 10: South Delhi Drainage Zone (SD)	Sewage from Mahipalpur Sub Drainage zone has been planned to convey towards proposed WWTP. The sewage generated from Ghitorni Catchment has been planned to discharge to existing WWTP of 5 MGD. The sewage generated from Mehrauli Catchment has been planned with respect to the existing WWTP of 5 MGD in the Sub Drainage Zone. Sewage generated from Vasant Kunj Sub Drainage Zone is being conveyed to existing Vasant Kunj WWTP. Sewage from Kapashera Sub Drainage zone has been planned to convey towards WWTP at Kapashera.
Zone 11: Outer South Delhi Drainage Zone (OSD)	The Sewerage Scheme has been planned and designed for this drainage zone. Two WWTPs are proposed to cater the sewage flow generated from this drainage zone.
Zone 12: Kanjhawala-Bawana (KB)	The sewage generated from Bawana & Kanjhawala Catchment has been planned to cater proposed WWTPs in this drainage zone.

The SMP Final Report has been framed as the key submission of the study comprising approach and methodology, population projections, review & analysis of existing and planned sewerage infrastructure, planning for proposed sewerage schemes with integration approach, outcome of feasibility study and cost estimates to arrive at implementation & investment plans.

The overall report has been formulated in six (6) volumes. Volume I covers Executive summary whereas Main Report is covered under Volume II. The full development of separate sewerage schemes for various drainage zones of NCT of Delhi are attached as Annexure 1 to 12 in Volumes III, IV and V. Volume VI represents Maps for Drainage Zone wise proposed infrastructure, unsewered areas of Delhi as per Group of Colonies (GOCs) and Map for overall proposed infrastructure comprising Schemes and Drainage Zones.

The structure of Master Plan Report is represented as follows:

VOLUME – I	EXECUTIVE SUMMARY
VOLUME – II	MAIN REPORT
VOLUME – III	ANNEXURE (1 TO 4)
	ANNEXURE - 1 Shahdara Drainage Zone (SHD)
	ANNEXURE - 2 Coronation Pillar Drainage (COR)
	ANNEXURE - 3 Narela Drainage Zone (NRL)
	ANNEXURE - 4 Rohini-Rithala Drainage Zone (RR)
VOLUME – IV	ANNEXURE (5 TO 8)
	ANNEXURE - 5 Kanjhawala-Bawana (KB)
	ANNEXURE - 6 Keshopur Drainage Zone (KSP)
	ANNEXURE - 7 Nilothi Drainage Zone (NLT)
	ANNEXURE - 8 Dwarka Drainage Zone (DWK)
VOLUME – V	ANNEXURE (9 TO 12)
	ANNEXURE - 9 Najafgarh Drainage Zone (NJF)
	ANNEXURE - 10 Okhla Drainage Zone (OKH)
	ANNEXURE - 11 South Delhi Drainage Zone (SD)
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VOLUME – VI	MAPS
	1. Twelve Drainage Zones of Delhi
	2. Sub-Drainage Zones
	3. Proposed Infrastructure for Shahdara Drainage Zone
	4. Proposed Infrastructure for Coronation Pillar Delhi Drainage Zone
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	6. Proposed Infrastructure for Rohini-Rithala Drainage Zone
	7. Proposed Infrastructure for Kanjhawala-Bawana Drainage Zone
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	10. Proposed Infrastructure for Dwarka Drainage Zone
	11. Proposed Infrastructure for Najafgarh Drainage Zone
	12. Proposed Infrastructure for Okhla Drainage Zone
	13. Proposed Infrastructure for South Delhi Drainage Zone
	14. Proposed Infrastructure for Outer South Delhi Drainage Zone
	15. Delhi Sewerage Master Plan - 2031

Summary of Sewerage Network, WWPS and WWTP as per SMP-2031.

- Proposed Sewerage length : 9807 km (Maximum Diameter: 1600 mm)
- Proposed Pumping Stations: 101 Nos. (27 Lift Stations, 74 Waste Water Pumping Stations, Capacity Range: 0.1 – 41 MGD).
- Proposed Waste Water Treatment Plant Capacity: 374 MGD (75 Nos. at 38 locations, Capacity Range: 0.6 – 38.6 MGD)

Investment and Implementation Plans

Investment Plan

Cost estimates have been prepared for provision of sewerage facilities for unsewered areas in NCT of Delhi. Total Investment anticipated for stipulated sewerage assets is INR 19500 Crores. Summary of the cost estimates prepared is listed in **Table 8.6**.

Total investment of project as evaluated on present basis = INR 10,077 Crores.

Break Up of the sewerage infrastructure with following assumptions:

Sl. No.	Item	Cost in INR Crores								
1	Sewerage Network <table border="1"><tr><td>Trunk Sewer (km)</td><td>210</td></tr><tr><td>Peripheral Sewer (km)</td><td>2090</td></tr><tr><td>Internal Sewer (km)</td><td>7507</td></tr><tr><td>Total Network Length (km)</td><td>9807</td></tr></table>	Trunk Sewer (km)	210	Peripheral Sewer (km)	2090	Internal Sewer (km)	7507	Total Network Length (km)	9807	6544
Trunk Sewer (km)	210									
Peripheral Sewer (km)	2090									
Internal Sewer (km)	7507									
Total Network Length (km)	9807									
2	Waste water pumping stations including Rising Mains and associated structures. Cost includes per year O&M and disposal arrangement of treated wastewater.	919								
3	Waste water treatment Plants for ultimate design year Total anticipated capacity : 374 MGD (1698 MLD)	2614								
	TOTAL INVESTMENT OF PROJECT (INR Cr.)	10,077								

Investment plan on five years incremental have been represented as below with escalation factor @ 8.5%.

Work booking factor has been estimated based on tentative implementation plan of prioritized projects.

Year	Anticipated Investment required (INR Cr)	Average escalations Year	Escalated Amount (INR Cr.)
Upto Yr 2016	1511.54	2	1,779.43
2016 - 2021	4534.63	5	6,818.53
2022 - 2027	3023.09	11	7,416.14
2027 - 2031	1007.70	15	3,425.91
TOTAL (INR Cr.)			19,440.00

Grand Total investment amount in INR: 19,440 (Say INR 19,500 Crores).

The Investment Plan in co-relation with implementation plan has been represented as below:



Figure 8.4: Investment Plan for proposed sewerage schemes

Implementation Plan

Tentative Implementation Plan has been prepared for proposed sewerage schemes as represented below in Table 6:

Table 6: Implementation Plan for proposed sewerage schemes

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
SHD	Yamuna Vihar	YV1	SHD-YV1-KP	Kardampuri GOC				
SHD	Yamuna Vihar	YV1	SHD-YV1-BM	Buland Masjid				
SHD	Yamuna Vihar	YV1	SHD-YV1-WJN	West Jyoti Nagar				
SHD	Yamuna Vihar	YV2	SHD-YV2-Z1	YV2Z1 Part of Karawal Nagar				
SHD	Yamuna Vihar	YV2	SHD-YV2-Z2	YV2Z2 Part of Mustafabad				
SHD	Yamuna Vihar	YV3	SHD-YV3	SHD YV3 Part of Saboli				
SHD	Yamuna Vihar	YV3	SHD-YV3-P2	SHD-YV3 Phase-II				
SHD	Sonia Vihar	SV	SHD-SV	Sonia Vihar GOC				
SHD	Kondli	KN1	SHD-KN1-SG	Shashi Garden				
SHD	Kondli	KN1	SHD-KN1-RG	Rani Garden				
SHD	Kondli	KN1	SHD-KN1-WVN	West Vinod Nagar				
SHD	Kondli	KN1	SHD-KN1-SM	Shanti Muhalla				
SHD	Kondli	KN1	SHD-KN1-MS	Makki Sarai				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
SHD	Kondli	KN1	SHD-KN1-JC	Janta Colony				
SHD	Kondli	KN2	SHD-KN2	Kondli GOC				
SHD	Yamuna Vihar	YV1	SHD-YV1-AN	Ashok Nagar				
OKH	Okhla	OK2	OKH-OK2-BHP1	Batla House Phase I				
OKH	Okhla	OK2	OKH-OK2-BHP2	Batla House Phase II				
OKH	Okhla	OK2	OKH-OK2-SB	Shaheen Bagh				
OKH	Okhla	OK2	OKH-OK2-MSJ	Maidangarhi & Saidullajab				
OKH	Okhla	OK2	OKH-OK2-MSJ2	Maidangarhi Phase II				
OKH	Okhla	OK2	OKH-OK2-TKD	Tuglakabad				
OKH	Okhla	OK2	OKH-OK2-SVP1	Sangam Vihar GOC Ph I				
OKH	Okhla	OK2	OKH-OK2-SVP2	Sangam Vihar GOC Ph II				
OKH	Okhla	OK2	OKH-OK2-PP	Pulprehladpur				
OKH	Okhla	OK2	OKH-OK2-MK	Madanpur Khadar				
OKH	Okhla	OK2	OKH-OK2-ALI	Aligaon				
OKH	Okhla	OK2	OKH-OK2-GA	Gautampuri Awas				
OKH	Okhla	OK2	OKH-OK2-MN	Malviya Nagar GOC				
OKH	Tajpur	OK2	OKH-OK2-TP	Tajpur GOC				
COR	Coronation Pillar	CP2	Cor-CP2-SP	Samaypur GOC				
COR	Coronation Pillar	CP2	Cor-CP2-WB	Wazirabad GOC				
COR	Coronation Pillar	CP2	Cor-CP2-BL	Bhalaswa GOC				
COR	Coronation Pillar	CP2	Cor-CP2-SRP	Saroop Nagar GOC				
COR	Coronation Pillar	CP2	COR-CP2-SNT	Sant Nagar GOC				
COR	Coronation Pillar	CP2	Cor-CP2-GV	Gandhi Vihar				
COR	Coronation Pillar	CP2	Cor-CP2-GP	Gopalpur				
NRL	Narela	NR	NRL-NR-SNG	Singhu				
NRL	Narela	NR	NRL-NR-HKB	Hamidpur, Khampur, Bakholi				
NRL	Narela	NR	NRL-NR-KU	Kureni GOC				
NRL	Palla	PL	NRL-PL	Palla GOC				
NRL	Palla	PL	NRL-BKP	Bakhtawar GOC				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
NRL	Zindpur	ZP	NRL-ZP	Zindpur GOC				
SD	Mahrauli	MH	SD-MH	Mehrauli				
SD	Mehrauli	MH	SD-MH-CM	Chhatarpur Village and Manglapuri				
SD	Ghitorni	GH	SD-GH	Ghitorni				
SD	Mahipalpur	MP	SD-MP	Mahipalpur				
SD	Ghitorni	GH	SD-GH-AN	Ayanagar GOC				
SD	Kapashera	KH	SD-KH-BWE	Bijwasan				
SD	Kapashera	KH	SD-KH	Kapashera GOC				
SD	Vasantkunj	VK	SD-VK-KG	Kishangarh				
OSD	Fatehpurberi	FC	OSD-FB	Fatehpurberi GOC				
OSD	Rajpurkhurd	RK	OSD-RK	Rajpur Khurd GOC				
DWK	Dwarka	DK2	DWK-DK2-ME	Mahaveer Enclave GOC				
DWK	Dwarka	DK2	DWK-DK2-VM	Vijay Enclave Mahaveer Vihar				
DWK	Dwarka	DK2	DWK-DK2-KGC	Kakrola GOC				
DWK	Dwarka	DK2	DWK-DK2-SC	Sitapuri II, Chanakya Place II				
DWK	Dwarka	DK2	DWK-DK2-BP	Bindapur GOC				
DWK	Dwarka	DK2	DWK-DK2-MV	Madhu Vihar GOC				
DWK	Dwarka	DK2	DWK-DK2-SAD	Sadh Nagar				
DWK	Dwarka	DK2	DWK-DK2-IP	Indra Park				
DWK	Dwarka	DK2	DWK-DK2-DV	Dabri Village				
DWK	Dwarka	DK2	DWK-DK2-SM	Shahbad Mohdpur				
DWK	Dwarka	DK2	DWK-DK2-RN	Raj Nagar Ext				
DWK	Dwarka	DK2	DWK-DK2-BWW	Bijwasan West				
DWK	Dwarka	DK2	DWK-DK2-SN	Sainik Nagar GOC				
DWK	Dwarka	DK2	DWK-DK2-NPB	Nala Par Basti				
DWK	Dwarka	DK2	DWK-DK2-PP	Pochanpur				
DWK	Dwarka	DK2	DWK-DK2-RGN	Raghu Nagar				
DWK	Dwarka	DK2	DWK-DK2-TP	Toganpur				
RR	Rithala	RT1	RR-RT1-SN	Sanjay Nagar				
RR	Rithala	RT2	RR-RT2-BV	Budh Vihar GOC				
RR	Rithala	RT3	RR-RT2-RP	Rajdhani Park				
RR	Rohini	RH2	RR-RH2-KI	Kirari GOC				
RR	Rohini	RH2	RR-RH2-BP	Begumpur GOC				
RR	Rohini	RH2	RR-RH2-SB	Sahibabad GOC				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
RR	Rohini	RH2	RR-RH2-RV	Raja Vihar				
KB	Kanjhawala	KJ	KB-KJ-SM	Salahpur Majra GOC				
KB	Kanjhawala	KJ	KB-KJ-KV	Kanjhawala GOC				
KB	Kanjhawala	KJ	KB-KJ-NP	Nizampur GOC				
KB	Kanjhawala	KJ	KB-KJ-GV	Ghwera GOC				
KB	Bawana	BW	KB-BW-BP	Baljitpur GOC				
KB	Bawana	BW	KB-BW-PK	Pooth Khurd GOC				
KB	Bawana	BW	KB-BW-ST	Sanooth GOC				
KB	Bawana	BW	KB-BW-NB	Nayabans GOC				
KSP	Keshopur	KP2	KSP-KP2-BN	Bhupinder Singh Nagar Group of Colonies				
NLT	Nilothi	NT2	NLT-NT2-KMR	Kamruddin Nagar				
NLT	Nilothi	NT2	NLT-NT2-MG	Mohan Garden				
NLT	Nilothi	NT2	NLT-NT2-VP	Vikaspuri				
NLT	Nilothi	NT2	NLT-NT2-UV	Uday Vihar				
NLT	Nilothi	NT2	NLT-NT2-SE	Shiv Enclave, Nilothi				
NLT	Nilothi	NT2	NLT-NT2-NNR	NNR Trunk Sewer				
NLT	Nilothi	NT2	NLT-NT2-NV	Nihal Vihar				
NLT	Nilothi	NT2	NLT-NT2-RN	Ranhola GOC				
NJF	Najafgarh	NJ	NJF-NJ-IP	Prem Nagar GOC				
NJF	Jhuljhuli	JH	NJF-JH	Jhuljhuli Village GOC				
NJF	Dichaon kalan	DK	NJF-DK	Dichaon Kalan GOC				
NJF	Dichaon kalan	DK	NLT-DK-TK	Tikri Kalan GOC				
NJF	Somesh Vihar	SV	NJF-SV	Somesh Vihar GOC				

Sewerage Management Regulations & Development Controls

The aim of this Plan is to ensure waste water conveyance systems and treatment meets acceptable environmental and health performance standards.

Specific objectives of sewerage management include the following:

- I. *Prevention of public health risk*
- II. *Protection of surface water*
- III. *Protection of groundwater*
- IV. *Protection of land*
- V. *Conservation and reuse of resources*
- VI. *Protection of community amenity*

To achieve above mentioned objectives the competent authorities shall handle the following matters:

1. Set up the development policies and schemes for the Sewer.
2. Set up the Sewerage rules and regulations and examine compliance.
3. Review and examine the development plan for the Sewerage system in Delhi.
4. Monitor and supervise the construction, management, and development for the Sewerage system in municipality and Delhi.
5. Administration of technique and the training of the Sewer operation and maintenance people.
6. Research and develop the sewerage techniques.
7. Coordinate the structure, construction and management of the Sewers in situations of multi-municipality and city.
8. Promote measures for conservation, recycling and reuse of water.

PLEASE NOTE: *As a Master Planner AECOM-WAPCOS have proposed the network alignment and associated structures, while it's DJB's decision to lay sewer lines and implementation of physical works in respective colonies/areas following directions provided by Govt. of Delhi / High court / Supreme Court.*

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS (MoEF)

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

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VOLUME – VI	MAPS

JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
JUNE 2014

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CHAPTER - 1

INTRODUCTION

CHAPTER - 1: INTRODUCTION

1.1 BACKGROUND

The National Capital Territory of Delhi (NCT) covers an area of 1,483 square kilometers and is divided into 9 census districts (as shown in **Figure 1.1** below) and 27 sub-divisions (Tehsils). Out of this, the urban area, including the new settlements in rural habitations, accounts for about 525 square kilometers. Delhi encompasses three governing bodies viz. the Municipal Corporation of Delhi (MCD), the New Delhi Municipal Council (NDMC) and Delhi Cantonment Board (DCB). The MCD is one of the largest municipal bodies in the world according to population size of the total NCT area, MCD occupies 94.22%, whereas NDMC and DCB occupy 2.88% and 2.90% respectively. MCD is now divided into three sub-divisions i.e. South Delhi Municipal Corporation (SDMC), East Delhi Municipal Corporation (EDMC) and North Delhi Municipal Corporation (NDMC).



Figure 1.1: Census Districts of NCT of Delhi

The National Capital Territory of Delhi has been divided into 15 Planning Zones / Division as per Delhi Development Authority (DDA) Master Plan 2021, out of which 8 zones ('A' to 'H') are in the Urban area and 6 zone 'J' to 'P' (Except 'I') are in Urban Extension / Rural Area, whereas Zone 'O' is designated for river Yamuna/Yamuna Front – refer **Figure 1.2** below:

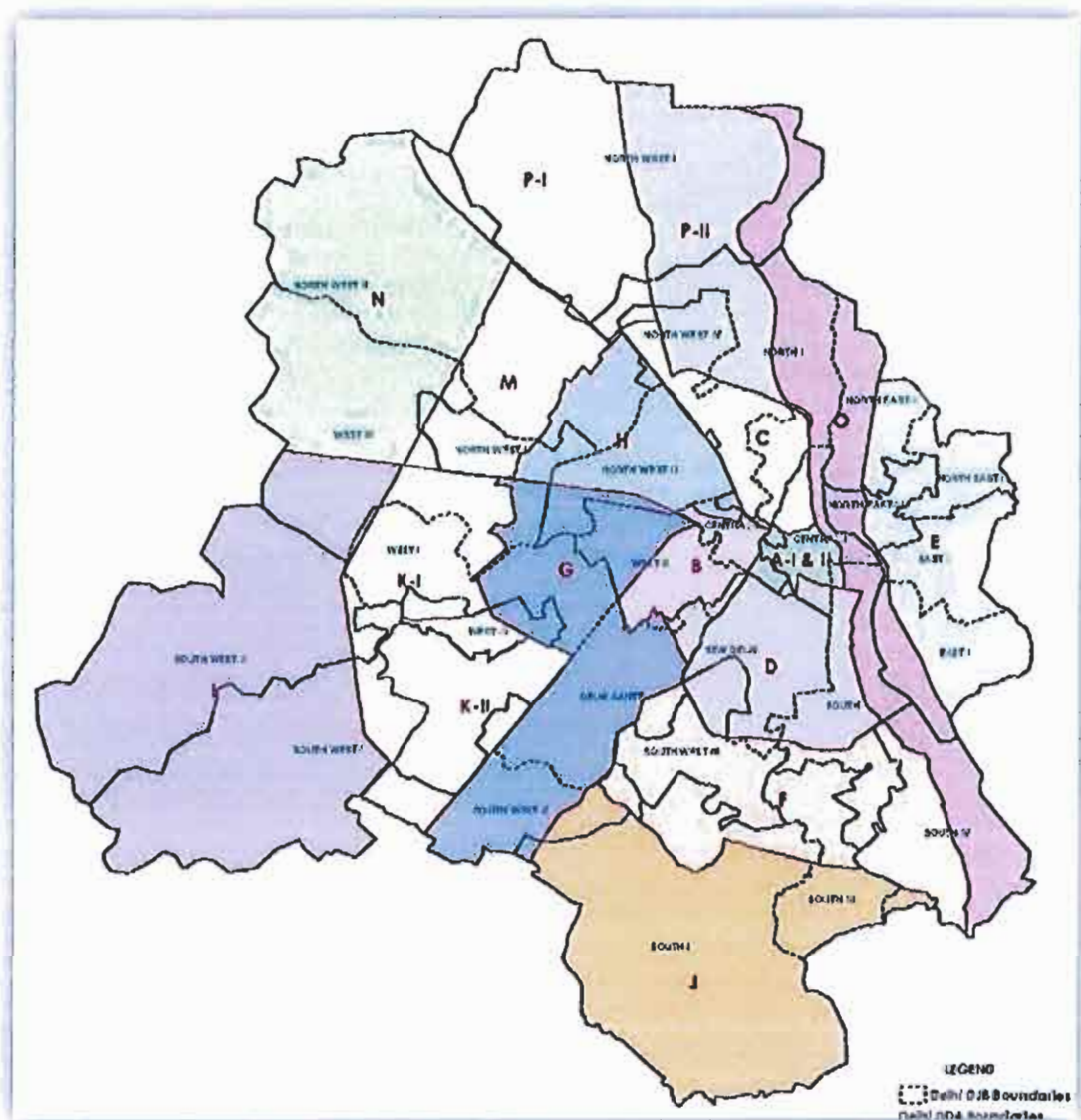


Figure 1.2: DDA Zones

River Yamuna

The River Yamuna, a major tributary of River Ganges, originates from the Yamunotri glacier near Banderpoonch peaks ($38^{\circ} 59' \text{ N } 78^{\circ} 27' \text{ E}$) in the Mussourie range of the Lower Himalayas at an elevation of about 6387 meters above mean sea level in district Uttarkashi (Uttaranchal). Arising from the source, River Yamuna flows through a series of valleys for about 200 km, in Lower Himalayas and emerges into Indo-Gangetic Plains. In the upper stretch of 200 km, it draws water from several major streams. The combined stream flows through the Shivalik range of hills of Himachal Pradesh and Uttaranchal states of India and enters into plains at Dak Pathar in Uttaranchal where the river water is regulated through weir and diverted into canal for power generation. From Dak Pathar, it flows through the famous Sikh religious place of Paonta Sahib. Flowing through Paonta Sahib it reaches Hathnikund/Tajewala in Yamuna Nagar district of Haryana state, where the river water is again diverted into Western Yamuna Canal and Eastern Yamuna Canal for irrigation. It enters Delhi near Palla village after traversing a route of about 224 km from Tajewala.

The river is again tapped at Wazirabad through a Barrage for drinking water supply to Delhi. Generally, no water is allowed to flow beyond Wazirabad Barrage in dry season, as the available water is not adequate to fulfill the demand of water supply of Delhi. Whatever water flows in the downstream of Wazirabad Barrage is the untreated or partially treated domestic and industrial wastewater contributed through

several drains. After 22 km downstream of Wazirabad Barrage there is another barrage, Okhla Barrage, through which Yamuna water is diverted into Agra Canal for irrigation. No water is allowed to flow through the barrage during dry season. Whatever water flows in the river beyond Okhla barrage is contributed through domestic and industrial wastewater generated from East Delhi, Noida and Sahibabad and joins the river through Shahdara drain. The Yamuna after receiving water through other important tributaries joins the River Ganga and the underground Saraswati at Prayag (Allahabad) after traversing about 950 km.

There are 18 major drains out falling in River Yamuna between Wazirabad Barrage and Okhla Barrage. These drains were originally meant for carrying storm water. But due to lack of sewerage system in many unauthorized colonies, rural villages as well as non-functioning of sewerage system in planned colonies, raw sewage is being discharged into the river. The pollution in the river is also contributed by other stakeholders due to the open defecation by the people living along the river banks and the banks of the drains, Industrial waste and dumping of garbage directly into drains and River Yamuna. This heavy pollution load in River Yamuna, which also releases foul gases, may cause severe problems to the environment and nearby inhabitants. Polluted water is also the breeding ground for mosquitoes, which further exaggerated the problem during the recent 2011 Commonwealth Games. Due to scarcity of water in Delhi, polluted ground water extracted through hand pumps or shallow tube wells may cause water borne diseases which may become epidemic resulting in a disaster. The quality of river water thus has been converted to below "E" category against the required "B" category (Bathing Standard). Hence, the reach of around 22 km of River Yamuna between Wazirabad Barrage and Okhla Barrage is the most crucial requiring mitigation. The challenge is to treat the quality of Yamuna water up to "B" category in this reach.

1.2 DELHI JAL BOARD (DJB)

The Delhi Jal Board was constituted on 6th April, 1998 through an Act of the Delhi Legislative Assembly incorporating the previous Delhi Water Supply and Sewage Disposal Undertaking. The Delhi Jal Board is responsible for the Production and Distribution of potable water after treating raw water from various sources like river Yamuna, Bhakhra Storage, Upper Ganga Canal & Groundwater and also provides treatment and disposal of waste water. The Delhi Jal Board provides water in bulk to the NDMC and Cantonment areas. Sewage from these areas is also collected for treatment and disposal by the Delhi Jal Board.

The Chief Minister, GNCTD is the chairperson of the Board, which has 17 members. The Chief Executive Officer of the Board has to be appointed by the GNCTD. The GNCTD also has been authorized to exercise other controls, including issue of directions, to the Board.

Delhi Jal Board (DJB) is responsible for procurement of raw water, treatment and supply to the three constituents and responsible for distribution of water supply and related works in MCD area.

The DJB is also responsible for collection, conveyance and treatment of wastewater generated in the entire NCT of Delhi, either directly or indirectly. It currently takes wastewater from the NDMC and the DCB areas, both of which are responsible for the provision of local sewer networks within their own territories. The wastewater infrastructure in these territories is owned by them and, consequently, is not the responsibility of the DJB. The DJB is legally obliged to convey and treat the wastewater generated by these two territories.

1.3 OBJECTIVE OF THE STUDY

Over the last 30 years, the population of Delhi has rapidly increased from 4 million (in 1971) to around 18 million people today. The burgeoning population coupled with slow and unorganized development in sewage infrastructure has posed a major threat to the city's sanitation issues, subsequently affecting river

water quality and public health of the inhabitants. Only about 50% of the population of Delhi is having access to sewerage system. Remaining 50% area of NCT Delhi is unsewered.

In response to this challenge, AECOM-WAPCOS has been engaged by Delhi Jal Board (DJB):

- to develop a holistic, integrated and sustainable Master Plan for design horizon of 2031.
- to ensure that the comprehensive, technically and financially viable plans (CAPEX & OPEX) are in place for the implementation of sewerage and non-sewerage improvement works.
- to improve the general sanitation conditions and also to improve and enhance the water quality in River Yamuna.

The entire National Capital Territory of Delhi (NCT) with an area of 1483 square kilometers can be broadly categorized into two: sewerred area and un-sewerred areas, as shown in **Figure 1.3** below:

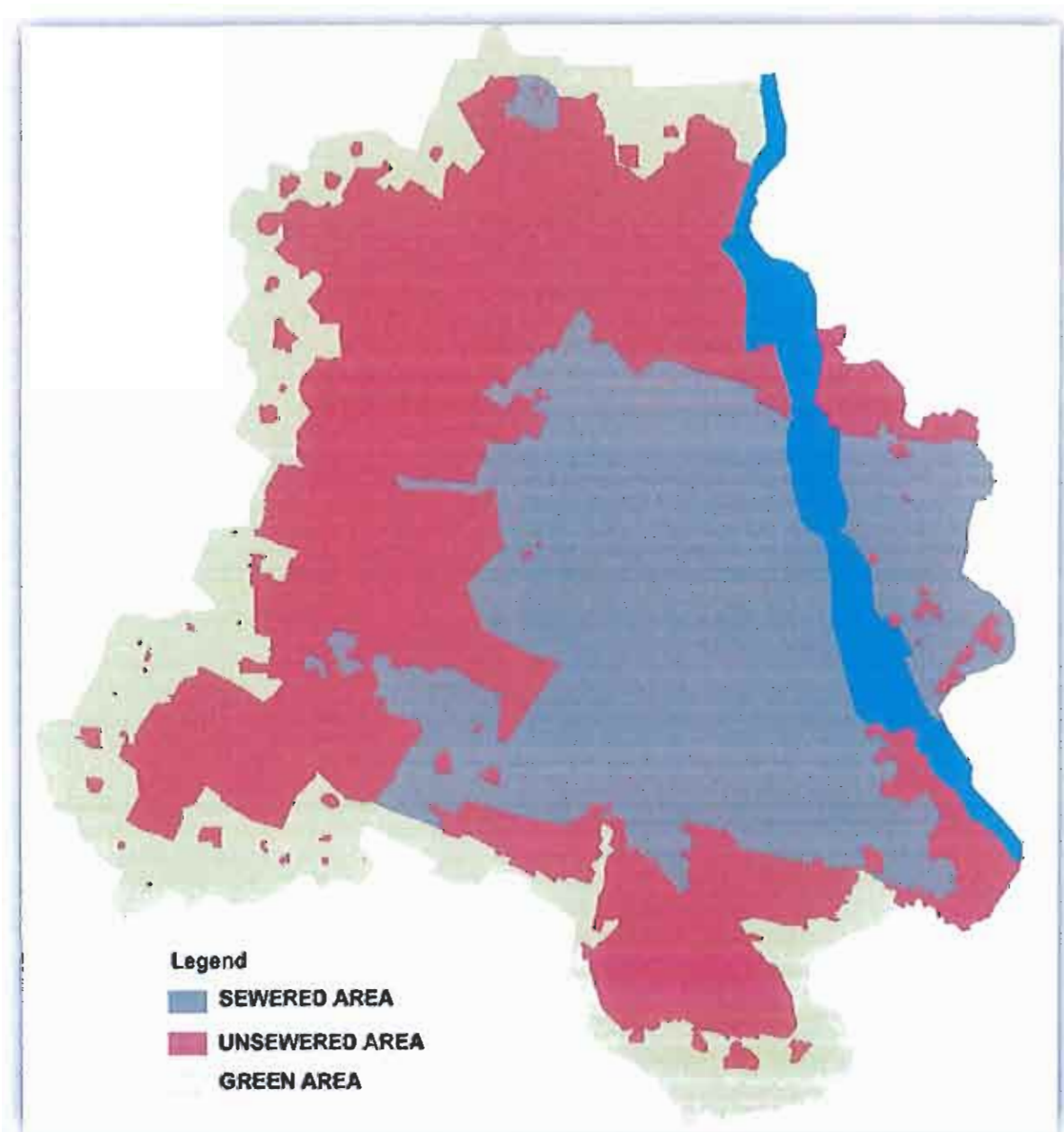


Figure 1.3: Sewered & Unsewered area of NCT of Delhi

1.4 DESIGN HORIZON

Master Plan to meet the sewerage needs of Delhi has been prepared for the design horizon of the year 2031.

1.5 PURPOSE OF THE REPORT

Master Plan report has been framed as the key submission of the study comprising approach and methodology, population projections, review & analysis of existing and planned sewerage infrastructure, planning for proposed sewerage schemes with integration approach, outcome of feasibility study and cost estimates to arrive at implementation & investment plans.

1.6 REPORT STRUCTURE

The Sewerage Master Plan Main Report i.e. **Volume II** has been presented in the following chapters:

➤ **Chapter-1 : Introduction**

This chapter provides the brief introduction, objectives and detailed scope of work of project for the preparation of Sewerage Master Plan Delhi-2031.

➤ **Chapter-2 : Profile of (NCT) Delhi**

This chapter illustrates the topography, climatic conditions, Geology, Groundwater conditions of NCT Delhi.

➤ **Chapter-3 : Existing Water/Sewerage Infrastructure**

The chapter describes the overall present infrastructure status of NCT Delhi.

➤ **Chapter-4 : Data Collection**

Summarizes the data / information collected and findings of field surveys conducted under this Study.

➤ **Chapter-5 : Population Projection**

In this chapter, basis of population data from different agency's reports, census data, and methodology of population projection, allocation of projected population in different DDA zones and forecasting of population by different mathematical methods are explained.

➤ **Chapter-6 : Planning and Design Criteria**

The chapter deals with the basic design criteria adopted to perform design of sewerage network referring to design guidelines published in CPHEEO manual, EPA guidelines and Australian guidelines. Some of these are minimum & maximum velocity, minimum & maximum cover, the material and size of conduits etc.

➤ **Chapter-7 : Approach and Methodology for GIS Data Integration and Hydraulic Modeling**

The chapter presents the detailed procedure of modeling approach for hydraulic performance assessment of network including construction of model, verification and analysis of various alternatives vis-à-vis discussion of results.

➤ **Chapter-8 : Ramifications of Sewerage Master Plan - 2031**

This chapter describes the basis of zoning, and lists out various zone delineation, wastewater generation of NCT Delhi, and zone wise proposed sewerage infrastructure, implementation plan and investment plan etc.

➤ **Chapter-9 : Recommended Options for Treated Wastewater Reuse and Disposal**

In this chapter various options for treated wastewater Reuse and Disposal options are discussed

➤ **Chapter-10 : Environmental Review**

In this chapter environmental issues are addressed including noise, air quality, water quality, waste management and ecology.

➤ **Chapter-11 : Traffic Review**

This chapter discusses the impacts and mitigation measures for traffic management schemes to overcome the potential impacts during laying of sewerage system.

➤ **Chapter-12: Land Requirements**

This chapter reviews the current land status and the availability of the land for sewer pipe laying and sewerage infrastructures that are proposed under Sewerage Master Plan.

CHAPTER - 2

PROFILE OF (NCT) DELHI

CHAPTER - 2: PROFILE OF (NCT) DELHI

2.1 TOPOGRAPHY

Delhi is situated on the banks of River Yamuna. The River Yamuna flows from North to South. A hard rocky ridge running from the Southern border of NCT in the south west in north easterly direction to the western banks of the River Yamuna near Wazirabad Barrage forms the main watershed in NCT of Delhi. The topography thus creates a drainage system that carries rain and storm water from higher elevation to lower elevation i.e. towards the west of River Yamuna.

The Eastern low-lying side which was originally part of the river's flood plain was considered un-habitable. Today however this Eastern wing, also known as the Trans Yamuna area, houses about 20 % of the total population of Delhi.

2.2 GEOLOGY AND GEOTECHNICAL DETAILS OF DELHI

Delhi is located in Northern India between the latitudes of 28°-24'-17" and 28°-53'-00" North and longitudes of 76°-50'-24" and 77°-20'-37" East. Delhi shares its border with the States of Uttar Pradesh and Haryana. Delhi has an area of 1,483 sq. km. Its maximum length is 51.90 km and greatest width is 48.48 km.

Delhi is situated on the right bank of the river Yamuna at the periphery of the Gangetic plains. It lies a little north of 28° N latitude and a little to the west of 78° longitude. To the west and south-west is the great Indian Thar desert of Rajasthan state, formerly known as Rajputana and, to the east lies the river Yamuna across which has spread the greater Delhi of today.

Geology

Geologically, the area comprises of quartzites of Delhi Supergroup (~1500 m.y), occasionally interbedded with mica schist and intruded by pegmatites. These rocks are unconformably overlain by Quaternary to Recent sediments (> 1.64 m.y). A.M. Haron (1917) mapped the area and classified the rock of the area in Alwar Series of Delhi System. The geology of the area was brought out in the course of geotechnical investigations by Krishnaswamy & Srivastava (1964), Tiku (1965), Srivastava, K.N. (1972), Srivastava. et al (1974) and mineral investigations by Srivastava, J.P. (1957-60). Recently Kachroo and Bagchi (1999) brought out detailed geology of Delhi in the course of thematic mapping of the rocks of Delhi Supergroup. **Table 2.1** gives the details of the gross lithology of the geological units.

Table 2.1: Stratigraphy of Geological Formations and their Lithology

System	Stratigraphy	Lithology
Quaternary	Newer Alluvium	Unconsolidated, interbedded lenses of sand, silt, gravel and clay confined to flood plains of Yamuna river.
	Older Alluvium	Unconsolidated interbedded, interfingering deposit of sand, clay and kankar, moderately sorted, thickness variable, at places more than 300m.
Pre-Cambrian	Alwar Quartzites	Well-stratified, thick-bedded brown to buff colour, hard and compact Quartzite intruded locally by pegmatite and quartz veins, and interbedded with mica schists.

The quartzites are exposed on the surface along the 'Ridge' in the central and southern parts of the region. It is opined that the Delhi Ridge has been uplifted in quarternary times. The quartzite as exposed in the ridge area is also encountered in bore wells at several places. The urban cover has masked the exposures of the quartzite. At most places the quartzite is massive grey to buff colored and show color banding and differential weathering. The bedding in quartzite is not prominent but is defined mostly by the presence of sedimentary structures like current bedding, ripple marks or load casts. The bedrock is overlain by the aeolian deposits, which are mainly loam, silty loam and sandy loam. The contact between these quartzites and overlying unconsolidated sediments of Older and Newer alluvium is unconformable. Generally, the thickness of the alluvium increases away from the ridge in sympathy with the depth of the basement. The detailed geological map of Delhi is shown in **Figure 2.1**.

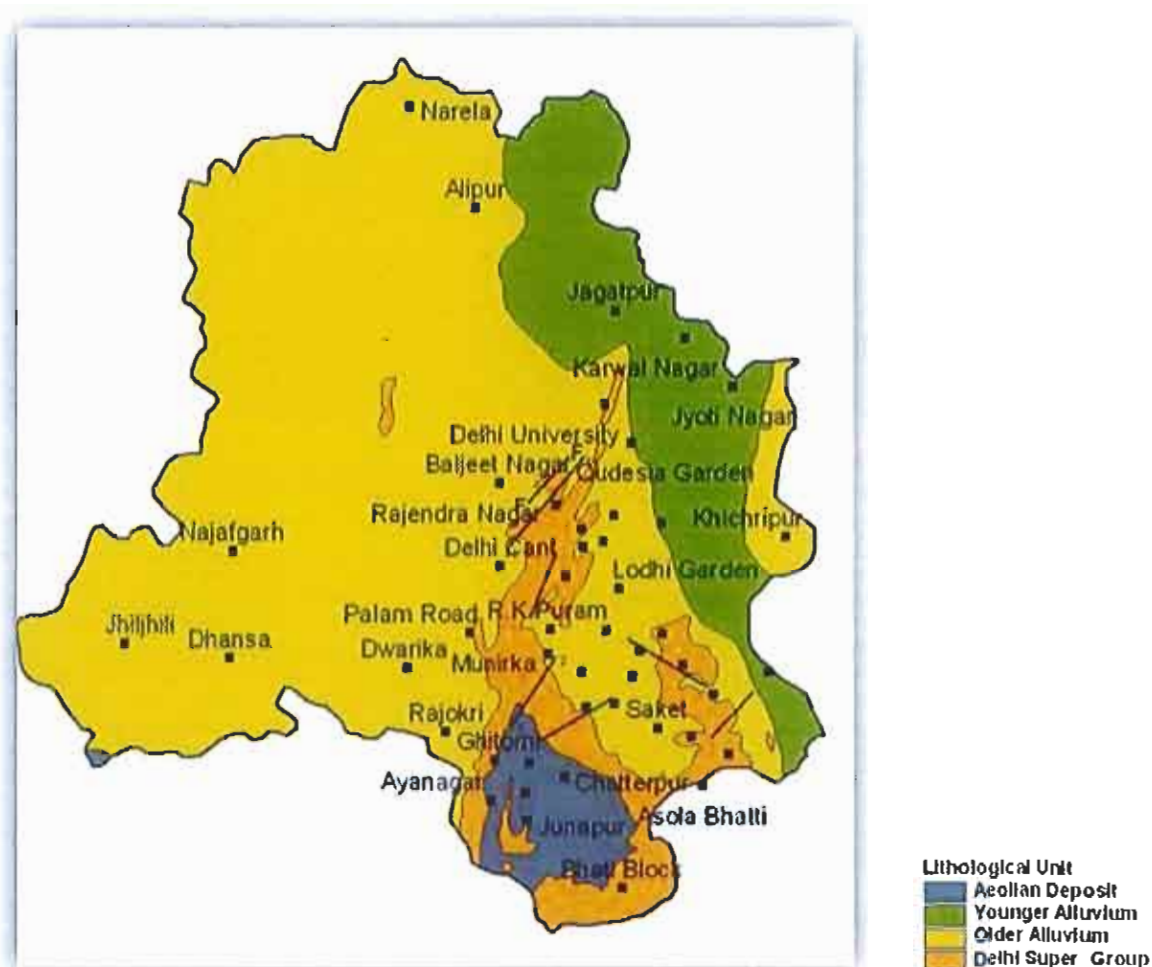


Figure 2.1: Geological Map of Delhi

Older Alluvium comprises interbedded and lenticular deposits of clay, silt and sand ranging from very fine to very coarse with occasional kankar. Major part of the area is covered by older alluvium, which extends from the western part of the area up to Ring Road in the north. The thickness of the alluvium is highly variable and is dependent mainly on the configuration of the basement. During the geophysical (Resistivity) survey undertaken, Global Hydrogeological Solutions established depth of bed rock at 560 m below ground level (BGL) at Shahbad Mohammadpur near IGI airport which is the deepest depth of bed rock recorded so far.

Newer Alluvium is confined to the flood plains of Yamuna River and also along the courses of major streams. It comprises of clay/silt mixed with small mica flakes, and medium to coarse-grained sand and gravel.

Subsurface Detail

Generally the bedrock topography in Delhi region is undulating with several humps and depressions. The depth of bedrock varies from near surface to beyond 200 meters deep from place to place, which is caused mainly due to the complex tectonic features of the area and thick sediments deposited on the bedrock. Several agencies like GSI, RITES, CGWB and others have carried out geotechnical investigations in Delhi for various purposes. The investigations carried out by the different agencies mainly include geophysical surveys, geotechnical investigations and drilling of shallow as well as intermediate depth drill holes with a view to either determine the nature of material lying below the surface, locate the possible source of ground water and delineate the bedrock profile.

The thickness of soil cover in Delhi area varies from nil to beyond 200m depths. This unusual variation is due to the appearance of NNE-SSW Delhi-Hardwar Ridge. Thickness of soil cover is generally much deeper towards eastern region than that of the west. In some places abrupt changes in the thickness of soil cover can be observed in this area, mainly due to the presence of faults. This narrow ridge develops in the form of a buried ridge passing from Chanakya Puri to Old Yamuna Bridge through Rail Bhawan, Ashok Road Connaught Place, Ramlila Ground and Chowri Bazar where bedrock is at very shallow depth varying from 5 to 20m below ground level. The thickness of soil cover around east of the ridge in North Delhi varies from almost nil to 30m, with a gradual easterly slope towards the river Yamuna. Towards west of the ridge, the thickness also varies from almost nil to 30m and beyond, with an abrupt deepening has been shown in north beyond 180m near Roshanara Garden. In the southern part of Delhi around Gurgaon and Palam, the thickness of soil cover generally starts varying from 75m and goes much beyond 120m, except in the vicinity of rock exposures. In the east-west direction the thickness of overburden varies from almost nil in the Link road - Pusa road to as much as 60m in the Patel road area. The thickness gradually increases in the axis of Jawaharlal Nehru road, Connaught Place, Rajghat area starting from 8m to 50m and goes beyond 120m in the Yamuna riverbed. However, more realistic estimation of thickness of soil cover of the area can be done by collecting the grid wise subsurface features of the area.

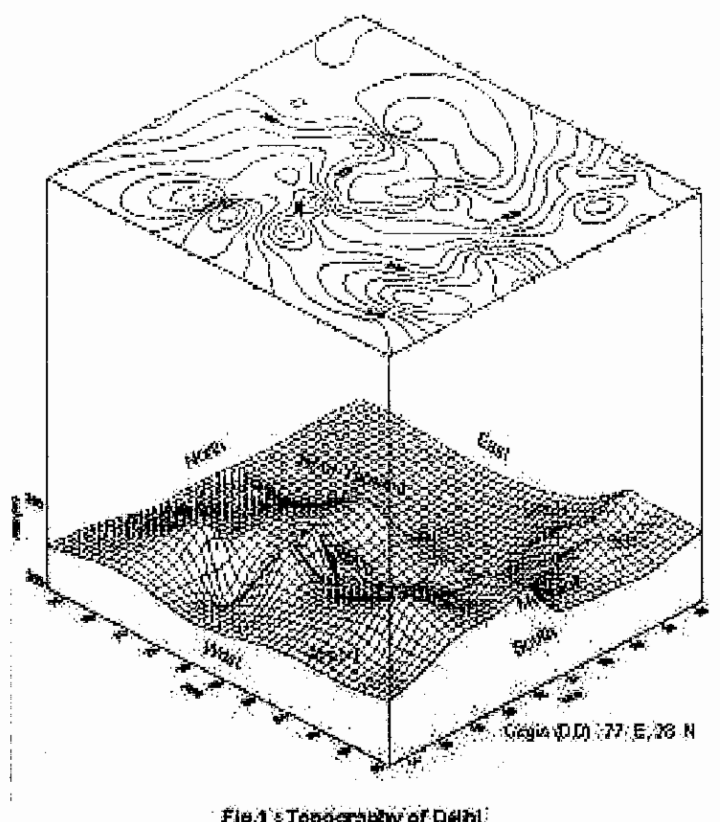


Fig.1 : Topography of Delhi

Figure 2.2: Topography of Delhi

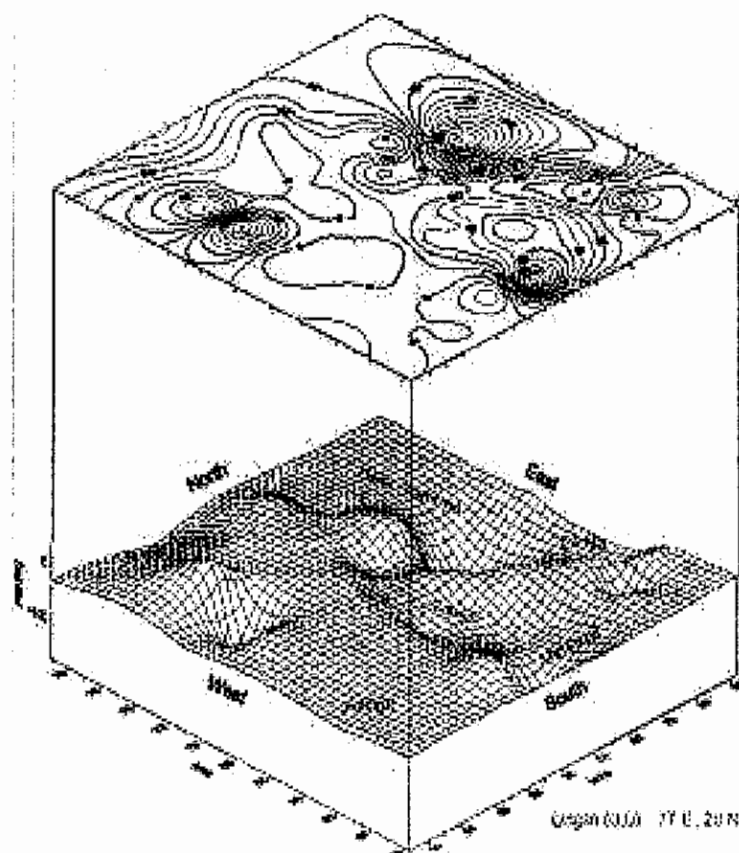


Fig.2 : Thickness of sedimentary deposits in Delhi

Figure 2.3: Thickness of sedimentary deposits in Delhi

Seismic Microzonation

After the Bhuj earthquake the national capital region of Delhi attracted major attention of several scientific studies in the recent times. Since Delhi falls in zone IV (IS 1893:2002) with high seismic activity, there is a great need for site characterization and seismic hazard mapping of the area.

The Seismic hazard & Risk Microzonation (SHRM) requires multi-disciplinary approach and sequence of studies to generate parameters for source, travel path, ground characterization & vulnerability analysis with inputs forthcoming from 5 disciplines viz. Geosciences (geology and geophysics), Seismology, Geotechnical Engineering, Engineering Seismology and Anthropology / Civil administration (Seismic Microzonation of NCT Delhi, A.K. Shukla, Rajesh Prakash, Dal Singh, Earthquake Risk Evaluation Center, India Meteorological Department, New Delhi).

The 1st level Microzonation map discretizes the territory of NCT Delhi in 9 units viz. (i) Ridge ambience of exposed rock with low hazard, (ii) Layer of impedance contrast at shallow depth (<30 m) with Moderate Hazard, (iii) Weathered rock zone with Moderate Hazard due to weathering induced pronounced ground response, (iv) Central Delhi with Moderate Hazard due to amplification in mid frequency level and Basin margin effect, (v) North-West Delhi plains (Bangar) of Moderate Hazard due to thick soil cover, (vi) South Najafgarh sedimentary fill (Dabar) with Moderate Hazard due to high amplification and liquefaction, (vii) Chhattarpur Basin with High Hazard due to anticipated Basin effect, (viii) Zone of Basin margin effect west of Delhi ridge: High Hazard, (ix) Newer alluvium proximal to Yamuna river: High Hazard due to Liquefaction Potential. **Figure 2.4** gives the details of the First Level Seismic Hazard Microzonation Map of NCT, Delhi.

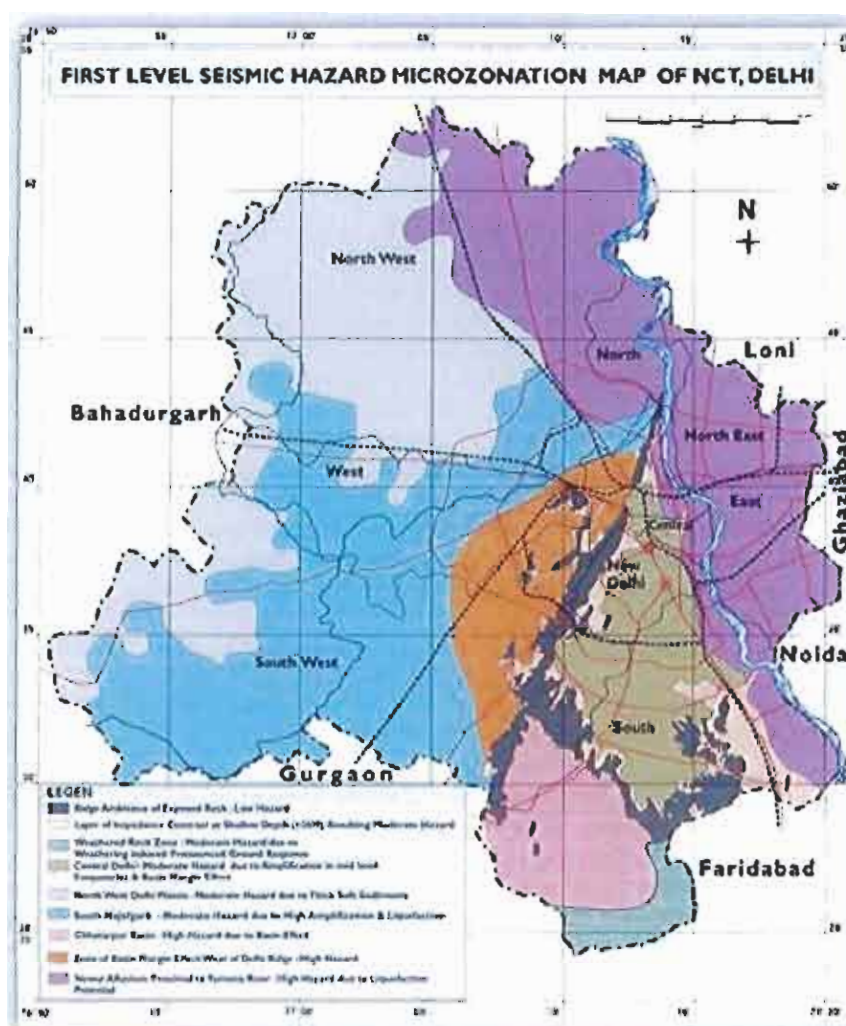


Figure 2.4: First Level Seismic Hazard Microzonation Map of NCT, Delhi

Hydrogeology

The ground water availability in the territory is controlled by the hydrogeological situation characterized by occurrence of alluvial formation and quartzite hard rocks. The NCT Delhi can be divided into following distinct hydrogeological units: Newer Alluvium - Yamuna flood plain deposits, Older Alluvium - Eastern and western sides of the ridge, Older Alluvium - Isolated and nearly closed Chattarpur alluvial basin and Quartzitic Formation - NNE-SSW trending Quartzitic Ridge.

The alluvial deposits are of Quaternary age. The newer alluvium belongs to recent age and is referred to the sediments deposited in the flood plains of Yamuna River. These sediments range in texture from clay/silt mixed with tiny mica flakes to medium/coarse sand and gravel. Newer alluvium, in general, is characterised by absence of kankar.

The older alluvium consists of sediments deposited as a result of past cycles of sedimentation of Pleistocene age and occurs extensively in the alluvial plains of the territory. This is comprised of inter bedded, lenticular and inter-fingering deposits of clay, silt and sand ranging in size from very fine to very coarse with occasional gravels. The kankar or secondary carbonates of lime occur with clay/silt deposits and sometimes as hard/compact pans. Older alluvium is predominantly clayey in nature in major parts of territory except the nearly closed alluvial basin of Chattarpur where the alluvial formation is derived from the weathered quartzites rocks.

The hard rock formations, mainly the Alwar quartzites of Delhi System exposed in the area belong to Pre-Cambrian age. The quartzites are pinkish to grey in colour, hard, compact, highly jointed/ fractured and weathered. These occur with interbeds of mica-schists and are intruded locally by pegmatites and quartz veins. The strike of these rocks varies northeast southwest to north-northeast south southwest with steep dips towards southeast and east except for some local variations due to folding. Quartzites are ferruginous and gritty types on weathering and subsequent disintegration give rise to coarse sand (Badarpur sands). Chemical weathering of deeper horizons is also common. The formation wise details of ground water characteristics in NCT Delhi are given below (**Table 2.2**).

Table 2.2: Summary of ground water characteristics in Different Geological formations in NCT Delhi

Sl. No.	Nature of Formation	Depth of the well (mbgl)	Discharge (m ³ /hr)	Drawdown (m)	Transmissivity (m ³ /hr)
1	Newer Alluvium	40 – 60	50 – 180	5.0 – 8	600 – 2000
2	Older Alluvium	30 – 60	20 – 60	6.0 – 24	130 – 403
3	Quartzite	50 – 150	02 – 10	6.0 – 30	05 – 135

The Depth to water level recorded in NCT Delhi as on date ranges from 1.20 to 67.73 mbgl. The deeper water levels are mostly found in south and south west districts of NCT Delhi, while the shallower water levels are found in central, northern and eastern part of Delhi (**Figure 2.5**). The CGWB data shows that nearly 50% wells of south district shows depth to water level more than 40 meters below ground level (mbgl) and nearly 35% wells show depth to water level in the range of 20 to 40 meters below ground level. In New Delhi and South-West district 56% and 46% wells respectively shows depth to water level in the range of 10 to 20 mbgl. In Central, East and North west districts 50%, 77% and 31% monitoring stations respectively have depth to water level in the range of 5-10mbgl. While in East, North, North East, North West, and West district 22%, 85%, 100%, 34% and 44% monitoring stations respectively have depth to water level in the range of 2 to 5 mbgl. The Yamuna flood plain in NCT Delhi also has depth to water level in the range of 2-5 mbgl.

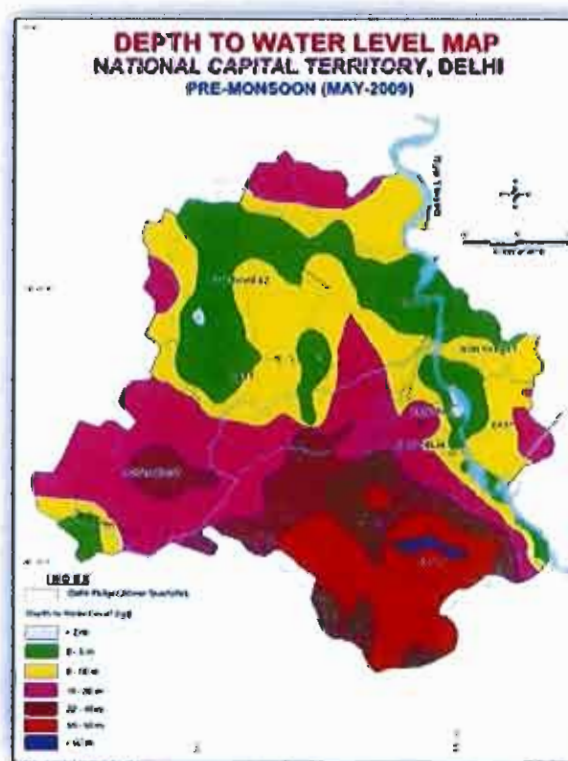


Figure 2.5: Depth to Water Level Map, NCT Delhi

Soils of Delhi

The whole of Delhi can be divided into four major categories according to soil classification. These Classes have very close correlation with vegetation, surface runoff, drainage efficiency and structural bearing capacity of soils. The soils of the Delhi have been influenced by Yamuna, the ridge and the winds from SW direction. The Delhi can be classified into four divisions on the basis of soil formation, which are shown in **Figure 2.6** and described here.

Bangar (old Alluvium)

12 percent of the area is covered by soils of Bangar. These tracts are found in the northwestern part of the territory where 5 soil series have been identified as Alipur, Shera, Narela, Ladpur and Najafgarh. Large areas are affected by water logging due to poor drainage, especially during rainy season. These soils are generally fertile with high moisture content but patches of saline alkaline soil are also found in the area. Sand dunes are present which are formed by aeolian deposits and soils coarse loamy to calcareous in texture.

There is a small tract of bangar land to the north of city – and the greater part of it lies to the north – west and the south and takes in all of the New Delhi east of the central ridge. The soil here is fertile the subsoil water sweet and left to nature this area would probably support a savannah or monsoon forest characteristic of say north-eastern Rajasthan or western UP. The most of the city is situated on the Bangar land and is concrete. Roads have been lined with trees and few of the city forests and large number of parks maintained by resident welfare association and dept of forest provide green space to this.

Bhangar contains many calcareous deposits and also has many kankars within it. Since the area containing Bhangar stands above flood levels, the soil remains as it is and is thus not very fertile and its character does not change with passage of time.

Dabar Soil (Low lying areas)

1.5 percent of the area is covered by soils of the Aravalli pediment. These soils are represented in the low-lying areas of Delhi and are mostly sandy loam to sandy clay loam. They are all found in the southwestern part of the NCT of Delhi, namely Najafgarh, Palam, Ladpur and Shikarpur. Large areas are covered by saline and alkaline soils due to poor drainage.

The dabar or flood-prone land is low lying bayou or catchment extending through much of the territory west of the ridge and south – west of the city. Due to the frequent flooding in the past and the water logged condition the soil is ruined because of salt concentration. The trees found in this region are those affected by salinity. Due to the urban nature of New Delhi growth, the area is mostly populated and is devoid of thick green areas.

Khaddar (New alluvium)

The soils of recent flood plain account for more 15 percent of the area. This type of soils shows a distinct stratification, being 15 percent on the surface and coarser below. It is usually silt to sandy loam. Here the clay content varies from 15 percent to 17 percent but in lower reaches it is below 10 percent. The soil structure is mainly single grain and mostly calcareous in nature. The four soil series representing the Khadar include Balla, Shahdara, Gokalpur and Madanpur. The Alipur series represents the Transitional Zone between the recent and the old Alluvium.

The riverine forms the part of this land and is on the sides of river Yamuna which flows through the north – eastern part of the city. The khadar had a characteristic riverine flora. The Yamuna flow is restricted at places due to development on its banks and resultant pollution load at several stretches.

Actually, the younger deposits are known as Khadar. These are not just younger; they are also more fertile than Bhangar soils. These soils are very good for intensive cultivation. These are also called new alluvial made up of fine granules. Khadar belongs to area in plains which lies below flood levels of river and because of flood water; this soil gets newer deposits with flood water every year which makes the soil very fertile.

Kohi Soil (Rocky areas)

6 percent of the area is covered by soils of the Aravalli Hills, which are subject to high run off and severe erosion. These are composed of quartzites or sandstones of the Delhi ridge. The texture varies from sandy loam to clay loam. Due to the uneven topography, the soils are subjected to a high rate of erosion.

New Delhi's hilly tracts correspond to ridge, which is slightly elevated, rocky landform lying in a longitudinal axis west of and more or less parallel to the Yamuna river. Because of its underlying rock and thin, sandy soil, the ridge is harsh, unforgiving habitat and trees growing there need to be adapted to survive drought. Characteristic ridge trees are stunted, thorny and open canopied. They have along taproots to search for moisture deep underground, and often, shallow spreading roots as well to exploit dew and light rain. These are the soils in project area.

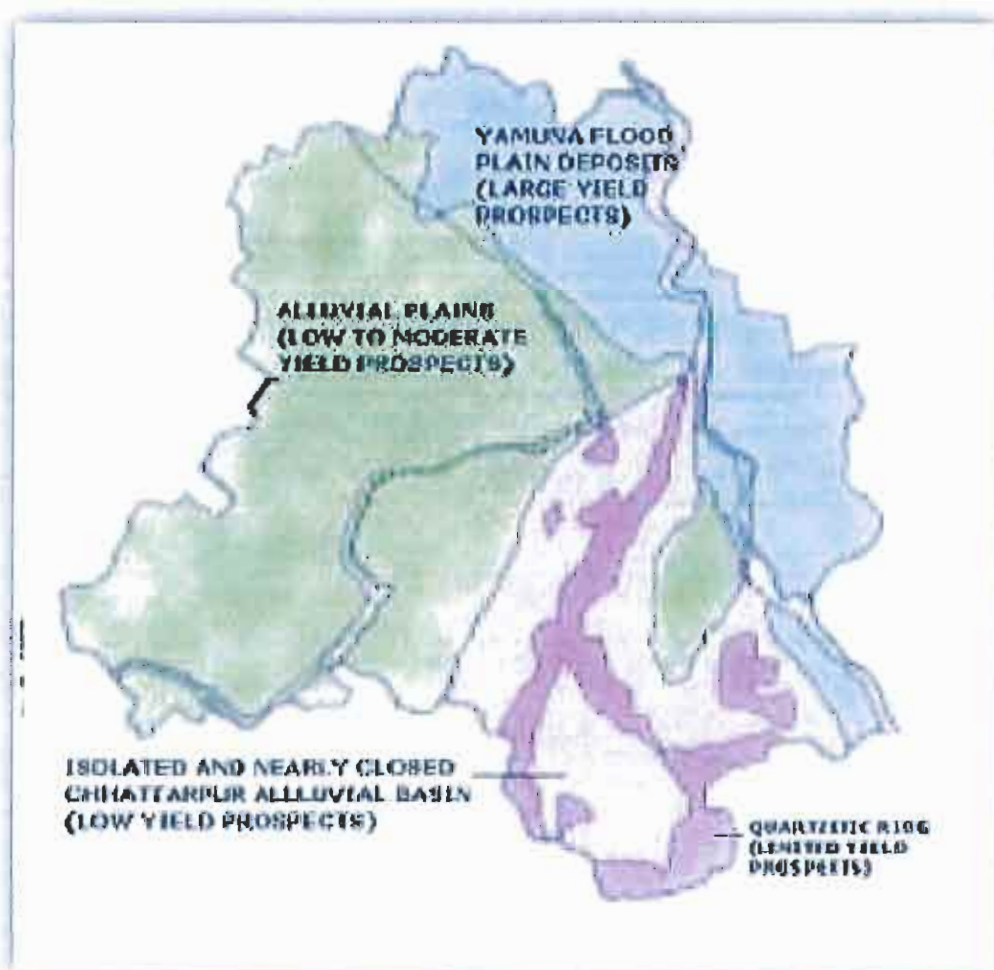


Figure 2.6: Soil classification of Delhi

2.3 CLIMATE

The climate of Delhi is mainly influenced by its inland position. Extreme dryness with hot summers and cold winters are characteristics of the climate. The year can broadly be divided into four seasons. The cold season starts towards the latter half of November when both day and night temperatures drop rapidly with the advance of the season. January is the coldest month with the mean daily maximum temperature at 21.3°C and the mean daily minimum at 7.3°C. This is followed by the hot season starting in March, which lasts till about the end of June when the monsoon arrives. May and June are the hottest months. While day temperatures are higher in May the nights are warmer in June. From April, the hot wind known locally as 'loo' blows and the weather is unpleasant. In May and June, the maximum temperatures may sometimes reach to 46 or 47°C. April and May are the driest months with relative humidity of 30% in the morning and less than 20% in the afternoon. The monsoon continues until the last week of September. The two post monsoon months of October and November constitute a transition period from the monsoon to the winter season.

CHAPTER - 3

EXISTING WATER / SEWERAGE INFRASTRUCTURE

CHAPTER - 3: EXISTING WATER/SEWERAGE INFRASTRUCTURE

0.1 WATER SUPPLY INFRASTRUCTURE

DJB is responsible for production and distribution of drinking water in Delhi. The Board is also responsible for collection, treatment and disposal of waste water/sewage in the capital.

DJB (Delhi Jal Board) water resources come mainly from three rivers i.e., Yamuna, Bhakra and Ganga rivers. Also, DJB produces water from Ranney wells in the Yamuna flood plain and 2760 tube wells scattered in Delhi.

DJB supplies water to almost every area through the distribution system except NDMC and the Cantonment areas where water is supplied to the respective organizations in bulk. To areas not covered by the distribution system, DJB provides water through tanker services. As per JICA Water Supply Master Plan – 2021 (JICA WS MP), present Water Supply Availability for NCT of Delhi is 850 MGD, as shown in **Table 3.1** below:

Table 3.1: Present Water Supply availability in Delhi

S. No.	Source of Raw Water	Name of the Plant	Installed Capacity as on 30.09.2011
1	River Yamuna	Chandrawal I & II	90 MGD
2	River Yamuna	Wazirabad I, II & III	131 MGD*
3	Bhakra Storage/ Yamuna	Haiderpur I & II	216 MGD*
4	Bhakra Storage	Nangloi	40 MGD
5	River Yamuna	Bawana	20 MGD
6	Upper Ganga Canal	Bhagirathi	110 MGD*
7	Upper Ganga Canal	Sonia Vihar	140 MGD
8	Sub Surface Water	Rainy Wells/ Tube Wells	100 MGD
TOTAL			847 MGD**

* Including Recycled filter backwash water

** Present Production of water is 850 MGD

Transmission System

Treated water is pumped from WTP through transmission pipes to some 100 (primary) Under Ground Reservoirs (UGRs) in Delhi. Length of existing transmission pipelines is approximately 700 km. About 85% of transmission pipes are of Pre-Stressed Concrete (PSC) pipes.

Distribution System

Water is boosted from (primary) UGR to large number of small UGRs. The Booster Pumping Stations (BPSs) distributes the water through distribution network. In Delhi, the water is distributed intermittently, scheduled twice a day for a few hours each in the morning and in the evening. The water supplied is seemingly sufficient in volume to meet water demand throughout the year except during 3 to 4 months in hot summer. On the one hand, water deficit areas in hot summer results from absolute lack of water supply amount, which needs raw water augmentation and on the other hand, some water deficit areas results seemingly from hydraulic inefficiency in network system due to high demand in short duration.

Water Treatment Facilities

As per JICA WS MP, present water supply availability for Delhi is 925 MGD. This water availability is subject to increase with the coming of water from Renuka Dam. There are 13 existing Water Treatment Plants in Delhi of total design capacity of 780 MGD (breakup as provided in **Table 3.2**) as shown in **Figure 3.1** below:

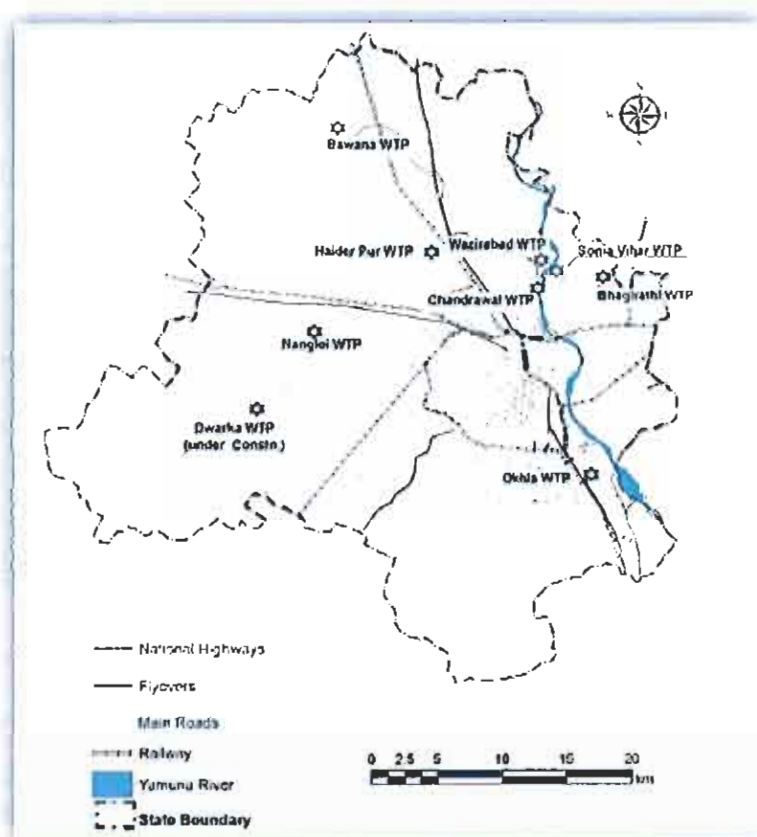


Figure 3.1: Location of various WTPs in NCT-Delhi

Table 3.2: Breakup of 780 MGD of WTP Capacity in Delhi

WTP	Year of Commissioning	Capacity (MGD)
Chandrawal I	30's	35
Chandrawal II	60's	55
Wazirabad I	1926	40
Wazirabad II	1970	40
Wazirabad III	1990	40
Haiderpur I	1977	100
Haiderpur II	1993/94	100
Bhagirathi	1983-85	100
Nangloi	2000	40
Sonia Vihar	2005	140
Bawana	2010	20
Dwarka (taps water from Munak Canal)	-	50
Okhla II (taps water from Munak Canal)	-	20
TOTAL EXISTING WTP CAPACITY		780

The command area of each of the 13 existing WTPs is shown in **Figure 3.2** below:

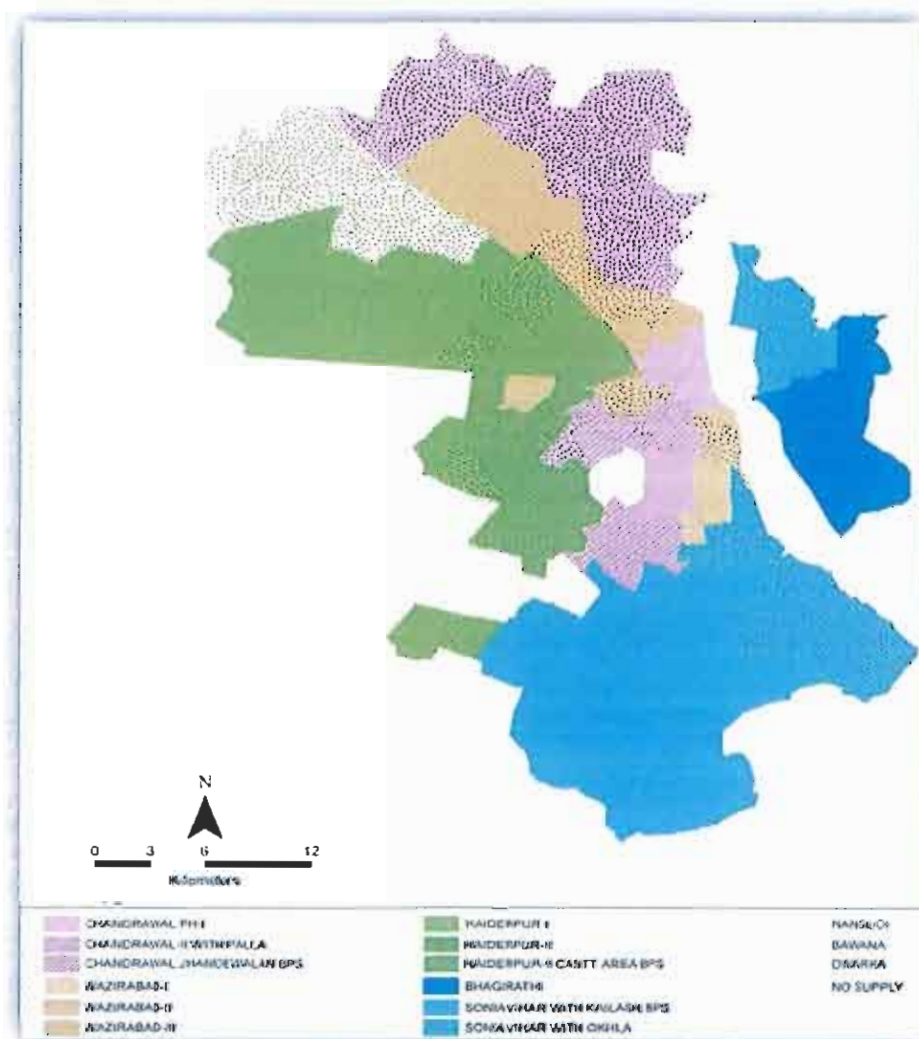


Figure 3.2: Command Area of existing WTPs

0.2 SEWERAGE INFRASTRUCTURE

Delhi Jal Board (DJB) is responsible for treatment of domestic sewage in the NCT of Delhi and also the executing agency entrusted with the construction and maintenance of Wastewater Treatment Plants (WWTPs), Wastewater Sewage Pumping Stations (WWPSs), Sewerage networks and associated structures. DJB has 34 WWTPs at 21 locations in the NCT of Delhi along with WWPSs.

For sewage management, Delhi is divided into six (6) major drainage zones as shown in **Figure 3.3** below:

1. Keshopur
2. Okhla
3. Rithala
4. Shahdara
5. Coronation Pillar
6. Outer Delhi

Keshopur, Okhla, Rithala, Shahdara and Coronation Pillar drainage zones are majorly sewered with few pockets of unsewered colonies. The sixth drainage zone i.e. Outer Delhi with extent from Narela and Bawana region in the North to Dera Mandi and Bhati Kalan in the South, is predominantly unsewered.

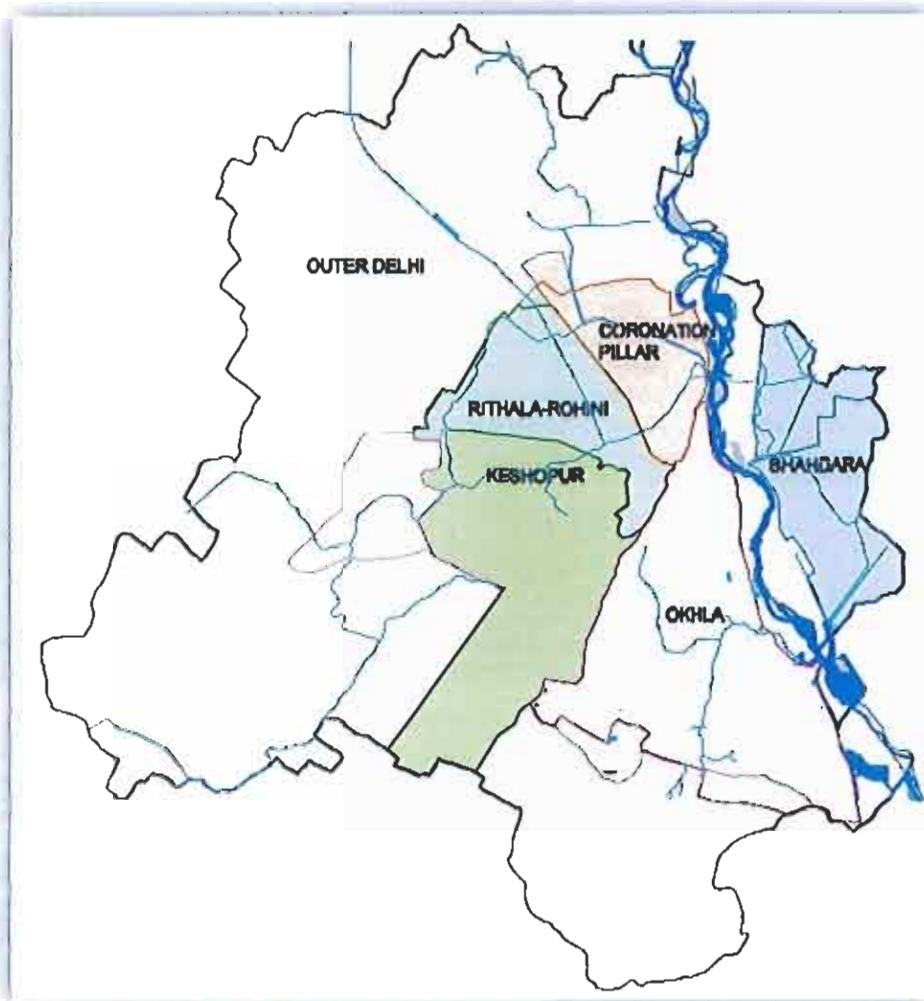


Figure 3.3: Six Drainage Zones of Delhi

The sewerage network of Delhi comprises 7000 km of sewerage lines including trunk sewers and branch sewers (peripheral/internal sewers). This includes main trunk sewers of total length of 192 km.

About 50% of population is covered by sewerage network, and sewage generated from the remaining population is going through a number of surface drains into the river.

A considerable extent of the trunk sewerage system (having size 900mm diameter and above) is either settled or silted up and needs desilting/rehabilitation for conveyance of the raw sewage from the colonies up to the pumping stations for further conveying to the WWTPs for treatment. As a result, the actual sewage reaching the WWTPs is currently less than the available treatment capacity resulting in under-utilization of the WWTPs. Commonly settled or collapsed sewers are diverted into storm water drains and eventually discharge to the Yamuna River. Further about 50% of the population living in unauthorized colonies, JJ clusters, Rural villages etc. does not have sewerage facilities resulting in waste coming out of these colonies and finding its way into open drains and finally into River Yamuna, contributing further to depletion of the quality of water in River Yamuna.

DJB is continuously carrying out various projects for providing sewerage facilities to all the residents which will ultimately help in abatement of pollution in the Yamuna:

- In 2005, DJB commissioned the upgradation of Sewerage System for Delhi Study (TCE Consulting Engineers Limited). This study covered all six major drainage zones and provided recommended system upgrades, mainly focusing on pumping station upgrades and upgrades to major trunk sewers.
- DJB had conducted a feasibility study which has revealed that out of 160 km of trunk sewer; approximately 111 km of the sewer line is heavily silted/ settled and needs rehabilitation and desilting. DJB has already rehabilitated 100 km of trunk sewer line and the work is in progress to rehabilitate the remaining works.

Sewage Collection System

Sewerage facilities are provided through network of sewers in planned colonies, unauthorized / regularized colonies, urban villages and JJ Resettlement colonies. Year-wise status of sewerage system and colony wise existing sewerage status have been presented below in **Table 3.3** and **Table 3.4** respectively.

Table 3.3: Year wise Status of Sewerage System of Delhi

Components	Year												
	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
Trunk Sewer (km)	130	130	130	132	135	140	143.6	147	150.5	153.9	160.1	168.7	178
Branch Sewers (km)	4693	4693	4693	5653	5703	5844	5956	6000	6070	6164	6217	6317	6410
Rehabilitation Desilting (km)	-	-	-	-	-	-	-	-	-	50	51.5	64.2	81
Unauthorized/ Regularized Colonies	356	361	366	402	427	458	482	493	506	517	526	536	540
Urban Village	81	82	82	93	93	93	98	99	105	107	108	111	111

Table 3.4: Colony Wise Existing Sewerage Status

Colonies (Category wise)	Total No. of unsewered/sewered Colonies	Total No. of Surveyed Colonies*	Total No. of Sewered Colonies/Villages
Urban Villages	135	32	103
Rural Villages	190	165	25
Unauthorized Colonies	1857	1575	282
JJ Clusters	46	0	46
Total	2228	1772	456

Wastewater Treatment Facilities

At present there are 34 Wastewater Treatment Plants (WWTPs) at 21 different locations, equipped to treat 2700.03 MLD (594.72 MGD) of sewage with utilization of around 57 %. Capacity of WWTP varies from (0.66 MGD) to (170 MGD). The Wastewater Treatment Plants in the city are 1–45 years old in age. Old age of WWTPs has resulted in loss of treatment efficiency. Due to network deficiencies, there is an overflow from sewers into storm water drains. **Table 3.5** below represents design capacity of existing

WWTPs and their present utilization efficiency based on the quantum of treated sewage by individual WWTP.

Table 3.5: Treatment Efficiency of existing WWTPs in Delhi

Name of Sewage Treatment Plant	Year of Construction	Installed Capacity		Utilization Rate (%)	Present utilization / Treated Sewage	
		(MGD)	(MLD)		(MGD)	(MLD)
Coronation Pillar Phase-I* & II	1999	30	136.2	48	22	99.9
Coronation Pillar Phase-III	2000	10	45.4			
Oxidation Ponds – Timarpur*	-	6	27.2			
Keshopur Phase-I	Recently Reconstructed	12	54.5	74	53	240.6
Keshopur Phase-II	1975	20	90.8			
Keshopur Phase-III	1990	40	181.6			
Okhla Phase-I	1937	30	136.2	75	127	576.6
Okhla Phase-II	1982	12	54.5			
Okhla Phase-III	1993	37	168			
Okhla Phase-IV	1993	45	204.3			
Okhla Phase-V	2001	16	72.6			
Okhla Phase-VI	2013	30	136.2			
Narela	2001	10	45.4	10	1	4.5
Yamuna Vihar Phase-I	1999	10	45.4	70	14	63.6
Yamuna Vihar Phase-II	2002	10	45.4			
Najafgarh	2002	5	22.7	16	0.8	3.6
Nilothi	2002	40	181.6	33	13	59
Dr. Sen Nursing Home Nalla	1998	2.2	10	100	2.2	10
Delhi Gate Nalla - I	1998	2.2	10	100	2.2	10
Pappan Kalan	2000	20	90.8	75	15	68.1
Kondli Phase-I	1987	10	45.4	39	35	158.9
Kondli Phase-II	1989	25	113.5			
Kondli Phase-III	2001	10	45.4			
Kondli Phase-IV	2013	45	204.3			
Mehrauli	2003	5	22.7	56	2.8	12.7
Rohini	2002	15	68.1	17	2.5	11.4
Rithala (Old)	1989	40	181.6	56	45	204.3
Rithala (New)	2002	40	181.6			
Vasant Kunj Phase-I	1982	2	9.1	84	4.2	19.1
Vasant Kunj Phase-II	1997	3	13.6			
Ghitorni	1997	5	22.7	0	0	0
Commonwealth Games Village	2010	1	4.5	10	0.1	0.4
Molarband	—	0.66	3	100	0.66	3

Name of Sewage Treatment Plant	Year of Construction	Installed Capacity		Utilization Rate (%)	Present utilization / Treated Sewage	
		(MGD)	(MLD)		(MGD)	(MLD)
Bakkarwala	—	0.66	3	15	0.1	0.5
Kapashera	2013	5	22.7	0	0	0
TOTAL DESIGN CAPACITY		594.72	2700.03		340.6	1546.2
Treated Sewage		340.6	1546.32			
Unsewered/Untreated Sewage		254.12	1153.70			

*Coronation Pillar Phase I & Timarpur WWTPs are defunct. DJB is in process of re-construction of Coronation Pillar Phase I to meet future sewage load.

The location of various WWTPs in Delhi is shown in **Figure 3.4** below:

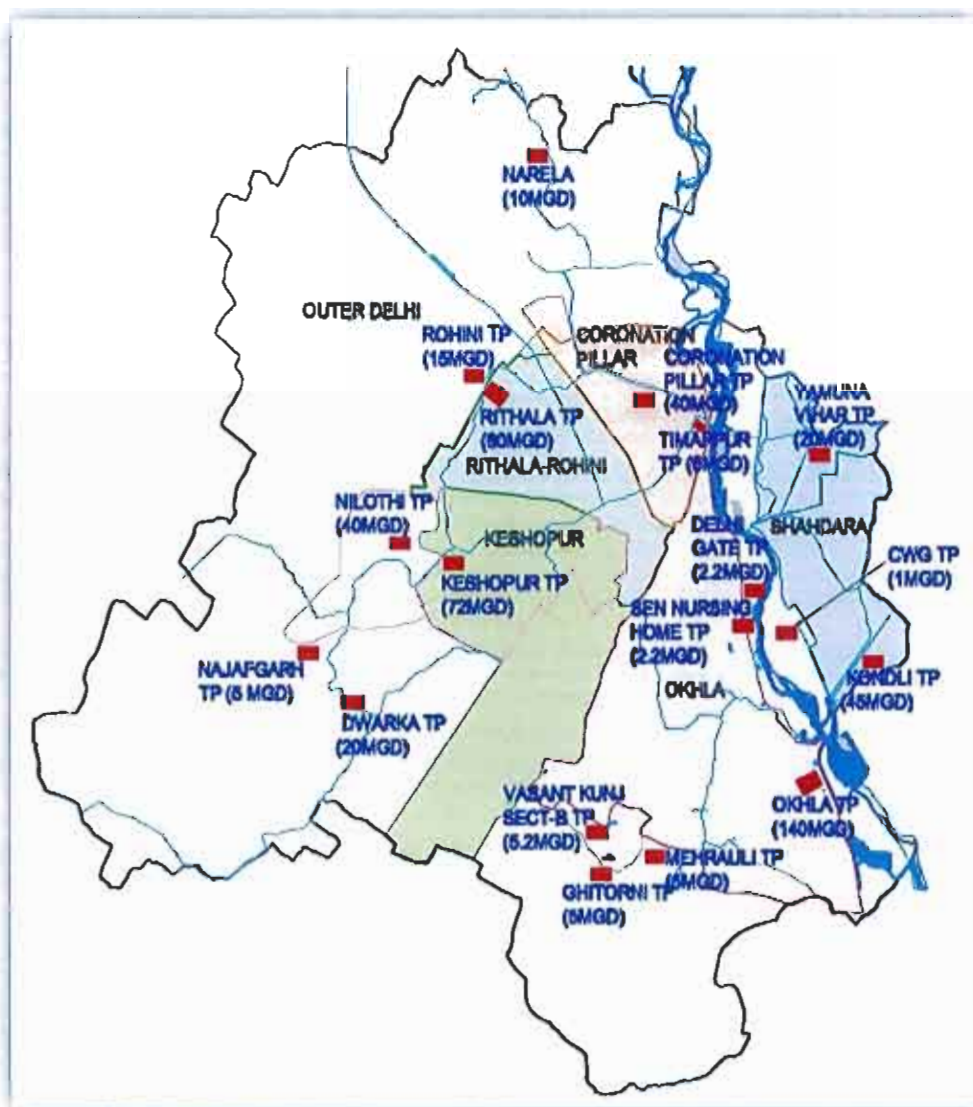


Figure 3.4: Location of various WWTPs in Delhi

Based on already completed study and anticipated flows from already sewered areas, DJB anticipates to increase the wastewater treatment capacity to (731.9 MGD). The details are presented in **Table 3.6** below:

Table 3.6: Proposed increase in wastewater treatment capacity in Delhi

Sl. No.	Location	Capacity in MGD		
		Present Sewage Treatment Capacity (MGD)	Under Construction / Proposed (MGD)	Total Sewage Treatment Capacity after augmentation (MGD)
1	Okhla #	170		170
2	Keshopur	72		72
3	Coronation Pillar	40	40**	80
4	Rithala	80		80
5	Kondli	90		90
6	Vasant Kunj	5		5
7	Yamuna Vihar	20	25*	45
8	Ghitorni	5		5
9	Dwarka (Pappan Kalan)	20	20*	40
10	Narela	10		10
11	Najafgarh	5		5
12	Mehrauli	5		5
13	Delhi Gate	2.2		2.2
14	Sen Nursing Home	2.2		2.2
15	Rohini	15		15
16	Nilothi	40	20*	60
17	Timarpur	6		6
18	Rural Villages (Kapashera)	5		5
19	CWG Village	1		1
20	Molarband	0.66		0.66
21	Bakkarwala	0.66		0.66
22	Chilla	NIL	9*	9
23	Delhi Gate Phase-II	NIL	15*	15
24	Delhi Cantt.	NIL	8**	8
TOTAL		594.72	137	731.72

WWTP under Construction**WWTP already proposed**# Okhla Tertiary Treatment Plant of capacity 2.2 MGD is under Construction*

The above details pertaining to upcoming infrastructure have been taken into consideration while proposing new infrastructure under Sewerage Master Plan (SMP)-2031 study.

CHAPTER - 4

DATA COLLECTION

CHAPTER - 4: DATA COLLECTION

To facilitate the preliminary design of sewerage system in the unsewered colonies / areas within the Study Area, up-to-date data has been collected from relevant government departments and through site walks and field surveys from which data collected is either implicitly or explicitly related to the planning of sewerage networks.

A field survey has been carried out under the study in order to collect sufficient data of the proposed study area for assessing the number and density of population in the area, ascertaining unit flow factors for setting up of sewage model and preliminary design and planning of sewerage network. Details of the data collection are summarized in the sections below.

4.1 EXISTING REPORTS AND INFORMATION

DJB and other government/institutional/independent agencies in Delhi have carried out several studies for assessing Delhi's existing sewerage system. The following various reports have been collected from different government bodies for analysis of data and for integration with SMP – 2031 works.

Urban Planning Data

- DDA Master Plan Delhi 2021 as amended up to 15th October 2009
- DDA Master Plan Delhi 2021 – September 2010
- DDA Zonal Development Plan Delhi 2021 – September 2010
- Handbook on Unauthorized Colonies & Constructions in Delhi - 2008
- Available Base maps of the study area – obtained from DJB's GIS cell
- Population statistics ward- wise starting from 1971 census year including ward-wise census maps
- Provisional Census data - 2011
- Information on existing administrative boundaries
- Information on existing and future industrial development by type, size, wastewater generation and their sewerage servicing needs
- Urban policies affecting infrastructure development (e.g. Slum rehabilitation/resettlement)
- Information on existing sewerage status of various categories of colonies as per UD list

Technical Data

- Engineering reports and drawings for existing sewerage facilities including Master Plans, Feasibility Studies and DPRs.
- Condition assessment reports/photographs of sewers and other sewerage facilities as available.
- Sewerage / Drainage Master Plans as prepared by TCE – 2002 and PWC – 2005
- City Development Plan as prepared by ILFS – 2006
- Laying of Interceptor Sewer Report as prepared by EIL – September 2008
- JICA Water Supply Master Plan Delhi –Draft December 2010
- Data regarding existing pumping stations including wastewater flows, capacities, type, number of pumps installed, sump volumes, condition of screens, power outages etc.

- Layout plans, process and hydraulic flow diagrams of existing WWTPs
- Influent and effluent quantity and quality data required for design and performance evaluation of existing WWTPs
- Geotechnical reports for recent works by DJB
- Information related to existing drainage and sewerage facilities
- Design data and layout drawings for existing and proposed sewer lines by DJB for integration/up-gradation purposes

4.2 SITE WALKS

Site walk to the identified unsewered colonies / areas have been carried out during the study, as shown in **Figure 4.1**. The site walk aims to collect up-to-date on-site information of the Study area, including the general background of colonies/villages, overall topography of the area, existing sewerage facilities such as septic tanks etc., constraints for laying of sewer lines such as narrow roads, laying alignment of existing water lines or other utility lines and presence of archaeological structures. The site walk also includes the delineation of administrative boundary of NDMC, Delhi Cantt and any other area which is not under DJB's jurisdiction.



Figure 4.1: Site Walks

Prepared base maps for field survey have been compared with the existing ground reality to identify and rectify major discrepancies, if any. Preliminary sewer alignments have been proposed based on the field survey data and observations from site walks. In particular, the outlet of village sewer has been carefully proposed in order to make convenient connections to the main trunks or to the existing sewers taking into account the topographical details of the area with a prime consideration of providing gravity flow connections. Another key consideration for the outlet points is to choose the major entrance/exit of each colony to avoid or minimize the impact on access to the colony during construction stage.

4.3 TOPOGRAPHIC SURVEY DATA

Topographical survey has been conducted in the study area aiming to acquire ground level information for preliminary sewerage facilities design. On-site information pertaining to the design and planning of sewer network layout has been collected through topographic and reconnaissance survey.

The information collected is targeted to confirm the extent of construction and construction feasibility, and the derivation of a cost effective design for the recommended sewerage facilities.

4.3.1 Extent of Topographical Survey

Field survey for the project includes overall infrastructure mapping, strip survey and site survey. Highly qualified and competent surveyors have carried out the survey work. Before undertaking any topographical survey, available topographic maps by Survey of India have been reviewed. Prepared base maps have been used to identify existing data and corridor of possible sewer alignments. During the topographical survey, traversing has been done along the center line of the corridor and cross-sections have been taken at every 50m interval. Thus, the topographical survey of the corridors results in collecting data for physical features, nearby structures, ground levels etc.

4.3.2 Key Findings of Topographic Survey

As envisaged in Master Planning scope, intensive survey and investigation work has been carried out in various colonies/un-sewered areas of Delhi. The following activities have been undertaken to build the GIS and hydraulic model.

- Identification of the prioritized Survey areas/colonies on the reasons stated below:
 - Priority of Integrated Network and Schemes
 - As per Urbanization Schemes under DDA Master Plan-2021
- Identification of Benchmarks (BM) along with reconnaissance survey for identifying the existing sewerage facilities (as shown in *Figure 4.2*)

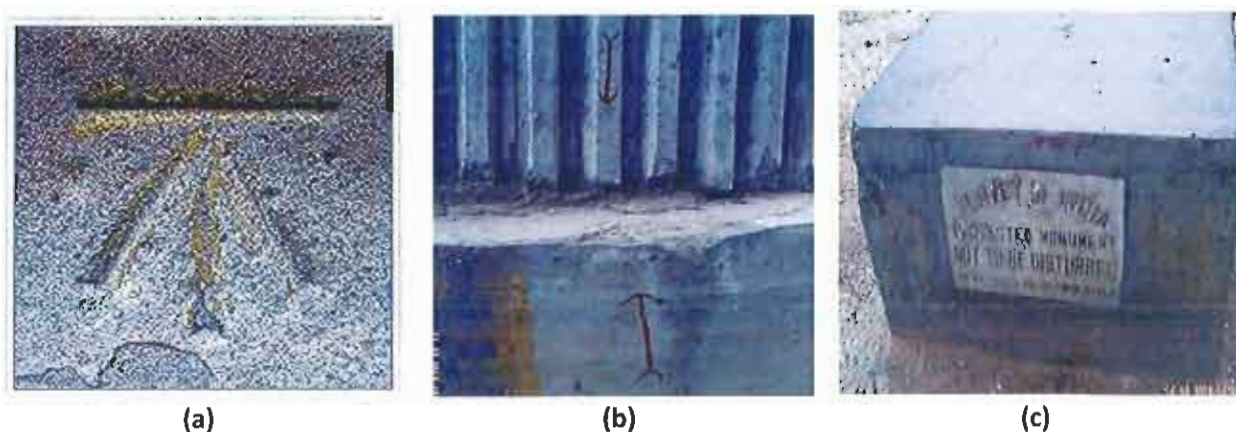


Figure 4.2: Benchmark (BM)



Figure 4.3: Temporary Benchmark (TBM)

- Transferring and closing of BMs from the identified BMs Marked at various locations by Delhi Jal Board (Kondli WWTP, Okhla WWTP), Survey of India (Wazirabad Water Works, Puspa Bhawan) Delhi Metro Rail Corporation (Tughlakabad Metro Station, Ghitorni Metro Station).

The spot levels have been obtained at starting and ending of the road/Gali at the distance of 30m and major undulations by Auto Levels. Topographic Survey has been carried out by using Total Station to prepare topographic maps with a scale of 1:2000 showing all the constructed structures, drains, property boundary lines, roads and other topographic details. Levels have been picked at property edges to demarcate the road width. The survey data has been used to finalize the GIS model.

Various attributes acquired from Topographical Survey like building count, floor count, building type, road width, land use, ground elevation, property edge lines etc. has been converted into .shp (GIS integrated shape file) format with its defining projection and survey collected attributes in the requisite database format as shown in **Figure 4.4**.

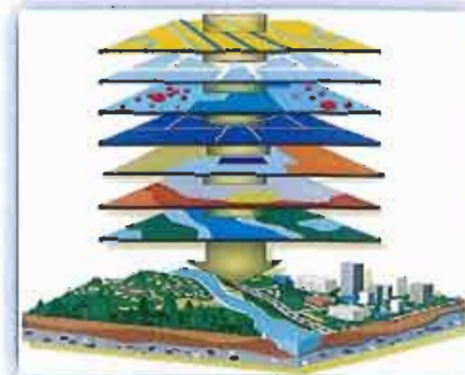


Figure 4.4: Building up of GIS Model

The total station is mounted on a tripod and levelled before use. Meanwhile, the prism is mounted on a pole of known height; the mounting bracket includes aids for aiming the instrument. The prism is mounted so that its reflection point is aligned with the center of the pole on which it has been mounted, as shown in **Figure-4.5** above. Although the tip of the pole is placed on the point to be surveyed, the instrument must be aimed at the prism. So it will calculate the position of the prism, not the point to be surveyed. Since the prism is directly above the tip, the height of the pole may be

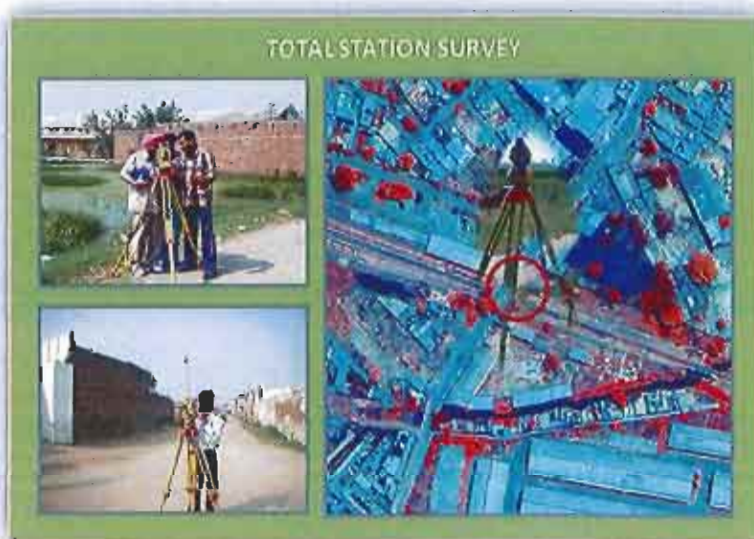


Figure 4.5: Total Station Survey

be subtracted to determine the location of the point. That may be done automatically. (The pole must be held upright, and a bubble level is attached to give the worker holding the pole a check. It is not as easy as one might expect to hold the pole upright, particularly if there is any wind; as a result, multiple readings may be required. Because of that problem, the sighting method chosen at Pompeii was, if possible, not to begin by sighting on the prism itself but on the tip of the pole where it touched the ground. The angle from north would then be fixed and unaffected by the movement of the pole. Then the aim of the telescope could be raised to the level of the prism, adjusting only the angle of inclination.

The Total Station instruments which we are using are Leica TS02, Topcon 220, etc. shown below in **Figure – 4.6 & 4.7:**



Figure 4.6: Total Station Leica TS02



Figure 4.7: Total Station Topcon 220

The Concept Layout Plans can be generated from the GIS database after integration with SewerGEMS adopting the ArcGIS operating environment. Layers and attributes to be shown in the map are flexible to control and appropriate information for different requests from the users can be catered for. There are mainly two sets of GIS Concept Layout Plans to be produced under the Study – the GIS Concept Layout Plans for Sewer Network System and the GIS Concept Layout Plans for Wastewater Treatment and Disposal Facilities.

The GIS Concept Layout Plans for Sewer Network System provides many layers related to the sewer system. For instance, sewer, box culvert, manhole, channel, rising main, valve or pumping station are the key elements to be shown in this layout plan. Besides, the status of the features is presented in the map as well. With the use of the layout plans, user could understand whether the feature is being proposed, work in progress or abandoned.

With the GIS Concept Layout Plans integrated with already existing DJB's GIS system, useful information can be controlled in order to fulfill different requirements. The user could distinguish the entire sewer network, the treatment network and associated sewerage facilities clearly and thus it could facilitate the daily work of DJB personnel and enhance their efficiency.

CHAPTER - 5

POPULATION PROJECTION

CHAPTER - 5: POPULATION PROJECTION

5.1 PREAMBLE

The knowledge about past populations and assumptions about future populations are fundamental to planning decisions. The projections are estimates of the population for future dates. They illustrate the plausible courses of future population and are developed using normative procedures comprised of mathematical models and analysis of growth rates based on historical data. These projected numbers are “best assessed” population estimates based on published government data comprising of most recent decennial census, published JICA water supply Master Plan, published MPD 2021 for Delhi, published City Development Plans, and Zonal development plans acquired for this project.

The population is estimated at 23.0 million people for the year 2021, as per MPD 2021, while the JICA Water Supply Master Plan estimates the population to be 26.0 million for the NCT Delhi. The estimated population of JICA Water Supply Master Plan is 3.0 million higher than that of the MPD 2021. A comprehensive overview of the existing and projected populations from these reports has been mentioned in this report.

Delhi encompasses three governing bodies viz. South Delhi Municipal Corporation (SDMC), North Delhi Municipal Corporation (NDMC), East Delhi Municipal Corporation (EDMC), New Delhi Municipal Council (NDMC) and Delhi Cantonment Board (DCB). The MCD is one of the largest municipal bodies in the world according to population size. Of the total NCT area, MCD occupies 94.22 %, whereas NDMC and DCB occupy 2.88% and 2.90% respectively. The population of the city has been greatly influenced by various factors such as base population, urbanization trend, land-use (existing and proposed), social amenities, livelihood opportunities etc.

Additionally, the socio-economic models of population projection are more commonly used by planners for Master Planning, industrial development or IT and IT service driven development. The fact is that, none of the method guarantees the exact precision of population projections, as the cities are dynamic entities and their development changes from time to time depending upon the Master Planning, City administration, policies, Infrastructure creation and Socio-economic conditions. The experts are of the opinion that the rapid growth of NCT Delhi, which has been observed in the last few decades is unsustainable and in future the growth will not be so rapid and is likely to decline. This phenomenon has been observed in several localities where the population is either stagnated or rather declining due to over-crowding, mis-matching infrastructure, or availability of un-congested alternative locations. Further, Gurgaon, Noida, Greater Noida, Ghaziabad, Faridabad, Meerut and other satellite towns around NCT are providing the matching infrastructure and will attract the population moving out of NCT or migrating towards the Capital from various states.

5.2 OBJECTIVES

One of the main objectives of the SMP is to establish the projected population for NCT Delhi for the Sewerage Master Plan 2031 using published census data and various reports published for infrastructure development work in NCT Delhi.

The key activities of the study are as follows:

- To forecast population for the project horizon year 2031 with interim target Years 2016, 2021 & 2026
- Analysis of present & future population using census data, Master Plan Delhi-2021 and JICA Water Supply Master Plan with various other published reports
- Analysis of future trend of population growth

- Population projection by using various mathematical methods as per CPHEEO guidelines
- The distribution of population by the geographical extents of command area of WWTP
- Estimation of wastewater generation to particular WWTP command area for present as well as future

5.3 LITERATURE AND PUBLISHED DOCUMENTATION REVIEW

The detailed analysis has been carried out for all available data that includes MPD 2021, Zonal Development Plan and JICA Water Supply Master Plan which are the critical drivers for developing the growth projections for the planning of NCT Delhi. The review of data has been carried out as follows:

5.3.1 Census Data

The Indian Census is the most credible source of information on Demography (Population characteristics), Economic Activity, Literacy and Education, Housing & Household Amenities, Urbanization, Fertility and Mortality, Scheduled Castes and Scheduled Tribes, Language, Religion, Migration, Disability and many other socio-cultural and demographic data since 1872. Census 2011 is the 15th National Census of the Country. This is the only source of primary data in the village, town and ward level. It provides valuable information for planning and formulation policies for Central and the State Governments and is widely used by National and International Agencies, Scholars, business people, industrialists, and many more. The following data has been collected from census and are presented in **Table 5.1** below:

Table 5.1: Decadal Census Population from 1951 to 2011

Year	Population
1951	1,744,072
1961	2,658,612
1971	4,065,698
1981	6,220,406
1991	9,420,644
2001	13,850,507
2011	16,753,235

As per the census record, Delhi was considered as a single district for population census 1991. In 1996, Government of NCT of Delhi, through a Gazette Notification, created 9 (nine) districts and 27 sub-divisions. Population census 2001 was conducted in Delhi in each of 9 (nine) districts and 27 sub-divisions. Ranking of districts by population, in 1991 and 2001 is given in **Table 5.2** below:

Table 5.2: District-wise Population

District	Area (Sq.km)	Population (Numbers)					
		Year-1961	Year-1971	Year-1981	Year-1991	Year-2001	Year-2011
North West	440	240,973	450,419	991,186	1,777,968	2,860,869	3,651,261
North	60	611,376	653,224	657,609	686,654	781,525	883,418
North East	60	38,155	157,262	487,466	1,085,250	1,768,061	2,240,749
East	64	135,325	306,232	623,850	1,023,078	1,463,583	1,707,725
New Delhi	35	143,846	164,702	144,115	168,669	179,112	133,713
Central	25	672,063	691,738	691,223	656,533	646,385	578,671

District	Area (Sq.km)	Population (Numbers)					
		Year-1961	Year-1971	Year-1981	Year-1991	Year-2001	Year-2011
West	129	250,702	572,976	958,931	1,433,038	2,128,908	2,531,583
South West	420	251,383	479,189	679,170	1,087,573	1,755,041	2,292,363
South	250	314,789	589,965	986,856	1,501,881	2,267,023	2,733,752
TOTAL	1,483	2,658,612	4,065,707	6,220,406	9,420,644	13,850,507	16,753,235

Note: The population of nine districts for 1971-1991 is derived by recasting the Census Data according to the present jurisdiction of the districts.

5.3.2 City Development Plan (CDP)

The CDP reports that the annual average exponential growth rate of population of Delhi was the highest (6.42%) during 1941-1951. Since then the annual growth has been recorded at 4.22% during 1951-1961; 4.25% during 1971-1981; and 4.15% during 1981-1991. The annual growth rate of population in Delhi during 1991-2001 is recorded as 3.85%.

The density of population in Delhi averages 9,340 persons per sq. km. in 2001 as compared to 6,352 persons in 1991. The density of population in Delhi is highest among all states /UT's in the country. The special distribution of population density in Delhi is given in following **Table 5.3:**

Table 5.3: Population Density - District Wise

District	Population Density (Per person's Sq. km)		
	1991	2001	2011
North East	18,088	29,468	37,346
South West	2,583	4,169	5,445
North West	4,042	6,502	8,298
South	6,012	9,068	10,935
West	11,116	16,503	19,625
East	15,986	22,868	26,683
North	11,471	13,246	14,973
New Delhi	4,791	5,117	3,820
Central	26,261	25,855	23,147

5.3.3 DDA Master Plan 2021

The Master Plan for Delhi 2021 is notified document being adopted for all urban development plans. It is a vision document prepared by the Ministry of Urban Development, published in the Gazette of India. The key highlights of this guiding document are as follows:

- The estimated population of Delhi as per MPD 2021 is 22-23 million (220 - 230 Lakhs) with average population density of 155 pph. However, for the planning for infrastructure facilities MPD has suggested to consider the projected population of 23.0 million. The projections are based on "annual urban growth rate" and no mathematical method has been used for establishing population projections. The projected population for the year 2011, 2016 and 2021 is 182, 199 and 230 Lakhs respectively.

- As per the DDA administrative divisions, Delhi has been divided into 15 Zones i.e. A to P, out of which 8 Zones are in the urban area, one in riverbed and the remaining 6 in the rural area (outer area) – refer **Figure 5.1** below:

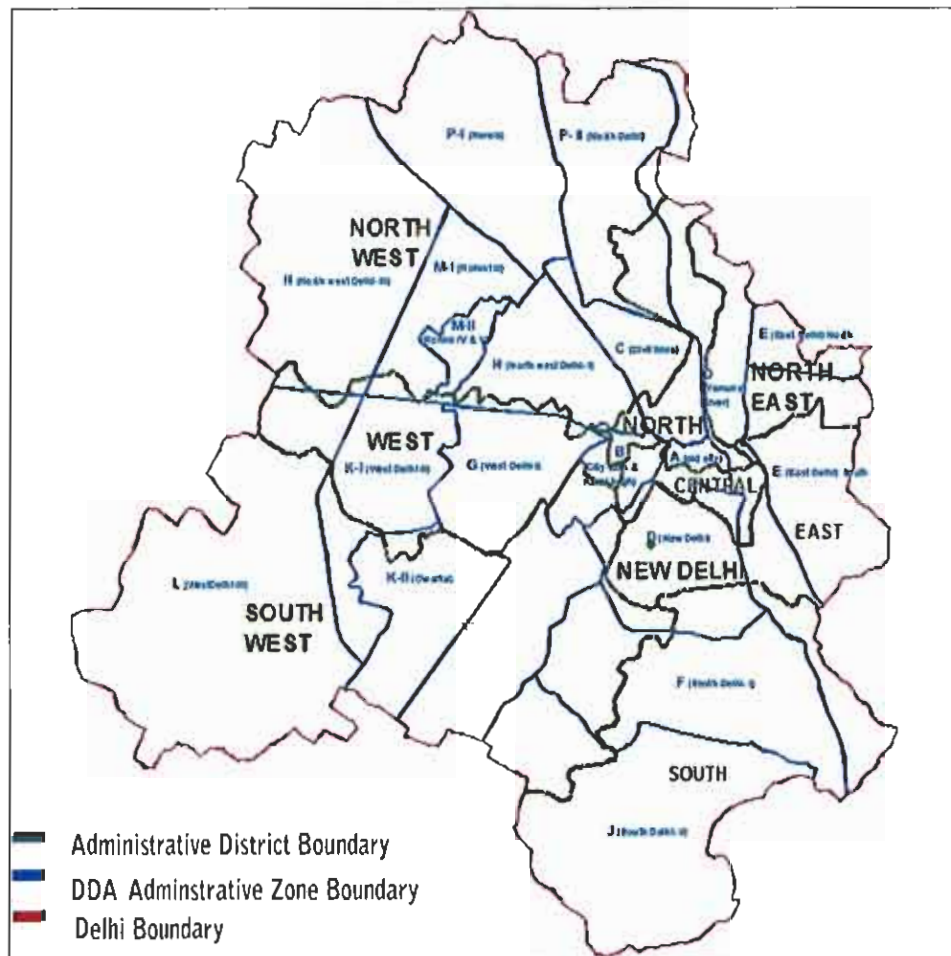


Figure 5.1: Administrative Districts and DDA Administrative Zones

The population growth rate in the urbanized area with high population density is low while the outer area zones is planned to increase. The population holding capacity of existing Urban Area is given in **Table 5.4** below:

Table 5.4: Zone-Wise Existing Holding Capacity of Existing Urban area – Source DDA MPD 2021

Name of the Zones		Population 2001 (in Lakh)	Holding Capacity MPD - 2001 (in Lakhs)	Holding Capacity MPD - 2021 (in Lakhs)
A.	Old City	5.70	4.20	5.70
B.	City Ext. (Karol Bagh)	6.24	6.30	6.30
C.	Civil Lines	6.79	7.51	7.88
D.	New Delhi	5.87	7.55	8.13
E.	Trans Yamuna	27.98	17.89	28.00
F.	South Delhi-1	17.17	12.78	19.75
G.	West Delhi-1	16.29	14.9	19.55
H.	North West Delhi-1	12.26	18.65	18.65
Sub-total		98.30	89.78	113.96

Name of the Zones	Population 2001 (in Lakh)	Holding Capacity MPD - 2001 (in Lakhs)	Holding Capacity MPD - 2021 (in Lakhs)
Dwarka	5.97		13.0
Rohini III	0.96		1.60
Rohini IV & V	1.98		8.20
Narela	1.79		16.20
Sub-total	10.70	32.22	39.00
GRAND TOTAL	109.00	122.00	152.96

- From the remaining population of 77.0 Lakhs out of 230.0 Lakhs, 29 Lakhs already exists in villages, census towns, unauthorized colonies and JJ clusters in the present rural areas. Thus, about 48 Lakhs additional population is to be accommodated in the future urban extensions. The immediate urban extension zones are J to L, N & P (I & II).

5.3.4 JICA Water Supply Draft Master Plan, December 2010

DJB supplies water to almost every area through the distribution system except NDMC and the cantonment area where water is supplied to the respective organizations in bulk. DJB water resources come mainly from three rivers, Yamuna, Bhakra and Ganga Rivers. The present and future water scarcity continues to be a cause for serious concern in Delhi. The objective of JICA Water Supply Master Plan is to prepare well in advance water supply facilities to meet water demand. The target year is set as 2021.

The facilities needed for the Sewerage Master Plan depends on the quantum of water supplied to the consumers and the process of supply. Therefore, the factors considered in Water Supply Master Plan needs to be studied and analysis of sewage generation has to be carried out.

The estimated population of 26.0 million is considered for NCT Delhi for the year of 2021 which is higher by 3.0 (three) million compared to MPD 2021. The logic stated in the Water Supply Master Plan for the different planning assumptions is that the distribution facilities could be utilized eventually when water resources are increased in future, but that the transmission facilities are to be planned in stages. Henceforth, the transmission facilities are planned for the population of 24.2 million, while distribution facilities were planned for 26.0 million populations, as shown in **Table 5.5** below:

Three scenarios of available water resources have been proposed (i.e. 925 MGD (4199.5 MLD), 1075 MGD (4880.5 MLD) and 1200 MGD (5448 MLD)) in Master Plan for the WTP & transmission facilities. The per capita consumption is set to be 60 gpcd (270 lpcd) for the total demand calculation including 15% NRW. Distribution facilities were planned for 60 gpcd demand while transmission and WTP facilities for 38 (173 lpcd), 45 (205 lpcd) & 50 (227 lpcd) gpcd were based on respective water available scenario.

Table 5.5: Summary of Planning Assumptions from the Water Supply Master Plan

Planning Assumption	Transmission Planning Scenarios			Distribution Planning Scenario
	1	2	3	
Design 2021 Population	24.2 million	24.2 million	24.2 million	26 million
Available Water Supply at 2021 (MGD)	925	1075	1200	1560
Per Capita Demand (gpcd)	38.0	45.0	50.0	60.0
Per Capita Demand (lpcd)	170.0	200.0	225.0	270.0

The population holding capacity of zone 'E' as per MPD 2021 is 2.8 million in the year 2021 while JICA Master Plan considered the population of 4.0 million adding 1.2 million considering E (North). MPD-2021 considers E-North as green zone which has been found as built up area in actual. The JICA water supply Master Plan used the population of all zones as per MPD 2021 except Zone E. The zonal population for the year 2021 is presented in **Table 5.6** below:

Table 5.6: Adopted Zonal Population by Water Supply Master Plan

	Zones	Population MPD - 2021	Area (Ha)	Population Density (PPH)	Adopted Population Density (PPH)	Adopted Zonal Population
Cluster -1	A (Old City)	570,000	1,169	488	488	570,000
	B (City Extn & Karol Bagh)	630,000	2,341	269	269	630,000
	C (Civil Lines)	788,000	3,818	206	206	788,000
	D (New Delhi)	813,000	6,739	121	121	813,000
	E (East Delhi) - North*	918,000	1,988	462	462	918,000
	E (East Delhi) - South*	3,082,000	7,078	435	435	3,082,000
	F (South Delhi -I)	1,975,000	11,886	166	166	1,975,000
	G (West Delhi - I)	1,955,000	12,200	160	160	1,955,000
	H (North west Delhi -I)	1,865,000	5,525	338	338	1,865,000
Sub Total Cluster 1		12,596,000	52,744	239		12,596,000
Cluster -2	K-II (Dwarka)	1,300,000	5,770	225	225	1,300,000
	M-Part I (Rohini III)	160,000	1,313	122	122	160,000
	M-Part II (Rohini IV & V)	820,000	4,285	191	191	820,000
	P-I (Narela)	1,620,000	9,530	170	170	1,620,000
Sub Total Cluster 2		3,900,000	20,898	187		3,900,000
Cluster -3	J	2,067,000	15,515	133	126	1,950,000
	K-I	1,100,000	6,383	172	133	850,000
	L	2,000,000	22,072	91	91	2,000,000
	P-II	1,900,000	8,449	225	125	1,054,000
	N	2,417,500	14,004	173	132	1,850,000
Sub Total Cluster 3		9,484,500	66,423	143	116	7,704,000
O (Yamuna River)		0	7,960	0	0	
TOTAL		25,980,500	148,026	176	163	24,200,000

5.3.5 Laying of Interceptor Sewerage System along Najafgarh, Supplementary & Shahdara drains, Sept 2008

Cleaning of the river, including improving current conditions and water quality, reducing floating rubbish, and reducing extent of pollution of the River Yamuna, would take many years. DJB, under direction from Honorable Supreme Court of India, has decided to implement the Interceptor Sewer Projects on priority basis to provide an incremental, immediate and visible improvement in water quality of main drains (Najafgarh, Supplementary and Shahdara drain) and thereby improving water quality in River Yamuna. The Interceptor Sewer, a conveyance infrastructure component, will convey wastewater from diversion

structures from the un-sewered areas as well as overflows from the existing sewers and direct it to the nearest existing WWTP.

The planning of Interceptor Sewer System requires the estimation of present and projections for future population. In the report, various methods as per requirement of the CPHEEO manual have been used for trial population projections. The methods selected are in line with the data requirements, time availability, government proposals and demographic characteristics. **Table 5.7** below represents a detailed year wise comparison for population projection figures derived from different mathematical methods.

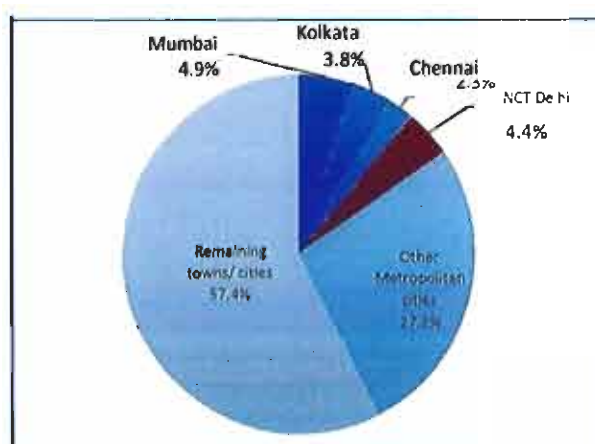
Table 5.7: Population Projections

Used Method	Census of India		Projected Population (Million's)			
	1991	2001	2008	2011	2021	2031
Demographic	9.42	13.85	16.54	17.91	21.72	25.51
Geometric	9.42	13.85	17.24	19.05	25.72	34.73
Periodical Growth rate	9.42	13.85	16.22	17.42	19.25	25.98
Decreasing Growth Rate	9.42	13.85	16.92	18.48	23.44	29.19
Density	9.42	13.85	16.18	18.7	25.04	27.48
Average (excluding Geometric Method)	9.42	13.85	16.47	18.13	22.36	27.04
Minimum			16.18	17.42	19.25	25.51
Maximum			17.24	19.05	25.72	34.73

5.3.6 Demographic Profile of NCT Delhi

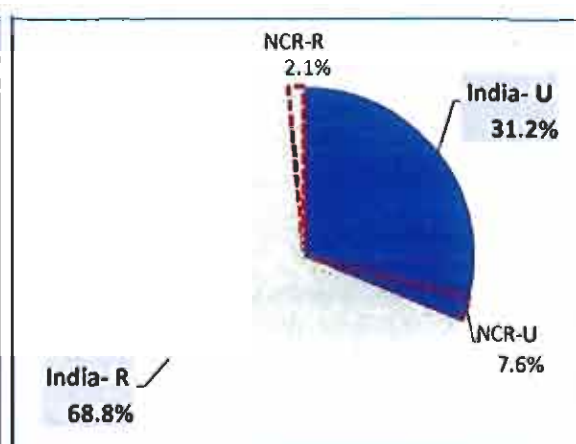
As per Census 2011, India's population is 1210 million, of which the urban population is 377 million. The level of urbanization has gone up from 27.8% in 2001 to 31.2% in 2011. As much as 42.6% of urban population is concentrated in 53 metropolitan cities. The four major metropolitan cities in India, namely, Mumbai, Kolkata, Chennai and Delhi together account for 15.4% of the total urban population of India (Fig-1). The NCR contains about 7.6% of India's urban population and 2.1% of the total rural population of India (Fig-2). About 4.4 % of the India's urban population resides in NCT Delhi alone.

Figure-1: Component of Urban Population of NCT- Delhi in India-2011



Source- Census of India, 2011* (Provisional)

Figure-2: Component of Urban and Rural Population of NCR in India-2011



Source- Census of India, 2011* (Provisional)

Delhi has a total population of 1,67,53,235 in year 2011 previously it was 1,38,50,507 in 2001. Out of the total population of Delhi, the population of male are 8,976,410 and female are 7,776,825 as per the 2011 Census.

The total population growth recorded in decade was 20.96 percent and the population of the state contributes to 1.38 percent of the total population in India. The total area of Delhi is 1,483 sq. km with a Density of 11,297 per sq km.

The Sex Ratio in Delhi is 866 for each 1000 male. In the last census of 2001, the sex ratio was 821 per 1000 males in Delhi. The child sex ratio is 866 per 1000 males and has decreased as compared to 942 in the 2001 census. The Literacy rate in Delhi has risen and is 86.34 percent, with male literacy at 91.03 percent and female literacy at 80.93 percent. In actual figures, total literates in Delhi are 12,763,352 out of which males and females are 7,210,050 and 5,553,302, respectively.

Area

The total area of NCT Delhi is 1483 Sq. km. with the rapid pace of urbanization; landscape of Delhi has undergone a change from majority of rural area to urban. The rural-urban areas changes during the last three census in Delhi are as follows:

Table 5.8: Delhi - Rural and Urban Area

Sl. No.	Classification of Area	1991		2001		2011	
		Sq. Km	%	Sq. Km	%	Sq. Km	%
1.	Rural	797.66	53.79	558.32	37.65	369.35	24.91
2.	Urban	685.34	46.21	924.68	62.35	1113.65	75.09
	Total	1483.00	100.00	1483.00	100.00	1483.00	100.00

Source: Census of India 2011

The growth in urban area during 2001-2011 was observed at average 20.44 per cent. This pace of urbanization has reduced the number of villages in Delhi from 300 in 1961 to 165 in 2001 and 112 in 2011. The number of urbanized villages has increased from 20 in 1961 to 135 in 2011. The number of census towns has increased from 3 in 1971 to 29 in 1991 and 110 in 2011. Thus more and more rural villages of Delhi are being declared Census Towns in each successive Census resulting in decreasing rural population and rural area in Delhi.

As per Census 2011, population of Delhi, as on 1st March, 2011, was 16.75 million as against 13.85 million as on 1st March, 2001. According to census 2011 (provisional) about 97.50 per cent of the population of Delhi live in urban areas and remaining 2.5 percent in rural areas. This urban population includes population of 110 Census towns in 2011 Census. As per Revenue Department record these census towns are located in rural area of Delhi and they are not part of notified urban area of Delhi.

Table 5.9: Population of India and Delhi & its Growth (1951-2011)

Sl. No.	Years	Delhi Population in Lakh	Growth (%)	India Population in Lakh	Growth (%)	Share of Delhi's Population in All India
1.	1951	17.44	--	3610.88	--	0.48
2.	1961	26.59	52.44	4392.35	21.64	0.61
3.	1971	40.66	52.93	5481.60	24.80	0.74
4.	1981	62.20	53.00	6833.29	24.66	0.91

Sl. No.	Years	Delhi Population in Lakh	Growth (%)	India Population in Lakh	Growth (%)	Share of Delhi's Population in All India
5.	1991	94.21	51.45	8464.21	23.87	1.11
6.	2001	138.51	47.02	10287.37	21.54	1.35
7.	2011	167.53	20.96	12101.93	17.64	1.38

The decadal growth rate of population during 2001-2011 was recorded at 21 per cent. This is a peculiar feature of Census 2011 of Delhi as in all Census since 1951, the decadal growth rate of population was more than 50% and 47% in 2001. This trend may be attributable to implementation of various employment promotion programmes like MNREGA and welfare schemes like pension to senior citizens and widows by Central and State Governments on the one hand and development of NCR priority towns viz Gurgaon, Faridabad, Sonapat, Noida, Ghaziabad, Meerut etc. contributing in reducing the migration to Delhi. The rate of growth of population in Delhi during the last decade was higher than the national level by 3.32 per cent. Delhi accounts about 0.05 per cent of the India's geographical area but consists 1.38 per cent of the nation's population.

Table 5.10: Urban and Rural Population of Delhi

Category	1971	% variation Since previous census	1981	% variation Since previous census	1991	% variation Since previous census	2001	% variation Since previous census	2011	% variation Since previous census
Total	4065698	52.93	6220406	53.00	9420644	51.45	13850507	47.02	16753235	20.96
Urban	3647023	54.57	5768200	58.16	8471625	46.87	12905780	52.34	16333916	26.56
Rural	418675	39.93	452206	8.01	949019	109.86	944727	0.45	419319	-55.61

Source: Planning Department Government of N.C.T. of Delhi

Table 5.11 and **5.12** provide the district wise demographic data on population, growth, sex ratio, literacy and density in Delhi as per census 2011.

Table 5.11: District-Wise Population of NCT Delhi: 2001 & 2011

Sl. No.	Districts	2001			2011		
		Number	Percent	Rank	Number	Percent	Rank
1	North West	2860869	20.65	1	3651261	21.79	1
2	South	2267023	16.37	2	2733752	16.32	2
3	West	2128908	15.37	3	2531583	15.11	3
4	North East	1768061	12.77	4	2240749	13.38	5
5	South West	1755041	12.67	5	2292363	13.68	4
6	East	1463583	10.57	6	1707725	10.19	6
7	North	781525	5.64	7	883418	5.27	7
8	Central	646385	4.67	8	578671	3.45	8
9	New Delhi	179112	1.29	9	133713	0.80	9
	TOTAL	13850507	100.00		16753235	100.00	

Source: - Census of India 2011 and Provisional Population Totals, NCT of Delhi

Table 5.12: District wise Demography of Delhi as per census 2011

Sl. No.	District	Population	Male Population	Female Population	Growth	Sex Ratio	Population Density
1	North West Delhi	3651261	1960677	1690584	27.63	862	8298
2	South Delhi	2733752	1470288	1263464	20.59	859	10935
3	West Delhi	2531583	1349685	1181898	18.91	876	19625
4	South West Delhi	2292363	1248700	1043663	30.62	836	5445
5	North East Delhi	2240749	1188307	1052442	26.73	886	37346
6	East Delhi	1707725	906721	801004	16.68	883	26683
7	North Delhi	883418	472260	411158	13.04	871	14973
8	Central Delhi	578671	305926	272745	-10.48	892	23149
9	New Delhi	133713	73846	59867	-25.35	811	3820

Source: Census 2011

Household Size

Number of persons living together in one house commonly called as household size. As per 2011 census, there were 3340538 households in Delhi. The average size of household in Delhi was found of 5.02. It indicates that in one house there had more than five persons in average.

More than one half of the households had more than five members during the year 2011. The distribution of households by size in Delhi in 2001 and 2011 are presented in **Table 5.13** below:

Table 5.13: Distribution of Households by Size in Delhi- 2001 & 2011

Sl. No.	Size of Household	No. of Household		Percent of total No. of Household	
		2001	2011	2001	2011
1.	One member	99786	123106	3.90	3.70
2.	Two members	206925	252370	8.10	7.60
3.	Three members	295216	428403	11.56	12.80
4.	Four Members	544289	803065	21.31	24.00
5.	Five Members	506711	681142	19.84	20.40
6.	Six to Eight Members	680065	853773	26.63	25.60
7.	Nine or more members	221157	198679	8.66	5.90
	TOTAL HOUSEHOLDS	2554149	3340538	100.00	100.00

Source: - Census of India.

Literacy Rate

As per the Census 2011, Delhi showed a high level of literacy i.e. 86.34 per cent as compared to 81.67 per cent in 2001 with the literacy rate of 91.03 per cent for males and 80.93 for females. The Rural and Urban literacy rates of Delhi were 82.67 and 86.43% respectively in 2011.

Sex ratio

Sex ratio is a very important demographic indicator for analysing Socio Economic features of population. It is the ratio of females per thousand male populations. As per 2011 census, the sex ratio of Delhi was 866. During the last decade sex ratio in Delhi increased from 821 in 2001 to 866 in 2011. In order to overcome this critical situation both at the national and state level, various stringent actions against female foeticide and complete abolition of sex determination practices during the pregnancy period have been introduced and implemented.

Age-wise Distribution of Population

The age-wise distribution of population is the best indicator of future human potential, the magnitude of responsibility of working population especially for taking care of children and their age-old parents.

One third of total population in Delhi during 2001 was in the category of children within the age group of 0 to 14 and the percentage change was recorded at a minimal rate. The condition was more or less same in all other age-wise categories either at positive in one group or at negative in consecutive age group. The information regarding age-wise distribution of Population of Delhi during 2001 is depicted in **Table 5.14**. Also, data regarding House utilization and facilities available to households are represented in **Table 5.15** and **5.16** respectively.

Table 5.14: Age-Wise Distribution of Population in Delhi: 1991 & 2001

Sl. No	Age Group	1991		2001	
		Number	Percent	Number	Percent
1.	0-14	3273482	34.75	4492939	32.44
2.	15-19	914871	9.71	1427979	10.31
3.	20-24	982866	10.43	1426860	10.30
4.	25-29	956788	10.16	1358925	9.81
5.	30-39	1438035	15.26	2211006	15.96
6.	40-49	867731	9.21	1432467	10.34
7.	50-59	504149	5.35	759505	5.48
8.	60 or more	439520	4.67	719650	5.20
9.	Age not stated	43202	0.46	21176	0.15
	TOTAL	9420644	100.00	13850507	100.00

Source: - Census of India

Table 5.15: House Utilisation as Per Census 1991, 2001 and 2011

Sl. No.	Items	1991	% of total	2001	% of total	2011	% of total
1.	Number of Census Houses	2446143	100	3379956	100	4605555	100
2.	Vacant Census Houses	293677	12	377790	11.18	512691	11.1
3.	Occupied Census Houses	2152466	88	3002166	88.82	4092864	88.9
4.	Occupied Census Houses by their Use						
i	Residence	1713952	79.63	2316996	77.18	3176329	77.6
ii	Residence-cum-other use	88386	4.11	135406	4.51	139157	3.40

Sl. No.	Items	1991	% of total	2001	% of total	2011	% of total
iii	Shop, office	172701	8.02	319233	10.63	376543	9.20
iv	School, College, etc.	--	--	7620	0.25	8186	0.20
v	Hotel, Lodge, Guest house, etc.	2734	0.13	6005	0.20	8142	0.20
vi	Hospital, Dispensary etc.	--	--	7661	0.26	8137	0.20
vii	Factory, Workshop, Work shed, etc.	86170	4.00	80165	2.67	90043	2.20
viii	Place of worship	3974	0.18	8249	0.27	8279	0.20
ix	Other non-residential use	84549	3.93	120831	4.02	278315	6.80

Source: Planning Department Government of N.C.T. of Delhi

Table 5.16: Facilities Available to Households - Census 1991, 2001 and 2011

S. No	Items	Households		Households		Households	
		1991	% age of Total households	2001	% age of Total households	2011	% age of Total households
1	Electricity available	1479620	79.48	2371811	92.86	3310809	99.1
2	Toilet facility available	1179797	63.37	1991209	77.96	2990741	89.5
3	Electricity and Toilet facilities available	1114424	59.86	1873914	73.77	2980190	89.21
4	Electricity available but no toilet facility	365196	19.62	497897	19.49	330619	9.89
5	Toilet available but no electricity	65373	3.51	117295	4.59	10551	0.31
6	No Electricity and toilet facility	316583	17.01	65043	2.55	19178	0.57
7	Water Supply						
i	Piped water supply	1409730	75.72	1924140	75.33	2716793	81.3
ii	Hand pumps / Tube wells	373355	20.06	559518	21.91	457977	13.7
iii	Well	43513	2.34	1019	0.04	3167	0.1
iv	other sources (Rivers/ Canal/ tanks)	34978	1.88	69472	2.72	162601	4.81
8	Fuel Used for Cooking						
i	Cooking Gas	865072	46.47	1737730	68.03	3003996	89.9
ii	Kerosene	774348	41.60	623298	24.40	175443	5.2

S. No	Items	Households		Households		Households	
		1991	% age of Total households	2001	% age of Total households	2011	% age of Total households
iii	Dung Cake	88680	4.76	50627	1.98	19487	0.6
iv	Wood	86861	4.67	98555	3.86	112291	3.4
v	Coal Light, Charcoal	24666	1.33	3713	0.15	4476	0.1
vi	Biogas	11913	0.64	6874	0.27	3017	0.1
vii	Electricity	2346	0.14	1257	0.05	1335	0.05
viii	Others	7269	0.39	1319	0.05	1866	0.05
ix	Crop residue	NA	NA	17479	0.69	9094	0.3
x	Crop Cooking	421	0.02	13297	0.52	9533	0.3
	TOTAL HOUSEHOLDS	1861576*	100.00	2554149	100.00	3340538	100

Source: Planning Department Government of N.C.T. of Delhi

5.4 SURVEY DATA (SEWERAGE MASTER PLAN STUDY - 2031)

A detailed topographical survey of project area has been carried out comprising the overall infrastructure mapping, strip surveys and site surveys. The methodology adopted comprises the first step of identifying the prioritized survey based on priority of Integrated Network and Schemes and also as per Urbanization Schemes under DDA Master Plan-2021. The colony wise base maps were created which contain prominent features like Temple, School, and Historical Places etc. These features help in facilitation of survey works. The survey team carries out reconnaissance survey to identify the existing sewerage condition in order to initiate Topographical survey for un-sewered colonies using base maps.

While carrying out topographical survey, the survey team captures levels at starting and ending of the Road/Gali and also at every 30 m distance and major undulations by Auto Levels. All the relevant features (Land use land cover features) with required attributes like land use, building count, floor information, culvert invert information, road material etc. from Total Station/Auto Level are also captured. Meanwhile, bench marks are also identified/ marked. These attributes play a major role in population estimation of a particular area. The topographical survey data is converted and integrated into GIS format with its defined projection and collected survey attribution. Based on this information, the contour levels were generated to examine the ground profile.

Using this real ground information, population for the present & future has been predicted. Different sets of dwelling units are considered for a particular area based on the land use attributes; Floor and building count information is used for generating various population scenarios for the project area. The most reasonable population scenario is then adopted and population density is calculated.

5.5 COMPARISON OF POPULATION PROJECTION (STUDIED BY VARIOUS AGENCIES FOR PLANNING OF DELHI INFRASTRUCTURE WORK)

To understand the growth scenario, the results of population projections for NCT Delhi from all the above various reports have been compared & presented in **Table 5.17** below:

Table 5.17: Population Projection for NCT (Delhi) - Comparison

Year ↓	Census		Reports and Published Date					
	Actual	Projections	MPD-2021	TCE	PWC (WB Project)	CDP (JNNURM)	EIL (IS Project)	JICA WS Master Plan-2021
Published Date →			2007	2002	2005	2006-07	2008	2010
1991	9.42	-	-	9.4	-	-	-	-
2001	13.85	13.85	13.78	14	13.78	-	13.85	13.78
2006	-	16.02	16.2	16.5	16.61	-	-	16.2
2008	-	-	-	-	-	-	16.46	-
2011	-	18.45	18.2	19	19.51	17.99	18.13	18.2
2016	-	21.29	19.9	20.5	21.08	-	-	19.9
2021	-	24.49	23	23	23.37	23.48	22.36	26.00
2026	-	27.98	-	-	25.9	-	-	-
2031	-	-	-	-	-	-	27.04	-
2036	-	-	-	-	-	-	30.46	-
2041	-	-	-	-	-	-	33.82	-

5.6 METHODOLOGY

The methodology adopted for this study concentrates on the collective urban agglomeration and includes review and analysis of the trends and inter-area growth patterns using available demographic data from the Census of India, Zonal Development Plans, Master Plan for Delhi 2021, JICA Water Supply Master Plan and various reports published by the agencies for infrastructure development work in the project area.

The outcome of this study have been the population projections for the different DDA zones, sub-zones and association to the twelve drainage zones created for the study of Sewerage Master Plan-2031. The projections has been done for the year 2011, 2021, 2026 and 2031 to facilitate the suitable sewerage infrastructure and to study the behavior of sewerage system for these upcoming years.

The steps for the methodology include collection of the published reports and data including the Zonal Development Plan, MPD 2021, and recent as well as historic census data. These documents were substantiated with available literature, reports from different agencies and surveys carried out in the region (Refer **Figure 5.2**). With this knowledge base, preliminary population projections for the decennial years were computed using mathematical methods (arithmetical, incremental and exponential). These methods were used as a basis for understanding the best fit with the published Zonal Development Plans with the intent of selecting the most appropriate method to compute future decennial projections.

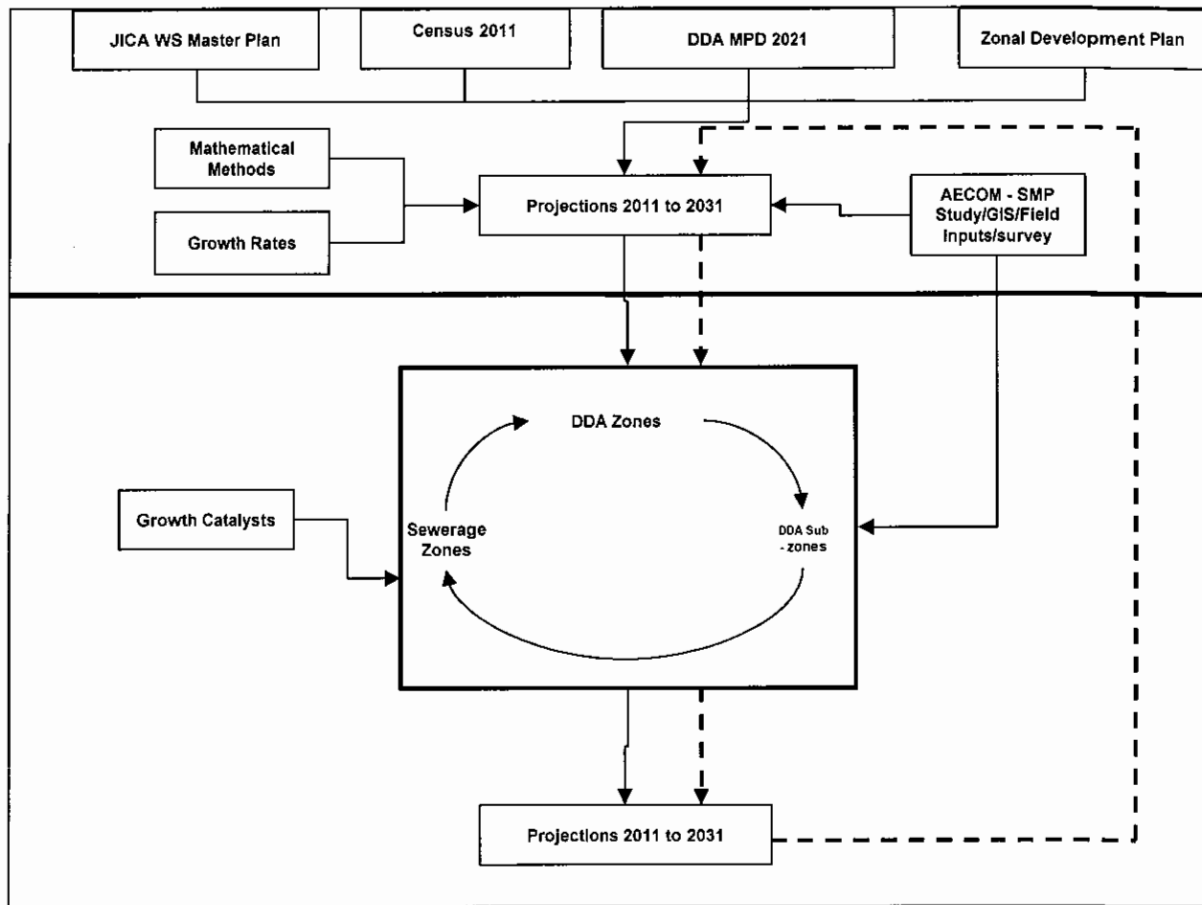


Figure 5.2: Methodology - Population Projection

A further analysis and comparative assessment of population was computed based on a review of past growth rates and future projected growth rates as documented in the DDA MPD for 2021, JICA Water Supply Master Plan, Zonal Development Plan and other reports. A combination of the understanding derived from the mathematical methods, an assessment of the “induced growth rate” as documented in the MPD 2021, and a comprehensive examination of past and future growth rates based on review of information obtained was used to develop the population projections.

Having finalized the projected populations by decadal intervals based on census years, estimates were interpolated for the Project Specific Years 2016, 2026 and 2031. To understand the spatial distribution of the population, the projected populations were allocated to the different zones as per DDA based on possible increased development density. This sequential process has been captured in **Figure 5.3**.

Having established these allocations for the decennial year 2031, intermediate and future decadal intervals were computed and similar exercises in spatial allocation were also conducted.

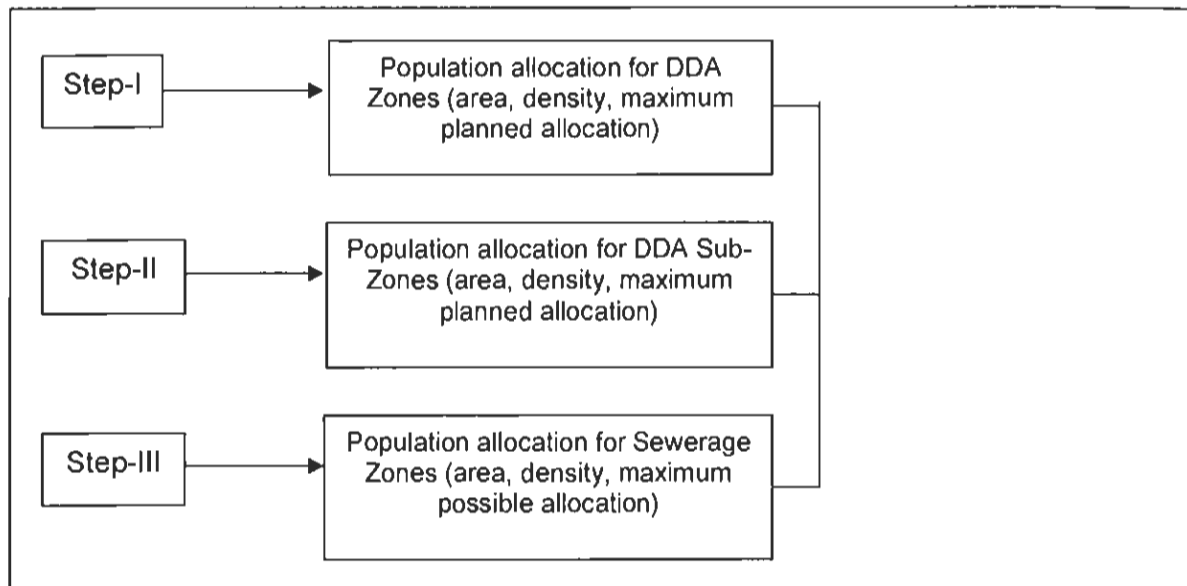


Figure 5.3: Methodology - Population Allocation

The distribution of the population was determined by the existing characteristics of the geographic unit, taking into account the current population density, development catalysts and deterrents, permissible land uses, development norms, and land use patterns. Land use patterns reflect designated land use in the case of zones and current land use is based on field observations.

5.7 POPULATION PROJECTION

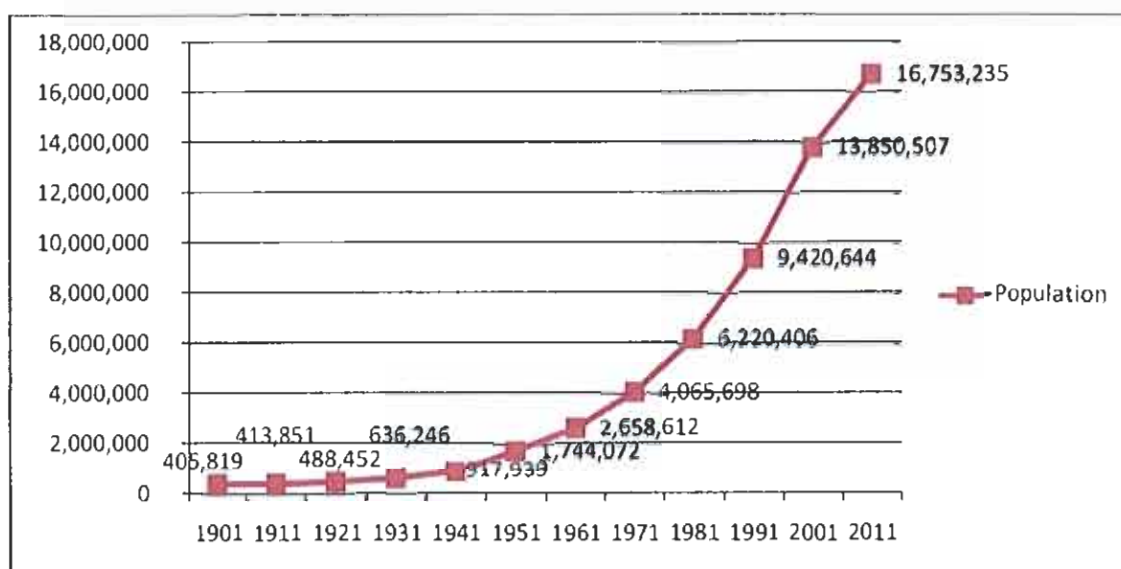
5.7.1 NCT Delhi Population Projection

The DDA Master Plan Delhi-2021, JICA Water Supply Master Plan and Zonal Development Plan provide a vision for development by the year 2021. The target of the sewerage planning framework for Delhi is to work with anticipated growth up to the year 2031, with an intermediate growth at 2016 and 2026. To develop projections for these two points of time, it is essential that existing growth projections be used as a basis and then to be extended to the horizon year of this project. The indicative population projections were developed for the NCT Delhi by using mathematical methods (arithmetical, incremental, decrease rate of growth and exponential) to develop estimates for population for decadal intervals of 2016, 2021, 2026 and 2031 using 1991 & 2001 Census as the base.

The population of Delhi has been increasing at an annual growth rate of 4% since 1961 and reached 13.85 million persons in 2001, with an average density of 95 persons per hectare in the city-area of 1483 sq. km. It will exceed 30 million in 2021 if it grows with 4% rate. The trend of growth of NCT Delhi has been worked out using Census of India data from 1951 to 2011 which is given in **Table 5.18** and **Graph 5.1**. Also, the analysis of projected population by MPD 2021 has been done & presented in **Table 5.19**. Both the trend of population & MPD 2021 prediction shows that there is a decrease in annual rate of growth of population of NCT of Delhi. The decadal trend shows annual average growth rate is 4.23%, while the projected growth rate as per the MPD 2021 is approximately 2.3 - 2.7%.

Table 5.18: Population Trend 1951-2011

Census Year	Population	Arithmetic Increase	Incremental Increase	Decadal Growth Rate (%)	Growth Rate (%)
1951	1,744,072	--	--	--	--
1961	2,658,612	914,540	--	52.44	4.31
1971	4,065,698	1,407,086	492,546	52.93	4.34
1981	6,220,406	2,154,708	747,622	53.00	4.34
1991	9,420,644	3,200,238	1,045,530	51.45	4.24
2001	13,850,507	4,429,863	1,229,625	47.02	3.93
2011	16,753,235	2,902,728	-1,527,135	20.96	1.92

**Graph 5.1: Growth of population of NCT Delhi over a period of 1901-2011****Table 5.19: Population Projection as per MPD 2021**

Year	Population	Decadal Growth Rate (%)	Annual Growth Rate (%)
2006	16,200,000	-	-
2011	18,200,000	31.04	2.77
2016	19,900,000	-	-
2021	23,000,000	26.37	2.37

MPD – 2021 suggests that during the course of implementation of plan, attempts should be made to restrict the population of Delhi to below 230 lakhs by 2021. The population will have to be estimated with due regard to all the factors governing the future growth and development of the project area in the industrial, commercial, educational, social and administration spheres. A judgment based on these factors would help in selecting the most suitable method for deriving the probable trend of the population growth. In reality, the population growth is a combination of two or more methods, thus the best suitable methods needs to be identified. In the present case, the various methods as per requirement of the CPHEEO Manual have been used for trial population projections. The methods selected account for the data requirements, time available and government proposals/ interventions and demographic characteristics.

The population projection has been carried out using Arithmetical Increase, Incremental Increase, Geometrical Increase and Annual Growth rate methods.

Arithmetical Increase

This method is generally applicable to large and old cities. In this method, the average increase of population per decade is calculated from past records and added to the present population to find out the population in the next decade. This method gives a low value and is suitable for well settled and established communities.

Formulae:

Arithmetic Increase Method: $P_N = P_0 + nx$

Where:

P_0 = Population in the base year = P_{2001}

N = Number of Years

n = Number of decades

x = average increase per decade

Incremental Increase

In this method, the increment in arithmetical increase is determined from the past decades and the average of that increment is added to the average increase. This method derives higher figures than those obtained by the arithmetical increase method.

Formulae:

Incremental Increase Method: $P_N = P_0 + nx + \frac{n(n+1)}{2} y$

Where:

P_0 = Population in the base year = P_{2001}

N = Number of Years

n = Number of decades

x = average increase per decade

y = average incremental increase per decade

Geometrical Increase Method

In this method, percentage increase is assumed to be the rate of growth and average of the percentage increase is used to find out future increment in population. This method gives much higher value and is mostly applicable for growing towns and cities having vast scope for expansion.

Formulae:

Geometrical Increase Method: $P_N = P_0 (1+rg)^n$

Where:

P_0 = Population in the base year = P_{2001}

N = Number of Years

n = Number of decades

rg = average percentage increase per decade

Annual Growth Rate Method (Exponential Method)

In this method, the rate of percentage increase or decrease is calculated and the average in the rate of growth is calculated. This method is applicable only in such cases where the rate of growth of population shows a downward trend.

Formulae:

Growth Rate Method: $P_N = P_0 (1 + \text{Growth Rate})^{n-o}$

Where:

P_0 = Population in the base year = P_{2001}

N = Number of Years

n = Projected Year

o = Base year

Growth Rate = average percentage increase per year

With this scenario and the preliminary data analysis for NCT (Delhi), it is suggested that for NCT (Delhi), Demographic method and Annual Growth rate methods would be considered suitable. The Geometric method gives very high growth scenario, which is unlikely in Delhi therefore, the model was not taken for population projections. Considering the prospects of expansion of outer Delhi area and population trend over a period of 1951-2001, the Rate of Growth Method were considered as most appropriate to forecast the future population of NCT (Delhi). It was observed that the estimates based on arithmetical & incremental methods were considerably on the lower side, whereas geometrical method projection was on the higher side than those projected in the MPD 2021, Census projection and various other report projections. (Refer **Table 5.20**).

Table 5.20: Population projection by mathematical methods

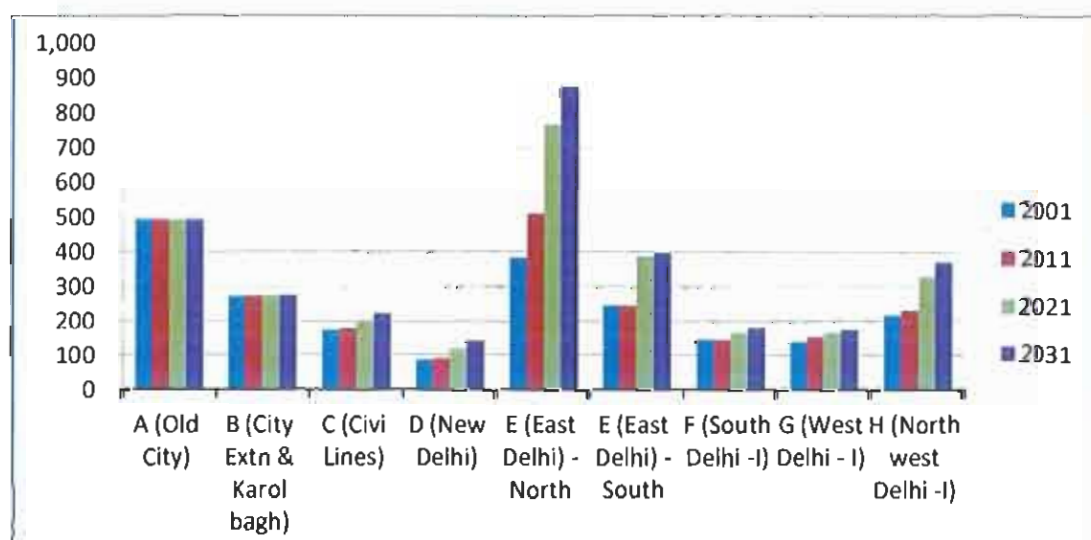
Used Method	Projected Population Numbers				
	2011	2016	2021	2026	2031
Arithmetical Increase	16,271,794	17,482,438	18,693,081	19,903,725	21,114,368
Incremental Increase	17,150,625	19,130,245	21,329,573	23,748,609	26,387,353
Geometrical Increase	20,957,924	25,780,394	31,712,526	39,009,657	47,985,875
Growth Rate	16,753,598	19,913,386	24,200,000	26,407,990	28,634,265

5.7.2 Zonal Population Projection

Arithmetical Increase and Incremental Increase method give the low value as compared to the projection suggested by MPD 2021 for the year 2021 while the Geometrical Increase method shows the higher value. The same has been presented in **Table 5.21** below. The Growth Rate Method (Exponential) has been adopted considering the possibility of the potential for growth for future years on account of availability of optimum water supply and development projected by MPD 2021. This predicted growth is all the more realistic as overall population density in Delhi is much higher than those already developed cities elsewhere in India.

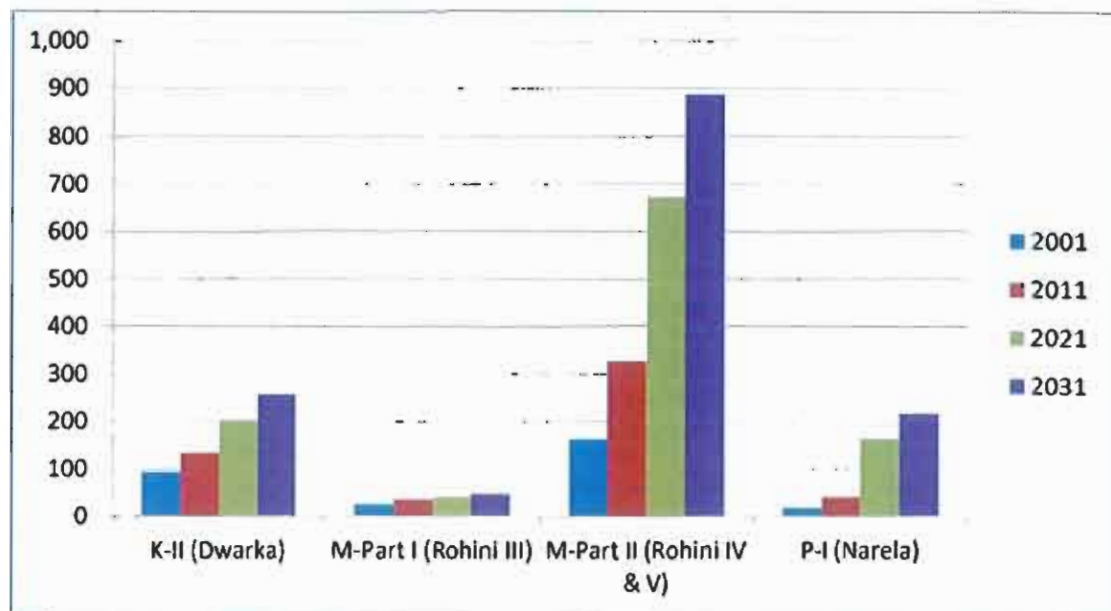
Table 5.21: Population projection– Zone Wise

Cluster	Zones	Area (ha)	Population Year - 2001	Population Year - 2011	Population Year - 2021	Population Year - 2031
Cluster -1	A (Old City)	1,159	5,70,000	5,70,000	5,70,000	5,70,000
	B (City Extn & Karol bagh)	2,304	6,24,000	6,28,000	6,30,000	6,31,893
	C (Civil Lines)	3,959	6,79,000	6,99,521	7,88,000	8,79,099
	D (New Delhi)	6,855	5,87,000	6,20,552	8,13,000	9,66,068
	E (East Delhi) - North	1,566	6,00,000	11,00,000	12,00,000	13,52,030
	E (East Delhi) - South	7,231	23,68,061	26,68,061	28,00,000	28,56,507
	F (South Delhi -I)	11,958	17,17,000	17,93,700	19,75,000	21,60,124
	G (West Delhi - I)	11,865	16,29,000	18,18,702	19,55,000	20,54,979
	H (North west Delhi -I)	5,677	12,26,000	12,81,509	18,65,000	21,01,280
	Sub-Total	52,574	1,00,00,061	1,11,80,046	1,25,96,000	1,35,71,980
Cluster -2	K-II (Dwarka)	6,408	5,97,000	8,59,607	13,00,000	17,30,343
	M-Part I (Rohini III)	3,855	96,000	1,39,705	1,60,000	1,92,405
	M-Part II (Rohini IV & V)	1,218	1,98,000	3,99,829	8,20,000	11,34,839
	P-I (Narela)	9,866	1,79,000	4,07,425	16,20,000	22,41,999
	Sub-Total	21,347	10,70,000	18,06,565	39,00,000	52,99,586
Cluster -3	J - (South Delhi-II)	15,178	5,87,900	12,58,086	19,50,000	26,46,656
	K-I (West Delhi -II)	5,782	5,97,500	7,74,000	8,50,000	10,05,572
	L - (West Delhi -III)	22,840	9,86,500	14,11,573	20,00,000	26,36,183
	P-II (North Delhi)	8,534	6,68,800	8,49,657	10,54,000	14,87,312
	N - (North West Delhi -III)	13,975	5,39,807	6,77,672	18,50,000	27,40,088
	Sub-Total	66,309	33,80,507	49,70,988	77,04,000	1,05,15,812
	O - River Front	8,070				
	TOTAL	1,48,300	1,44,50,568	1,79,57,599	2,42,00,000	2,93,87,379



Graph 5.2: Population density (PPH) of Cluster-1 (Saturated Areas)

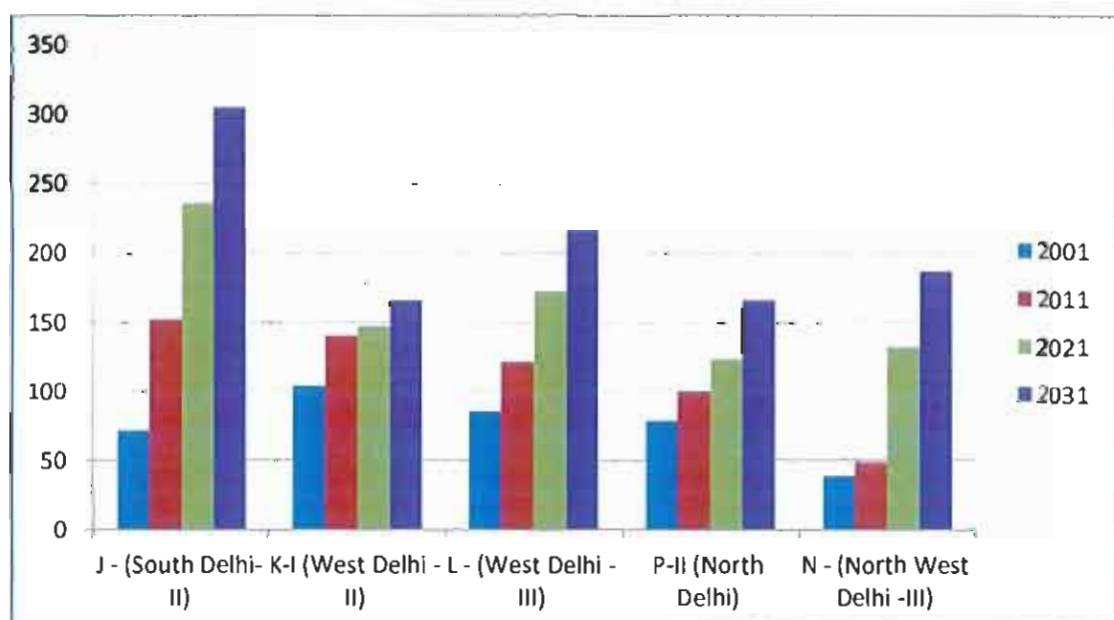
Graph 5.2 clearly indicates the saturated density levels of zones within Cluster 1. These are the zones with high population density but low growth rates. For every zone within Cluster 1 except E-North, population density of 2021 and 2031 are in similar ranges showing negligible population growth. For E-North there is a little increase in population from 2021 to 2031 which is well depicted by the graph above.



Graph 5.3: Population density (PPH) of Cluster-2 (Urban Extension Areas)

Graph 5.3 clearly indicates the density levels of zones within Cluster 2. These are the zones which have started urbanization and their population density is planned to increase. Except for Zone M – Part I, the population for each zone within Cluster 2 is showing increasing trend from 2001 to 2031, so as the population density. For M – Part I, the population growth rate is almost negligible from 2001 to 2031.

Graph 5.4 clearly indicates the density levels of zones within Cluster 3. These are the zones which will start urbanization and will attain high density levels like those of core areas of Delhi. Population growth trend for these zones is increasing from 2001 to 2031, so as the population density. These are the outer areas of Delhi where future expansion is expected to take place.



Graph 5.4: Population density (PPH) of Cluster-3 (Urbanizable Area)

Conclusion

The population projections for NCT Delhi have been developed using documented information made available to the Project Team. The projected population has been rationally examined in the context of the growth drivers and is considered as reasonable and achievable, given the development characteristics of NCT Delhi. The projections developed in this report must be treated as such and should not be considered to be absolute, fixed numbers.

The Project Team has worked towards development of Sewerage Master Plan 2031. This report addresses the development of estimated growth projections for the purpose of developing a Sewerage Master Plan. The projections done by Master Planning Department (MPD-2021), Census of India and JICA Water Supply Master Plan have been the basis of the projections made in this study.

The tools of GIS and Remote Sensing have been extensively used for the analysis of the present land use patterns and development densities. These have provided vital information for projections and distribution at a micro level. The allocation of population is made in a scientific manner considering the growth catalysts proposed in the Master Plan 2021 and Water Supply Pattern as per JICA Water Supply Master Plan.

The Development density and land use patterns (existing and proposed) are important to project the distribution of population over the decades for the three broad categories of Residential, Commercial and Industrial.

CHAPTER - 6

PLANNING AND DESIGN CRITERIA

CHAPTER - 6: PLANNING AND DESIGN CRITERIA

6.1 SEWERAGE SYSTEM

6.1.1 Design Period

The design of the Sewerage System is principally based on Central Public Health and Environmental Engineering Organization (CPHEEO) Manual on Sewerage System and Sewage Treatment. The following design criterion have been adopted for the project Design Period.

The design period for the respective components of the sewerage system is given in **Table 6.1** below: (Ref. Table 2, p.6, CPHEEO Manual on Sewerage and Sewage Treatment).

Table 6.1: Component Wise Design Period – Sewerage System

Sl. No.	Component	Recommended Design Period in Years	Remarks
1	Collection System i.e. Sewer Network	30	System to be designed for prospective population of 30 years
2	Pumping Station and associated structures (Civil Works)	30	Duplication machinery within the pumping station or sufficient standby would be easier/ cost of civil works will be economical for full design period.
3	Pumping Machinery	15	Life of pumping machinery is generally 15 years.
4	Wastewater Treatment Plant (WWTP)	30	The construction may be in a phased manner as initially the flows may not reach the designed levels, and it will be uneconomical to install the full capacity plant initially.

6.1.2 Unit Flow and Peak Factor

Unit Flow Factors

Unit flow factors are design parameters that are used to estimate design flows of sewerage systems and sewage treatment facilities. The unit flow factor is the average sewage flow (average dry weather flow or ADWF) contributed by one unit of sewage source (person or employee) per day. The design flow is determined by summing the products of the number of contributing units of each source with appropriate unit flow factors.

The unit flow factors for various sewage sources like residential, commercial, government, educational and religious as specified in the CPHEEO manual and as adopted in DJB are listed below. These unit flow factors are inclusive of 5% infiltration (being HDPE pipes – refer Chapter 6).

- Residential – 135 lpcd (160 lpcd water requirement)
- Commercial – 40 lpcd (47 lpcd water requirement-CPHEEO)
- Government – 40 lpcd (47 lpcd water requirement-CPHEEO)
- Educational – 40 lpcd (47 lpcd water requirement-CPHEEO)

- Religious – 12.6 lpcd (15 lpcd water requirement)

Peaking Factors

Peaking flows are cumulative results of combination of factors such as diurnal and seasonal flow variations of flow components and characteristic response of inflow and base flows to storm events.

Peak flows can be determined by multiplying the average dry weather flow by the peaking factor.

Population based peaking factors (as described in CPHEEO manual) are used for hydraulic modeling purposes in this study. Population based peaking factors decrease with increasing population. For domestic sewage flows, the following criteria presented in **Table 6.2** based on population, have been used (Ref. 3.2.5, p.39, CPHEEO Manual on Sewerage and Sewage Treatment).

Table 6.2: Peak Factor

Contributory Population	Peak Factor
Up to 20,000	3.00
20,001 to 50,000	2.50
50,001 to 7,50,000	2.25
Above 7,50,000	2.00

The variable peak factor with the variation in contributory population is used in establishment of the sewage loading by using the corresponding module of the Bentley's software SewerGEMS Sanitary.

6.1.3 Shape and Size of Sewers

The shape of sewers varies from circular, elliptical, egg shaped, semi elliptical to mouth shaped. The application of the respective kind will depend on site conditions and project requirements. Circular sewers are adopted when the flow of sewage is nearly uniform, as these are stronger, cheaper and structurally more stable than others. Oval or egg-shaped sewers are adopted best for situations where there is an intermittent flow of sewage - that is, when the flow varies considerably at different times. The reason for this is, at the time when there is, but a small quantity of sewage passing, the flow occupies the narrow bottom of the egg-shaped sewer at a greater depth than it would be in a circular sewer of the same area of section. This increased depth of the sewage causes it to flow with greater velocity, and thus renders the sewer higher hydraulic efficiency. However they have become obsolete due to problems in laying, instability at bottom and high precision required during laying. Horizontal Elliptical pipe is used with equivalent circular sizes with tongue and groove cement mortar or mastic compound joint. The horizontal elliptical pipe is installed with the major axis horizontal and is used for minimum cover situations or other conditions where vertical clearance problems are encountered. It offers the hydraulic advantage of greater capacity for the same depth of flow than other shapes of equivalent sectional area. Loads under similar cover conditions are similar to that of circular pipe with the same span. Thus they are mostly used under conditions of insufficient cover for laying of pipes.

In order to ensure smooth flow for carrying peak discharge by a hydraulically efficient system and less prone to blockage, it is proposed to have circular pipes with minimum of 250 mm internal diameter for the sewerage collection system.

Earlier HDPE pipes as per IS:14333 were considered for providing sewer lines of dia 280 – 710 mm outer diameter. However, DWC pipes got IS authentication at a later stage which had techno-commercial advantage over HDPE pipes and thus has been considered and recommended for 250 upto 500 mm.

For sewers of internal diameter 700 mm and above diameter, RCC pipes duly lined with 2 to 3 mm thick PE lining has been proposed.

The shape and sizes of the sewer were adopted as per IS 14333:1996 for High Density Polyethylene pipes for Sewerage and IS 458:1988 for RCC NP3 pipes with PE Lining. Based on the route alignment and ground conditions, HDPE pipes of PE 80 grade with Nominal Pressure PN-4 were selected. The following **Table 6.3** shows pipes & materials proposed for the project.

Table 6.3: Pipe Details – Adopted for Sewerage Network

Sl. No.	Outer Diameter (mm)	Inner Diameter (mm)
PE-80, PN-4 & SDR -19 HDPE pipe		
1	280	250.6
2	315	281.8
3	355	317.6
4	400	357.8
5	450	402.6
6	500	447.4
7	560	501
8	630	563.6
9	710	635.2
SN 8 DWC Pipe		
1	295	250
2	358	300
3	480	400
4	595	500
NP3 Class R.C.C Non pressure pipe having S & S joints with PE lining with rubber ring		
1	870	700
2	990	800
3	1100	900
4	1230	1000
5	1340	1100
6	1450	1200
7	1680	1400
8	1930	1600
NP4 class R.C.C Jacking pipe with PE lining reinforced concrete with stainless steel collar & rubber joints		
1	870	700
2	990	800
3	1100	900
4	1230	1000
5	1340	1100
6	1450	1200
7	1680	1400
8	1930	1600
9	2160	1800

6.1.4 Capacity of Sewer

The sewers has been designed as per DJB's norms to flow maximum up to half full (50%) for diameter 280 to 400 (OD) mm, 2/3rd full (67%) for diameter 450 to 1000 (OD)mm, 3/4th full (75%) for diameter 1115 to 1535 (OD)mm and 80% for diameter above 1740 mm respectively.

6.1.5 Limiting Velocities and Gradients in Sewer

It is proposed that minimum gradient to be adopted are such that to maintain a Self-Cleansing Velocity of 0.8 m/s at design peak flow in new sanitary sewers under the ultimate scenario (year 2031), subject to minimum velocity of 0.6 m/s for peak flows at the current scenario (year 2011). Hence, while designing the new sewers, it is proposed to maintain minimum velocity of 0.6 m/sec for the peak flows in year 2011. The maximum gradient to be adopted is such that the maximum velocity should not exceed 3.0 m/s when flowing half or full bore in order to prevent scouring of sewer by erosive action of suspended matter.

In case of starting manholes for laterals, branches and sometimes even on the intermediate sections, minimum velocity for design flow is likely to be less than the self cleansing velocity. But manholes and sewers will be flushed out during peak flow period carrying forward silt, which may get deposited during minimum flow period, especially during night hours. Adopting lower values of velocities through lesser gradients has helped in avoiding deep excavations. However, at certain sections, where undercrossing of deeper sub drains and main drains as physical constraints, smaller sections of the sewer may be sloped at a steeper gradient to minimize the number and height of drops required to reach the required invert levels. In developing sewer network, this point should be given due consideration prior to design of sewers. In case where the above velocity criteria are not met, prescribed slope for different flows in CPHEEO manual shall be adopted for design purpose.

6.1.6 Minimum Cover

The minimum cover from ground level shall be as described in **Table 6.4** below:

Table 6.4: Permissible Cover Limit

Type of cover	Minimum Cover
From Finished ground level	0.9 m above crown level 0.6 m above crown level (Wherever applicable)

The cover for the sewer crossing under main drains shall be at least 3.0 m from drain bed (original design bed level, below the silt levels) to the top of pipe or 2 X Diameter of pipe whichever is greater.

There shall be a layer of rock protection or encasement over the top of the pipe where the cover is insufficient.

Wherever trenchless method of installation is proposed to undercross the main drains / canals, soil improvements and other considerations have been recommended during implementation works.

6.1.7 Hydraulic Formula / Design Formula

Manning's Formula shall be adopted for the design of gravity sewers:

$$V = \frac{1}{n} \times R^{\frac{2}{3}} \times S^{\frac{1}{2}} \quad \text{and,}$$

$$Q = A \times V$$

Where,

V = Velocity when pipe flows full in m/s

n = Manning's Roughness Coefficient

S = Slope of Hydraulic Gradient

R = Hydraulic Radius in m

Q = Flow rate when pipe flows full in m³/s

A = Cross Sectional Area of pipe in Sq. meters

The value of Manning's co-efficient for different pipe materials are given in Table 3.4 of CPHEEO manual.

For different pipes, values of 'n' are as shown below in **Table 6.5**:

Table 6.5: Manning's Co-efficient Pipe Material Wise

Manning's Co-efficient		
Conduit Material	Condition of Interior Surface	
	Good	Fair
Cement Concrete	0.013	0.015
Plastic, polyethylene : HDPE, RCC with PE lining, DWC	0.011	0.011

Value of 'n', i.e. co-efficient of roughness (Manning's Co-efficient), is adopted as 0.011 for all diameters of PE lined concrete, HDPE and DWC pipes.

6.1.8 Manhole (Sewer Appurtenance)

Ref: Manual on Sewerage and Sewage Treatment, Ministry of Urban Development New Delhi, December 1993, Page No. 74-77, Chapter 4: Sewer Appurtenances.

➤ **Rectangular Manholes:**

- Size 900 x 800 mm for depth upto 0.9m
- Size 1200 x 900 mm for depth between 0.9 to 2.5 m.

➤ **Circular Manholes:**

- Circular manholes are stronger than rectangular and arch type manholes and thus these are preferred over rectangular as well as arch type manholes.
- The circular manholes are provided for all depths starting from 0.9 m.

- Circular manholes are straight down in lower portion and slanting in top portion so as to narrow down the top opening equal to internal dia of manhole cover.

Sewer transitions occur wherever conduits of different characteristics are connected. The difference may be flow, area, shape, grade, alignment and conduit material, with a combination of one or all characteristics. Manholes should be located at all such transitions.

Spacing of Manholes

On sewers, which are to be cleaned manually, but cannot be entered for cleaning or inspection, the optimum distance between manholes may be 30m but adopted value is 15m due to heavily dense area. For sewers which are to be cleaned with mechanical devices, the spacing of manholes will depend upon the type of equipment to be used for cleaning sewers. For the diameters less than 910 mm, spacing of manholes adopted is 30 m to 90 m as per site accessibility.

The spacing of manholes above 90 m to 150 m may be allowed for sewers of diameter 910 to 1520 mm, 150 to 200 m may be allowed for 1520 mm to 2000 mm and which may further be increased up to 300 m for sewer of over 2.0 m diameter as per site accessibility.

Circular manholes can be provided for all depths starting from 0.91 m for depth below 0.9m, rectangular/square chambers would be adopted. The internal diameter of circular manholes may be kept as shown in **Table 6.6** for varying depths (Ref. 4.2.1.2 of CPHEEO Manual on Sewerage and Sewage Treatment).

Table 6.6: Diameter Wise Depth for Manholes

S. No.	Depth	Diameter of Manhole
1.	0.91 m to 1.67 m	910 mm
2.	1.67 m to 2.28 m	1220 mm
3.	2.28 m to 11.29 m	1520 mm
4.	3.81 m to 10.67 m	1830 mm
5.	6.09 m to 10.67 m	2400 mm

The size of manhole covers should be such that there should be clear opening of not less than 560 mm diameters for manholes exceeding 0.91 m depth (Ref. 4.2.1.3 of CPHEEO Manual on Sewerage and Sewage Treatment).

Construction of manholes is preferred with pre-cast RCC manhole with chosen jointing systems or cast-in-situ RCC manhole with PE lining of approved thickness except in the channel portions, reinforced concrete bases, rings and cone sections with rubber gaskets between sections. Recent developments for groundwater infiltration elimination involves the use of mastic sealing around the outside of manholes at the joints. However, brick manholes with Cement mortar applied to the inside of manhole is a cost effective way of reducing infiltration in wet soils. These modifications shall result in a significant decrease of infiltration in manholes.

6.1.9 Drop Manhole

When a sewer connects with another sewer, where the difference in level between water lines (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the

connection within 600 mm, a drop connection shall be provided for which a manhole may be built incorporating a vertical or nearly vertical drop pipe from the higher sewer to the lower one. (Ref. 4.2.2.4 of CPHEEO Manual on Sewerage and Sewage Treatment).

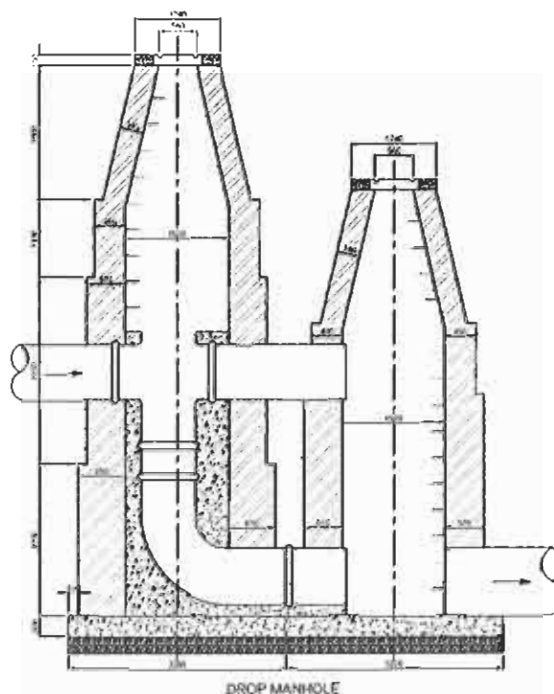


Figure 6.1: Typical Drop Manhole

6.1.10 Junction Manholes

Junction manholes are provided where more than two pipes intersect. These are provided to combine the inflow from two or more pipes with one designated outlet. The diameter of the junction manhole must be large enough so that the distances between adjacent openings have enough strength to resist lateral and vertical loads, as well as stresses caused by handling.

6.1.11 Manhole Covers

As per IS - 4111: 1986, the size of manhole covers should be such that there should be clear opening of not less than 560 mm diameter for manholes exceeding 0.91 m depth. Manhole cover and frame will be SFRC (Steel fibre reinforced concrete) conforming to the relevant IS.

6.1.12 Rate of Infiltration/inflow

Infiltration into the sewerage system occurs through the defective sewers, access chambers, etc. and this is the value, which can only be measured after the construction. Since the sewerage system is proposed with "HDPE", "DWC" and "RCC with PE lining" pipes, chances of leakage from the joints will become less significant. Thus for HDPE pipes with fused joint, 5% will be on the conservative side instead of the standard 10% allowance. However, the system condition deteriorates with age and will allow some infiltration over long service life. To avoid putting any value to it, infiltration is assumed to be included in the sewage/wastewater expected from the various water users. E.g. 100% of residential use includes the average sewage flows plus infiltration. In the hydraulic design of sewers, an allowance for infiltration for the project area is considered.

6.1.13 Bedding Details for Poly Ethylene Pipes

Bedding in different type of ground Soils for Flexible PE pipes:

Flexible pipe performance is highly dependent on proper bedding to provide the required sidewall support. A pipe with lateral sidewall support is capable of carrying a significantly larger load than an unsupported pipe. Without sidewall support, some flexible pipes would be crushed by the weight of the backfill above. For this reason, it is imperative that flexible pipes be properly backfilled with high-quality materials (as shown in **Figure 6.2**) and should not be used in areas where future adjacent excavations are likely. These excavations could expose or weaken the bedding envelope supporting the pipe.

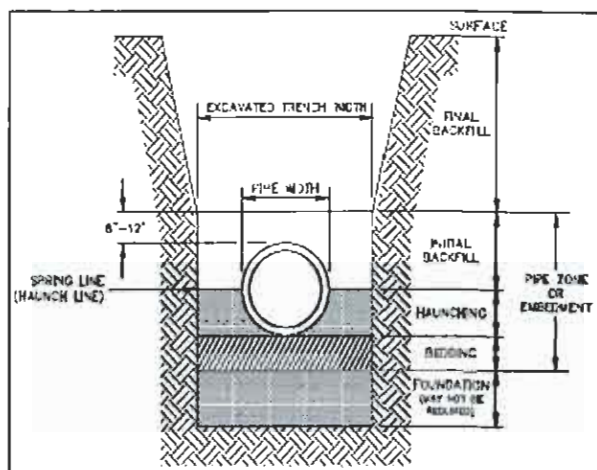


Figure 6.2: Soil-pipe interaction for flexible pipes

- In general PE Pipes should be bedded on a continuous layer of 75 mm thickness with materials complying with the following requirements (as shown in **Figure 6.3**):
 - Sand, free from rocks or other hard or sharp objects retained on a 13.2mm sieve.
 - Gravel or crushed rock rounded (no sharp material) of suitable grading up to a maximum size of 15mm.
 - The excavated material, free from rocks and broken up such that it contains no clay lumps greater than 75 mm which would prevent adequate compaction
 - Pipe bedding for PE pipe should be an angular material, with the material tamped under the haunches of the pipe.
 - Typically, the bedding equal to one-third the pipe O.D. should be loosely placed, while the remainder shall be compacted to a minimum 90% of maximum density.

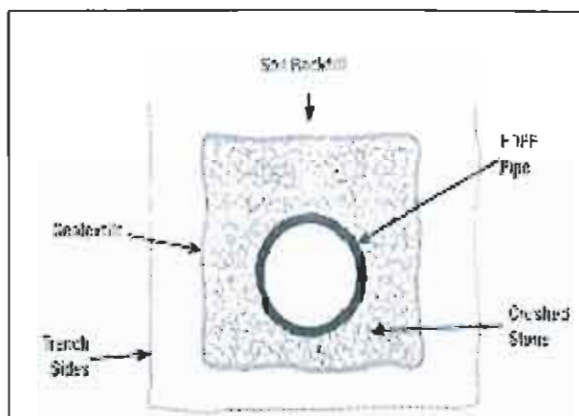


Figure 6.3: Bedding Materials

- Three important parameters should be considered for bedding of flexible pipes:
 - The loading over the pipe
 - Soil toughness (Soil Profile its cohesion etc.)
 - Pipe toughness (Pipe Elasticity)
- A flexible pipe obtains its load-carrying ability from its flexibility. Just like a rigid pipe, after the installation of a flexible pipe, the trench bedding and backfill materials will settle. However, because the flexible pipe deflects when loaded, the central soil column, directly over the pipe, will settle more than the adjacent soil columns (as shown in **Figure 6.4**).
- Where the pipe is to be laid through rock or ground of variable consistency, the trench should be excavated approx. 75 mm-100 mm below its normal depth, and a bedding material as specified

above placed before the pipe to provide a bed of suitable consistency or a Plain Cement Concrete (PCC) layer of 75 mm shall be laid at the bottom of the trench to support the pipe.

- Where the pipe is to be laid through contaminated ground then the soil should be checked to determine if it would be chemically aggressive to PE pipes. If so, the aggressive material should be removed and imported bedding and backfill should be used as specified above.
- Hence, the preference for granular bedding material is based on this being more or less self compacting and producing adequate support with little attention to the compaction, hence should be given preference.
- Backfilling upto 300 mm above the top of the pipe shall be carefully done and the soil thoroughly rammed, tamped or vibrated in layers not exceeding 150 mm, particular care being taken to thoroughly consolidate the materials under the haunches of the pipe.
- The haunching area is the most important layer since it provides the pipe with most of the support against the soil and traffic loads. The backfill material should be installed uniformly on each side of the pipe in layers or lifts. Layers of about 4 to 6 inches (100 - 150 mm) are recommended for optimum construction.

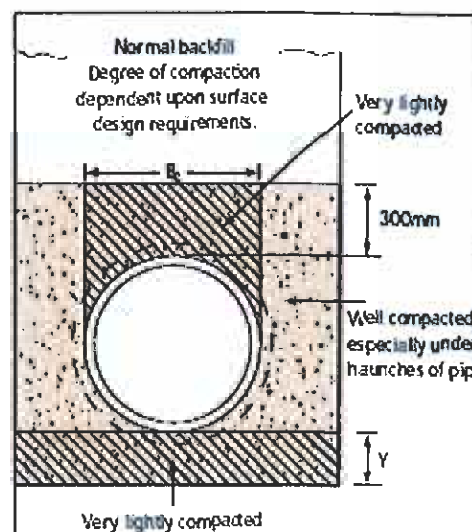


Figure 6.4: Bedding Details

Low plasticity materials may be used for backfilling since it achieves the required density, since denser the fill, lesser is the tendency towards pipe ovality because the live wheel loads will be attracted away from the pipe by the soil.

6.2 WASTEWATER PUMPING STATION

6.2.1 Design Criteria adopted for WWPS

The criteria adopted in the design of Pumping Stations are:

The volume of the sump is computed on the pumping capacity and the number of starts/stops per hour. The maximum number of starts/ stops occurs when the inflow is half the outflow. The volume is calculated on the following formula.

$$V = T \times Q$$

Where

Q = Pumping in Cubic meter per hour

T = time between start/ stop in hours

The pump should be capable of developing the required total head at rated capacity. Pump should be suitable for single as well as parallel efficient operation at any point in between the minimum and maximum system resistance.

The total head capacity curve of the pump should be continuously rising towards the shut – off. The pump should deliver at least 125% of its rated capacity at 75% of the specified total head.

Pump sizing should be coordinated with wet-well design in order to avoid frequent on-off cycling of pumps. Excessive starting will cause undue wear on starting equipment. Standard motors should not be started more than 6 times an hour. When more frequent starting is required, special motors should be provided.

- Minimum water level in the sump is designed considering water level in the sewer at lean flow i.e. $\frac{1}{2}$ the average flow.
- Pumping capacity has been designed at peak flow based on the capacities of the flow and 2.5 m/s maximum for peak flow.
- 'C' value has been taken as 140-120 for ductile iron pipe, lined inside with cement mortar.
- Pumping systems has been designed for flows during 2031 in phased manner considering stand by capacities.
- The pumping mains have been designed to give the most economical solution taking into consideration the power consumption, the cost of the rising main and the velocity at different sewage flows during the design period.
- Pumps selected for proposed pumping stations shall be submersible pumps.
- In selection of economical sizes of rising mains, energy cost has been assumed at Rs 5.00 per unit and the costs have been capitalized at 8.5% interest for the period of 15 years.

6.2.2 Adopted Design Criteria -Rising Mains

The following are design requirements for rising mains:

- Rising mains up to 1100mm size will be HDPE/Ductile iron class, K-9/ ductile iron class with cement mortar lining (whichever applicable as per detailed engineering). Larger rising mains with inside cement mortar lining.
- For pumping stations having design peak flow rate of 1000 L/s (3600cum/hr) and above, provides two numbers of rising mains, each having design capacity of 50% peak flow. Pumping stations having the capacity less than 1000 L/s shall be provided with single rising main having design capacity of 100% peak flow.
- Pump discharge pipe and rising mains shall be sized to maintain the velocity of 0.90 to 2.1 m/sec.
- Inside lining shall be Sulphate Resisting Cement (SRC) in accordance with IS 4179-2005, B for sewage application.
- Outside lining should be provided for additional external protection to ductile iron pipe for long service performance, especially for smaller diameter pipes where wall thickness is comparatively less. Following external protection is normally being provided:

S. No.	Type of Coating	Reference Standards
1	Zinc coating with finishing layer of Bitumen/ Epoxy	ISO 8179 -1
2	Zinc coating with finishing layer with additional protection by polyethylene sleeving	ISO 8180

- All the pipes and fittings above the ground level shall be flanged type. All buried pipes and fittings shall be socket and spigot rubber ring jointed for DI pipes and butt fusion in case of HDPE Pipes.
- Fittings for DI pipes shall be confirming to IS 9523-2000, and lined same as pipe.

- HDPE pipes and fittings shall be as per IS: 8008 and IS: 8360.
- Flange: Raised-face, ductile iron, screwed on conforming to BS 4504 PN16.
- Bolts, nut and washer material shall be as per IS 1363, IS 1364 – 1992.
- Gaskets shall be Flat-ring type for PN10 raised-face flanges. Gasket pressure rating shall be equal to or exceed the system hydrostatic test pressure. Gasket material shall be 3mm thick nylon-reinforced cloth-inserted rubber, corrosive acid and alkali free.

6.2.3 Adopted Design Criteria for Electrical System

The following are design requirements for electrical system:

(A) For Pumping Station Load Less than or equal to 80KW:

- As per National Electric Code 1985, If the total working load of sewage pumping station is less than or equal to 80KW then the LT supply 415V should be directly taken from state electricity board.

(B) For Pumping Station Load Greater than 80KW:

- If the total working load of sewage pumping station is more than 80KW then, twin source of supply shall be made available on 11KV system by DJB, which will be stepped down to 415V +/- 10% for operation of electrical equipments.
- Two numbers (1W+1S) stepped down 11/0.433KV voltage grade dry type transformers of adequate capacity as calculated by total working load of plant for peak pumping capacity, with off circuit tap changer & with outdoor duty have been selected.

(C) Common Points for Above Clause (A) & (B)

- All equipment & material has been designed & manufactured as per latest applicable international standards/IS codes.
- One number outdoor type DG set with auto mains failure (AMF) panel of adequate capacity based on average pumping & auxiliary load has been selected.
- The power requirement for LT load i.e. 415V will be fed through LT MCC panel.
- The external & internal lighting system will have energy efficient lighting fixture & CFL fixture of industrial, commercial & streetlight/area light type best suited for pumping station.
- If the lighting load of plant is less than 4KW then it should be fed through single phase lighting distribution board and if it is more than 4KW it should be fed through three phase lighting distribution board.
- Automatic power factor correction capacitors with capacitor panel are provided for improving the lagging power factor minimum 0.98 or above as per IEC 60871, IS 13585 & IS 13925.
- The sizes of power & control cables selected shall be based on various detaring factors for grouping, ambient temperature, depth of laying & also by considering the voltage drop criteria.
- The XLPE, PVC power & control cables shall be as per relevant IS codes.
- The cables shall be with stand all mechanical & thermal stresses under all operating condition. The cable shall be laid in cable trenches & in cable trays as best suited to site condition.
- The earthing should be carried out as per IS 3043 to get total earthing resistance less than 1 ohm.

6.2.4 Adopted Design Criteria -Structural Design of WWPS

The pumping stations shall be rectangular in shape and shall consist of an inlet chamber, coarse screen channels and a wet well. Submersible pumps will be installed in the wet-well. All electrical equipments like transformers, DG set, switchgear, etc shall be installed at a suitable distance from the wet well. Civil Structure shall be provided for the electrical equipment installations.

Circular shape is provided for lift stations.

All the pumping stations shall comprise of RCC Wall Construction having RCC Base Raft Slab and Floor Slabs.

For all practical purposes and carrying out structural designing the water table has been considered to be at ground level. The present / natural ground level has been raised up to road level to prepare FGL and further top of walls is kept 500mm above that FGL so as to make the site free from flooding, etc.

The preliminary structural designing using Reynolds's Chart, Moody's Chart and IS 3370 has been carried for the SPS with Wet well having submersible pumps. Thicknesses of the walls and slabs so reached are used. Factor of safety against uplift is considered to be 1.2.

Control Room Building for WWPS is single storied building providing space for DG Room. HT panel, Store and office etc.

Building is designed as RCC framed structure with filler bricks. The building is analysed and designed as per IS 456, using limit state methodology.

Office or Workshop is considered to be of load bearing construction for small Pumping Stations.

All the loads and load combinations are considered as per IS: 875.

Dead Load

Weight of concrete = 25 kN/sqm

Weight of floor finish = 24 kN/sqm

Unit weight of brick work = 25 kN/sqm

Live Load

Live Load – Building (Non – Plant) = 2.5 kN/sqm

Live Load on terrace = 1.5 kN/sqm

Live Load on floor = 5 kN/sqm

Live load on Floors Supporting blowers, pumps, compressors, etc. = 10 kN/sqm

Live Load for maintenance bays=10 KN/m² or actually computed whichever is higher.

Earthquake Load is considered as per IS: 1893 for seismic Zone V.

6.3 WASTE WATER TREATMENT PLANT

6.3.1 Wastewater - Introduction

Wastewater is a common term which may be defined as a combination of the liquid or water containing wastes removed from residences, institutions, commercial and industrial establishments together with groundwater, storm water as may be present. Wastewater of a community having different kind of

establishments, can be further divided into two categories; Municipal Wastewater and Industrial Wastewater. Municipal wastewater primarily contains sewage and gray water from residential, commercial and institutional establishments. Industrial wastewater is generated by an industrial activity or process. The characteristic of both, municipal and industrial wastewater are far different from each other and therefore, always recommended to have separate system for their collection, conveyance and treatment.

6.3.2 Municipal Wastewater Characteristics

The city of Delhi has a separate wastewater system which means that there are separate network for collection and transport of Sewage & Gray water and Storm water. However, some amount of storm water enters the system through broken manholes, roof drain and illegal connections with drains. Besides this, in areas with deep sewers and/or high groundwater, water seeps into the system through cracks or leaks in the pipes.

Typical characteristic of untreated or raw municipal wastewater in Delhi is presented in **Table 6.7** below:

Table 6.7: Typical Characteristics of Raw Municipal Wastewater

Parameters	Units	Value
BOD ₅ at 20 Degree Celsius	(mg/l)	250
COD	(mg/l)	500
Total suspended solid (TSS)	(mg/l)	400
Volatile suspended solids (VSS)	(mg/l)	200
Faecal coliform (FC)	MPN/100 ML	1,00,00,000.0
Oil & Grease	(mg/l)	30
Temperature (T)	Degree Celsius	18 - 25
TKN	mg/l	40.00
Ammonical nitrogen (NH ₃ -N)	mg/l	25.00
Total phosphorus (PO ₄)	mg/l	12 -16

Untreated wastewater contains numerous pathogenic microorganisms and may have toxic compounds that may endanger public health and environment. Therefore, it is required to treat the wastewater to prescribed standards before its final disposal or recycle/reuse. The recommended treated wastewater quality parameters are presented in **Table 6.8** below:

Table 6.8: Recommended Treated Wastewater Quality parameters

Parameters	Units	Value
Total suspended solid (TSS)	(mg/l)	<10
BOD ₅ at 20 Degree Celsius	(mg/l)	<10
Faecal coliform (FC)	MPN/100 ML	<2,500
TKN	(mg/l)	<10
Oil & Grease	(mg/l)	<10

6.3.3 Wastewater Treatment

Wastewater collected from communities needs to be treated to prescribed standards depending on intended use of treated effluent, such as disposal to water body, land or reuse for potable / non-potable applications.

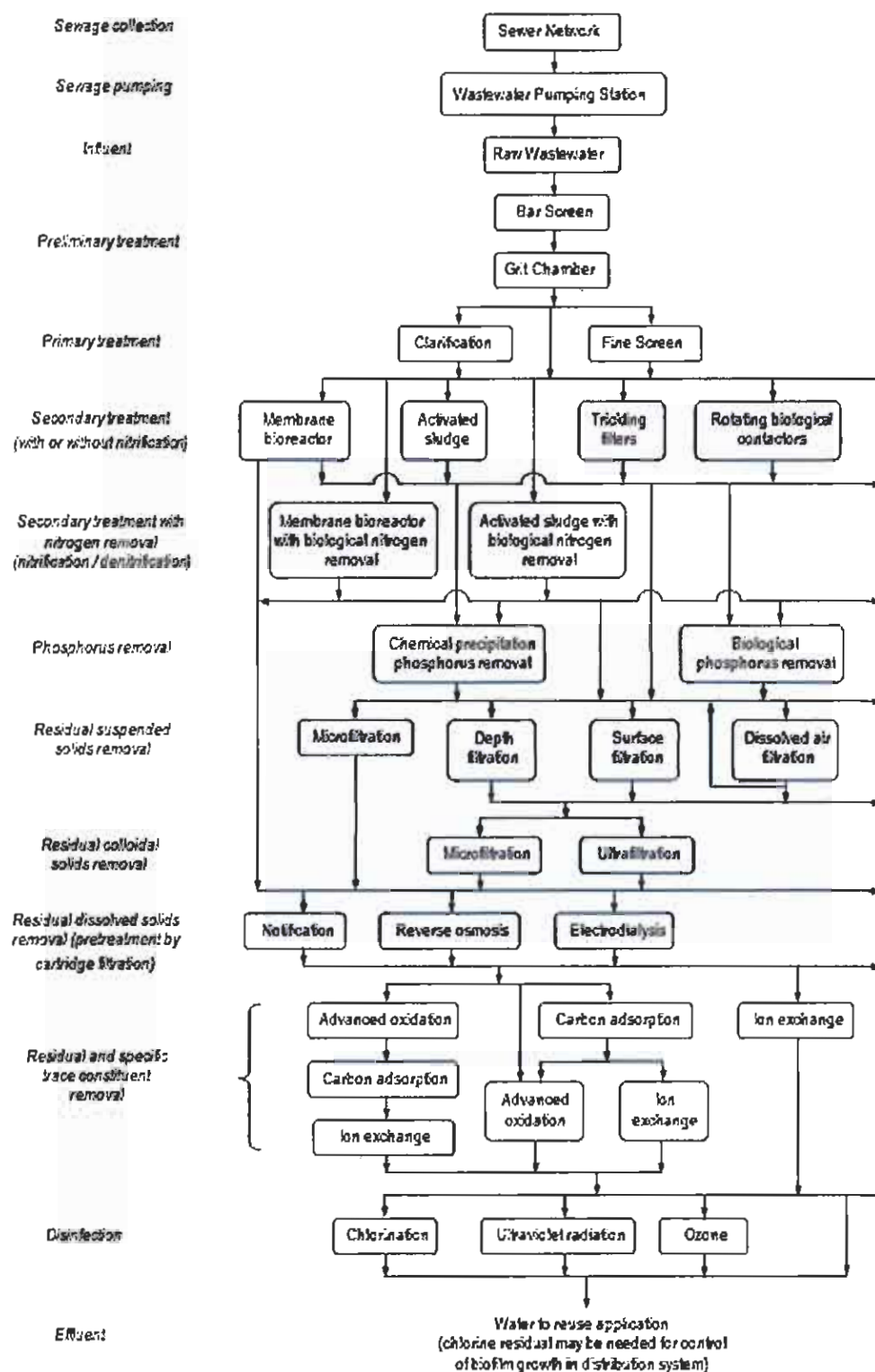


Figure 6.5: Flow diagram for sewage collection & treatment

6.3.4 Treatment Methods

Methods of treatment in which the application of physical forces predominate are known as unit operations. Methods of treatment in which the removal of contaminants is brought about by chemical or biological reactions are known as *unit processes*. At the present time, unit operations and processes are grouped together to provide various levels of treatment known as preliminary, primary, advanced primary, secondary (without or with nutrient removal), and advanced (or tertiary) treatment. In preliminary treatment, gross solids such as large objects, rags, and grit are removed that may damage equipment. In primary treatment, a physical operation, usually sedimentation, is used to remove the floating and settleable materials found in wastewater. For advanced primary treatment, chemicals are added to enhance the removal of suspended solids and, to a lesser extent, dissolved solids. In secondary treatment, biological and chemical processes are used to remove most of the organic matter. In advanced treatment, additional combinations of unit operations and processes are used to remove residual suspended solids and other constituents that are not reduced significantly by conventional secondary treatment. A listing of unit operations and processes used for the removal of major constituents found in wastewater is presented in **Table 6.9**.

Table 6.9: Levels of Wastewater Treatment

Treatment Level	Description
Preliminary	Removal of wastewater constituents such as rags, sticks, floatables, grit, and grease that may cause maintenance or operational problems with the treatment operations, processes, and ancillary systems.
Primary	Removal of a portion of the suspended solids and organic matter from the wastewater.
Advanced primary	Enhanced removal of suspended solids and organic matter from the wastewater. Typically accomplished by chemical addition or filtration.
Secondary	Removal of biodegradable organic matter (in solution or suspension) and suspended solids. Disinfection is also typically included in the definition of conventional secondary treatment.
Secondary with nutrient removal	Removal of biodegradable organics, suspended solids, and nutrients (nitrogen, phosphorus, or both nitrogen and phosphorus).
Tertiary	Removal of residual suspended solids (after secondary treatment), usually by granular medium filtration or micro screens. Disinfection is also typically a part of tertiary treatment. Nutrient removal is often included in this definition.
Advanced	Removal of dissolved and suspended materials remaining after normal biological treatment when required for various water reuse applications.

Table 6.10: Unit operations and processes used to remove constituents found in wastewater

Constituent	Unit operation or process
Suspended solids	Screening
	Grit removal
	Sedimentation
	High-rate clarification
	Flotation
	Chemical precipitation
	Depth filtration
	Surface filtration
Biodegradable organic	Aerobic suspended growth variations
	Aerobic attached growth variations
	Anaerobic suspended growth variations
	Anaerobic attached growth variations
	Lagoon variation
	Physical-chemical systems
	Chemical oxidation
	Advanced oxidation
	Membrane filtration
NUTRIENTS	
Nitrogen	Chemical oxidation (breakpoint chlorination)
	Suspended-growth nitrification and denitrification variations
	Fixed-film nitrification and denitrification variations
	Air stripping
	Ion exchange
Phosphorus	Chemical treatment
	Biological phosphorus removal
Nitrogen and phosphorus	Biological nutrient removal variations
Pathogens	Chlorine compounds
	Chlorine dioxide
	Ozone
	Ultraviolet (UV) radiation
Colloidal and dissolved solids	Membranes
	Chemical treatment
	Carbon adsorption
	Ion exchange
Volatile organic compounds	Air stripping
	Carbon adsorption
	Advanced oxidation
Odors	Chemical scrubbers
	Carbons adsorption
	Biofilters
	Compost filters

6.3.5 Unit Operations

The unit operations most commonly used in wastewater treatment include (1) screening, (2) coarse solids reduction (comminution, maceration, and screenings grindings), (3) flow equalization, (4) mixing and flocculation, (5) grit removal, (6) sedimentation, (7) high-rate clarification, (8) accelerated gravity separation (vortex separators), (9) floatation, (10) oxygen transfer, (11) aeration, and (12) volatilization and stripping of volatile organic compounds (VOCs). The principal applications of these operations and treatment devices used are summarized in **Table 6.11**.

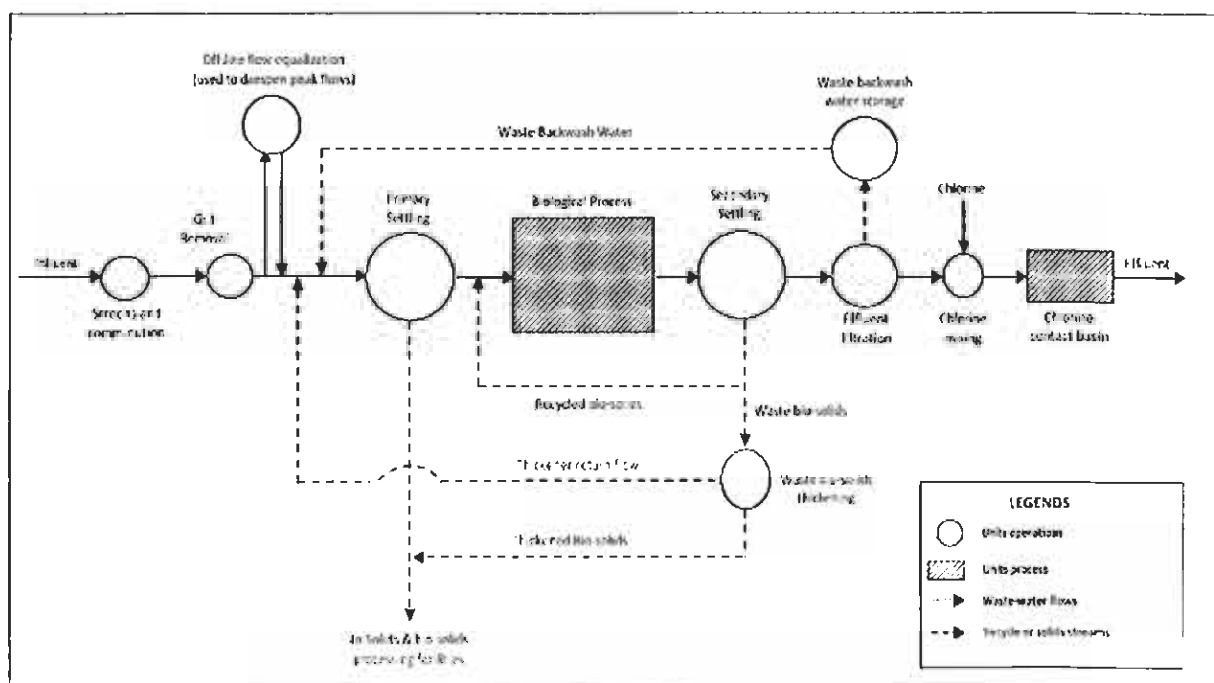


Figure 6.6: Location of physical unit operations in a wastewater-treatment plant flow diagram

Table 6.11: Typical physical unit operations used for wastewater treatment

Operation	Application	Device
Screening, coarse	Removal of coarse solids such as sticks, rags, and other debris in untreated wastewater by interception (surface straining)	Bar rack
Screening, fine	Removal of small particles	Fine screen
Screening, micro	Removal of fine solids, floatable matter, and algae	Microscreen
Comminution	In-stream grinding of coarse solids to reduce size	Comminutor
Grinding / maceration	Grinding of solids removed by bar racks Side-stream grinding of coarse solids	Screening, grinding Macerator
Flow equalization	Temporary storage of flow to equalize flowrates and mass loadings of BOD and suspended solids	Equalization tank
Mixing	Blending chemicals with wastewater and for homogenizing and maintaining solids in	Rapid mixer

Operation	Application	Device
	suspension.	
Flocculation	Promoting the aggregation of small particles into larger particles to enhance their removal by gravity sedimentation.	Flocculator
Accelerated sedimentation	Removal of grit	Grit chamber
	Removal of grit and coarse solids	Vortex separator
Sedimentation	Removal of settleable solids	Primary clarifier
		High-rate clarifier
	Thickening of solids and biosolids	Gravity thickener
Flotation	Removal of finely divided suspended solids and particles with densities close to that of water, also thickens biosolids	Dissolved-air Flotation (DAF)
	Removal of oil and grease	Induced-air floatation
Aeration	Addition of oxygen to biological process	Diffused air aeration
	Postaeration of treated effluent	Mechanical aerator
		Cascade aerator
VOC control	Removal of volatile and semivolatile organic compounds from wastewaters	Gas stripper Diffused-air and mechanical aeration
Depth filtration	Removal of suspended solids	Depth filters
Membrane filtration	Removal of suspended and colloidal solids and dissolved organic and inorganic matter	Reverse osmosis and other membrane systems
Air stripping	Removal of ammonia, hydrogen sulfide, and other gases from wastewater and digester supernatant	Packed tower

6.3.6 Unit Process

Unit processes are defined as methods of treatment in which the removal of contaminants is brought about by chemical or biological reactions.

6.3.6.1 Chemical Unit Processes

Applications of chemical unit processes for the management and treatment of wastewater are presented in **Table 6.12**. Chemical processes, in conjunction with various physical operations, have been developed for the complete secondary treatment of untreated (raw) wastewater, including the removal of either nitrogen or phosphorus or both. Chemical processes have also been developed to remove phosphorus by chemical precipitation, and are designed to be used in conjunction with biological treatment.

Other chemical processes have been developed for the removal of heavy metals and for specific organic compounds and for the advanced treatment of wastewater. Currently the most important applications of chemical unit processes in wastewater treatment are for (1) the disinfection of wastewater, (2) the precipitation of phosphorus, and (3) the coagulation of particulate matter found in wastewater at various stages in the treatment process.

Table 6.12: Applications of chemical unit processes in wastewater treatment

Process	Application
Advanced oxidation processes	Removal of refractory organic compounds
Chemical coagulation	The chemical destabilization of particles in wastewater to bring about their aggregation during perikinetic and orthokinetic flocculation
Chemical disinfection	Disinfection with chlorine, chlorine compounds, bromine, and ozone Control of slime growths in sewers Control of odors
Chemical neutralization	Control of pH
Chemical oxidation	Removal of BOD, grease, etc. Removal of ammonia (NH_4^+) Destruction of microorganisms Control of odors in sewers, pump stations, and treatment plants Removal of resistant organic compounds
Chemical precipitation	Enhancement removal of total suspended solids and BOD in primary sedimentation facilities Removal of phosphorus Removal of heavy metals Physical-chemical treatment Corrosion control in sewers due to H_2S
Chemical scale control	Control of scaling due to calcium carbonate and related compounds
Chemical stabilization	Stabilization of treated effluents
Ion exchange	Removal of ammonia (NH_4^+), heavy metals, total dissolved solids Removal of organic compounds

Apart from being comparatively costly, the inherent disadvantage associated with chemical unit processes is that they are additive process. As a result there is usually a net increase in the dissolved constituents in the wastewater, which is not desirable particularly if the treated wastewater is to be reused. On the other hand, biological processes are subtractive which means that dissolved wastewater constituents are removed.

The sewage mostly contains biodegradable constituents, which can easily be treated biologically rather than opting for chemical treatment. However, chemical treatment is needed for advanced treatment such as disinfection, removal of phosphorous etc. Therefore, it is preferred to use Biological unit processes in conjunction with chemical unit process and physical unit operations for treatment of wastewater.

6.3.6.2 Biological Unit Processes

Biological processes use microorganisms in the biochemical decomposition of wastewaters to stable end products. The principal biological processes used for wastewater treatment can be divided into two main categories: *suspended growth and attached growth (or biofilm)* processes. Typical process applications for suspended and attached growth biological treatment processes are given in **Table 6.14**, along with other treatment processes. The successful design and operation of the processes require an understanding of the types of microorganisms involved, the specific reactions that they perform, the environmental factors that affect their performance, their nutritional needs, and their reaction kinetics.

Table 6.13: Definitions of common terminology used for biological wastewater treatment

Term	Definition
Metabolic function	
Aerobic (oxic) processes	Biological treatment processes that occur in the presence of oxygen
Anaerobic processes	Biological treatment processes that occur in the absence of oxygen
Anoxic processes	The process by which nitrate nitrogen is converted biologically to nitrogen gas in the absence of oxygen. This process is also known as denitrification.
Facultative processes	Biological treatment processes in which the organisms can function in the presence or absence of molecular oxygen.
Combined aerobic / anoxic / anaerobic processes	Various combinations of aerobic, anoxic and anaerobic processes grouped together to achieve a specific treatment objective.
Treatment processes	
Suspended-growth processes	Biological treatment processes in which the microorganisms responsible for the conversion of the organic matter or other constituents in the wastewater to gases and cell tissue are maintained in suspension with the liquid.
Attached-growth processes	Biological treatment processes in which the microorganisms responsible for the conversion of the organic matter or other constituents in the wastewater to gases and cell tissue are attached to some inert medium, such as rocks, slag, or specially designed ceramic or plastic materials. Attached-growth treatment processes are also known as fixed-film processes.
Combined processes	Term used to describe combined processes (e.g., combined suspended and attached growth processes).
Lagoon processes	A generic term applied to treatment processes that take place in ponds or lagoons with various aspect ratios and depths.
Treatment functions	
Biological nutrient removal	The term applied to the removal of nitrogen and phosphorus in biological treatment processes.
Biological phosphorus removal	The term applied to the biological removal of phosphorus by accumulation in biomass and subsequent solids separation.
Carbonaceous BOD removal	Biological conversion of the carbonaceous organic matter in wastewater to cell tissue and various gaseous end products. In

Term	Definition
	the conversion, it is assumed that the nitrogen present in the various compounds is converted to ammonia.
Nitrification	The two-step biological process by which ammonia is converted first to nitrite and then to nitrate.
Denitrification	The biological process by which nitrate is reduced to nitrogen and other gaseous end products
Stabilization	The biological process by which the organic matter in the sludges produced from the primary settling and biological treatment of wastewater is stabilized, usually by conversion to gases and cell tissue. Depending on whether this stabilization is carried out under aerobic or anaerobic conditions, the process is known as aerobic or anaerobic digestion.
Substrate	The term used to denote the organic matter or nutrients that are converted during biological treatment or that may be limiting in biological treatment. For example, the carbonaceous organic matter in wastewater is referred to as the substrate that is converted during biological treatment.

Table 6.14: Major biological treatment processes used for wastewater treatment

Type	Common name	Use
AEROBIC PROCESSES		
Suspended growth	Activated sludge process(es)	Carbonaceous BOD removal, nitrification
	Aerated lagoons	Carbonaceous BOD removal, nitrification
	Aerobic digestion	Stabilization, carbonaceous BOD removal
Attached growth	Trickling filters	Carbonaceous BOD removal, nitrification
	Rotating biological contactors	Carbonaceous BOD removal, nitrification
	Packed-bed reactors	Carbonaceous BOD removal, nitrification
Hybrid (combined) suspended and attached growth processes	Trickling filter / activated sludge	Carbonaceous BOD removal, nitrification
ANOXIC PROCESSES		
Suspended growth	Suspended-growth denitrification	Denitrification
Attached growth	Attached-growth denitrification	Denitrification
ANAEROBIC PROCESSES		
Suspended growth	Anaerobic contact processes	Carbonaceous BOD removal
	Anaerobic digestion	Stabilization, solids destruction, pathogen kill

Type	Common name	Use
Attached growth	Anaerobic packed and fluidized bed	Carbonaceous BOD removal, waste stabilization, denitrification
Sludge blanket	Upflow anaerobic sludge blanket	Carbonaceous BOD removal, especially high-strength wastes
Hybrid	Upflow sludge blanket / attached growth	Carbonaceous BOD removal
COMBINED AEROBIC, ANOXIC, AND ANAEROBIC PROCESSES		
Suspended growth	Single or multistage processes, various proprietary processes	Carbonaceous BOD removal, nitrification, denitrification, and phosphorus removal
Hybrid	Single or multistage processes with packing for attached growth	Carbonaceous BOD removal, nitrification, denitrification, and phosphorus removal
LAGOON PROCESSES		
Aerobic lagoons	Aerobic lagoons	Carbonaceous BOD removal
Maturation (tertiary) lagoons	Maturation (tertiary) lagoons	Carbonaceous BOD removal, nitrification
Facultative lagoons	Facultative lagoons	Carbonaceous BOD removal
Anaerobic lagoons	Anaerobic lagoons	Carbonaceous BOD removal, waste stabilization

6.3.6.3 Suspended Growth Processes

In suspended growth processes, the microorganisms responsible for treatment are maintained in liquid suspension by appropriate mixing methods. Many suspended growth processes used in municipal and industrial wastewater treatment are operated with a positive dissolved oxygen concentration (aerobic), but applications exist where suspended growth anaerobic (no oxygen present) reactors are used, such as for high organic concentration industrial wastewaters and organic sludges. The most common suspended growth process used for municipal wastewater treatment is the activated-sludge process shown in **Figure 6.7** and discussed below:

The activated-sludge process was developed around 1913 at the Lawrence Experiment Station in Massachusetts by Clark and Gage (Metcalf and Eddy, 1930), and by Arden and Lockett (1914) at the Manchester Sewage Works in Manchester, England. The activated-sludge process was so named because it involved the production of an activated mass of microorganisms capable of stabilizing a waste under aerobic conditions. In the aeration tank, contact time is provided for mixing and aerating influent wastewater with the microbial suspension generally referred to as the mixed liquor suspended solids (MLSS) or mixed liquor volatile suspended solids (MLVSS). Mechanical equipment is used to provide the mixing and transfer of oxygen into the process. The mixed liquor then flows to a clarifier where the microbial suspension is settled and thickened. The settled biomass, described as activated sludge because of the presence of active microorganisms, is returned to the aeration tank to continue biodegradation of the influent organic material. A portion of the thickened solids is removed daily or periodically as the process produces excess biomass that would accumulate along with the non-biodegradable solids contained in the influent wastewater. If the accumulated solids are not removed, they will eventually find their way to the system effluent.

An important feature of the activated-sludge process is the formation of floc particles, ranging in size from 50 to 200 μm , which can be removed by gravity settling, leaving a relatively clear liquid as the treated effluent. Typically, greater than 99 percent of the suspended solids can be removed in the clarification step.

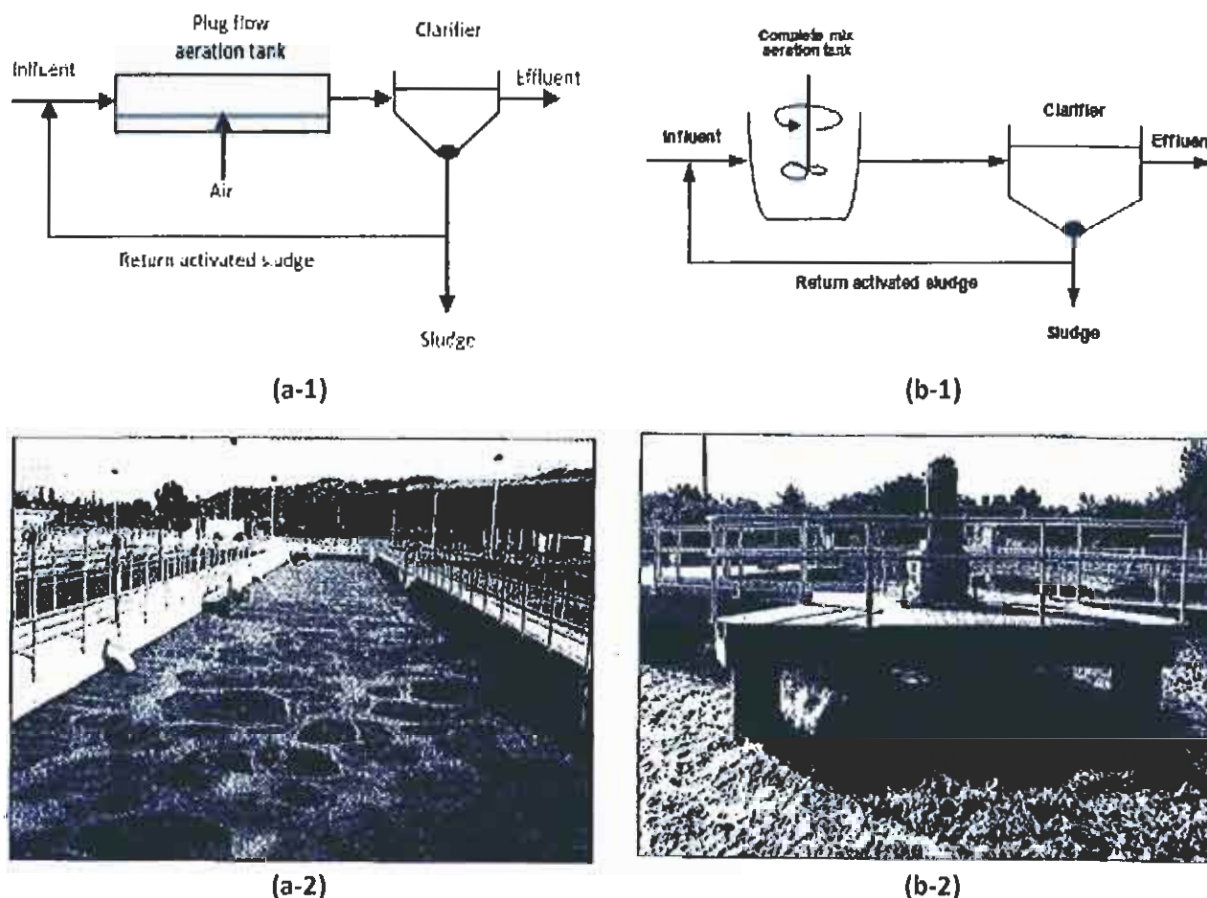


Figure 6.7: Suspended growth biological treatment process (a-1) schematic and (a-2) view of plug-flow activated-sludge process and (b-1) schematic and (b-2) view of complete-mix activated-sludge process

6.3.6.4 Attached Growth Processes

In attached growth processes, the microorganisms responsible for the conversion of organic material or nutrients are attached to an inert packing material. The organic material and nutrients are removed from the wastewater flowing past the attached growth also known as a biofilm. Packing materials used in attached growth processes include rock, gravel, slag, sand, redwood, and a wide range of plastic and other synthetic materials. Attached growth processes can also be operated as aerobic or anaerobic processes. The packing can be submerged completely in liquid or not submerged with air or gas space above the biofilm liquid layer.

The most common aerobic attached growth process used is the trickling filter in which wastewater is distributed over the top area of a vessel containing non-submerged packing material. Historically, rock was used most commonly as the packing material for trickling filters, with typical depths ranging from 1.25 to 2 m (4 to 6 ft.). Most modern trickling filters vary in height from 5 to 10 m (16 to 33 ft.) and are filled with a plastic packing material for biofilm attachment. The plastic packing material is designed such that about 90 to 95 percent of the volume in the tower consists of void space. Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached

biofilm. Influent wastewater is distributed over the packing the flows as a non-uniform liquid film over the attached biofilm. Excess biomass sloughs from the attached growth periodically and clarification is required for liquid / solids separation to provide an effluent with an acceptable suspended solids concentration. The solids are collected at the bottom of the clarifier and removed for waste-sludge processing

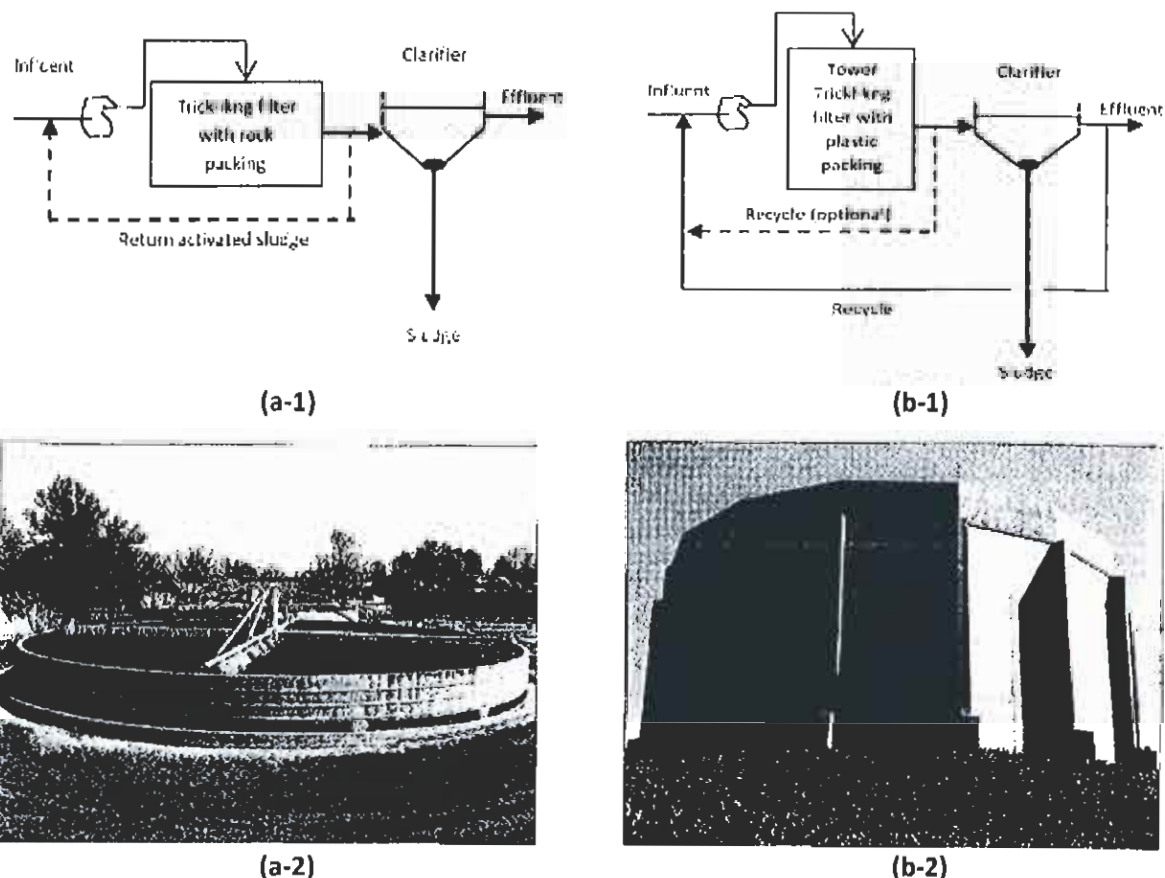


Figure 6.8: Attached growth biological treatment process (a-1) schematic and (a-2) view of trickling filter with rock packing and (b-1) schematic and (b-2) view of tower trickling filter with plastic packing . The tower filter is 10 m high and 50 m in diameter.

6.3.6.5 Process Selection Considerations

As part of evaluation methodology for various technological options for sewage treatment, a number of parameters have been identified. These include performance, stability, resource requirement and associated costs, impact of effluent discharge on environment and possibility of resource recovery. Some of the important parameters considered for comparing the different treatment technologies are:

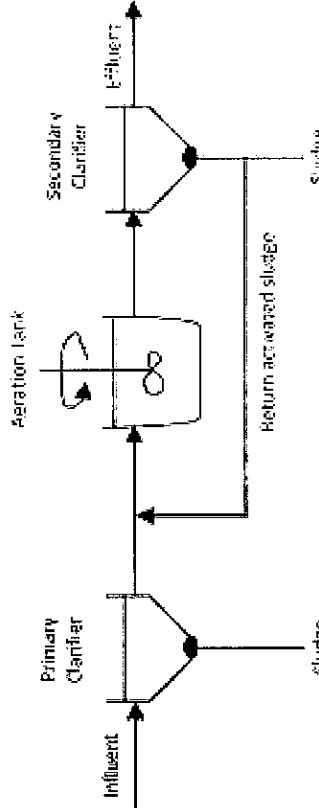
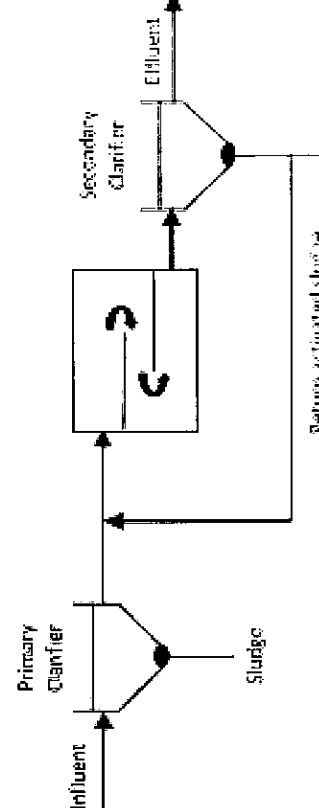
- Influent wastewater characteristics
- Performance in terms of Quality of treated sewage – achieving higher treatment standards including nutrient removal
- Performance Stability
- Resource Requirement and associated costs
- Impact of effluent discharge
- Potential of resource generation

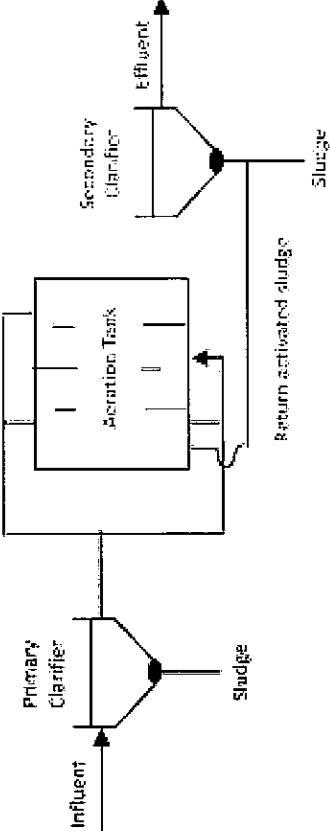
- Recovery of the treated used water for secondary uses in urban development
- Complexity – Considers the installation, start-up, and shutdown methods for the technology
- Air/Odour Emissions – Considers if the process has impacts on air and odour emissions for the facility
- Energy Efficient system – Considers the amount of energy required to adequately maintain the process and if any energy saving is possible.
- Footprint – Considers how the footprint helps to identify the land needed to expand a facility for increased capacity.
- Future changes to operating conditions should also be considered.

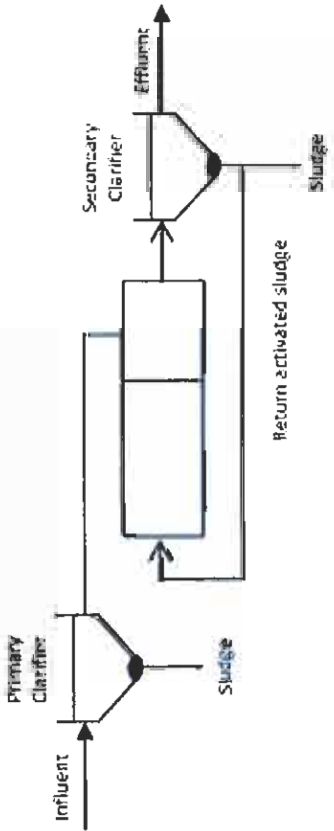
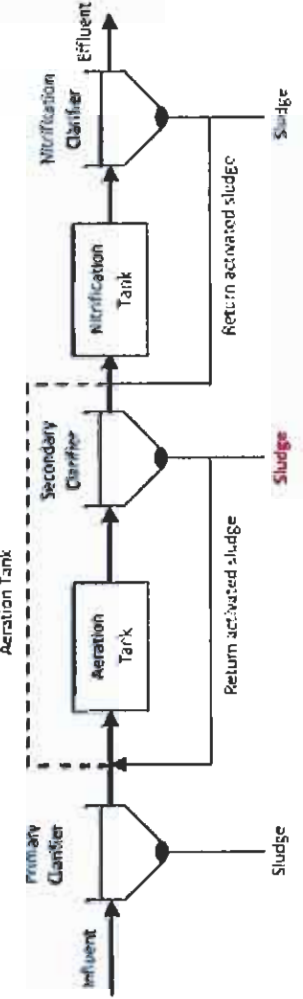
Activated sludge processes are proven processes and being successfully utilized for many types of wastewaters across the globe. Since its inception, the basic process has undergone various improvements with technological advances in equipment, electronics and process control and increased understanding of microbial process and fundamentals. Activated sludge processes used today incorporate biological nutrient removal and capable of producing high quality effluents for variety of reuse applications.

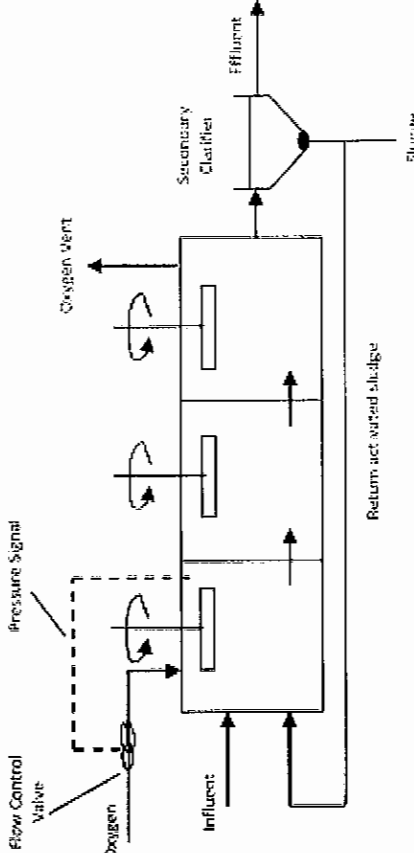
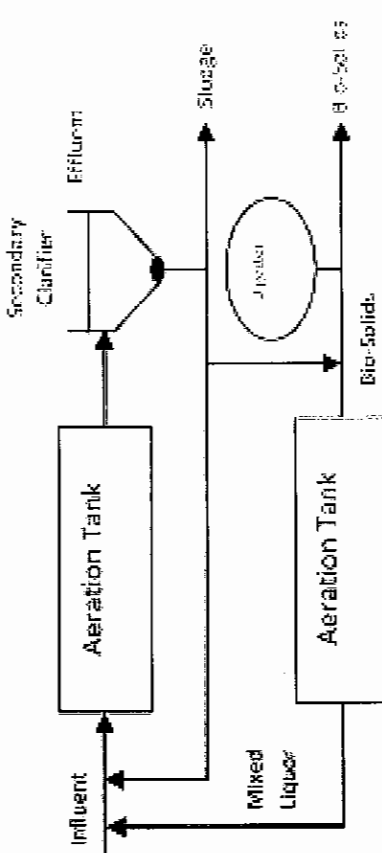
Selection of an activated-sludge process for BOD and nutrient removal is a function of many considerations including specific site constraints, compatibility with the existing process, compatibility with existing equipment, present and future treatment needs, level of capability of the operating staff, capital costs, and operating costs. Significant features and limitations of the various activated-sludge process alternatives that affect process selection in certain applications are summarized in **Table 6.15**:

Table 6.15: Description of activated-sludge processes

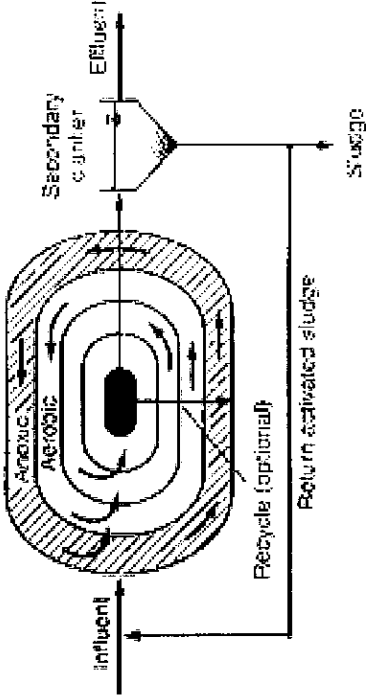
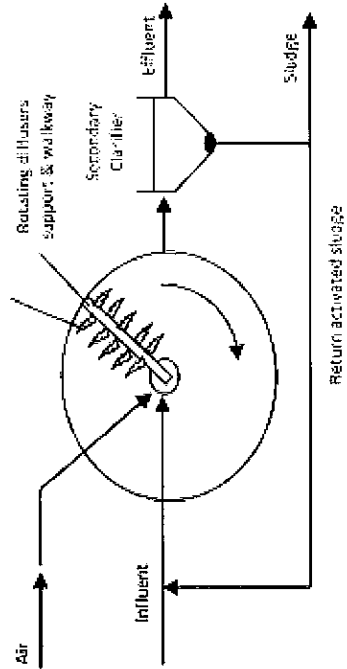
Process	Description
COMPLETE-MIX (a) Complete-mix activated-sludge (CMAS) 	The CMAS process is an application of the flow regime of a continuous-flow stirred-tank reactor. Settled wastewater and recycled activated sludge are introduced typically at several points in the aeration tank. The organic load on the aeration tank, MLSS concentration, and oxygen demand are uniform throughout the tank. An advantage of the CMAS process is the dilution of shock loads that occur in the treatment of industrial wastewater. The CMAS process is relatively simple to operate but tends to have low organic substrate concentrations (i.e., low F/M ratios) that encourage the growth of filamentous bacteria, causing sludge bulking problems.
PLUG-FLOW (b) Conventional plug flow 	Settled wastewater and return activated sludge (RAS) enter the front end of the aeration tank and are mixed by diffused air or mechanical aeration. Typically, from 3 to 5 channels (passes) are used. In early designs, air application was generally uniform throughout the tank length; however, low DO concentrations usually occurred in the initial passes of the tank. In modern designs, the aeration system is designed to match the oxygen demand along the length of the tank by tapering the aeration rates, i.e., applying higher rates in the beginning and lower rates near the end of the tank. During the aeration period, adsorption, flocculation, and oxidation of organic matter occur. Activated-sludge solids are separated in a secondary settling tank.

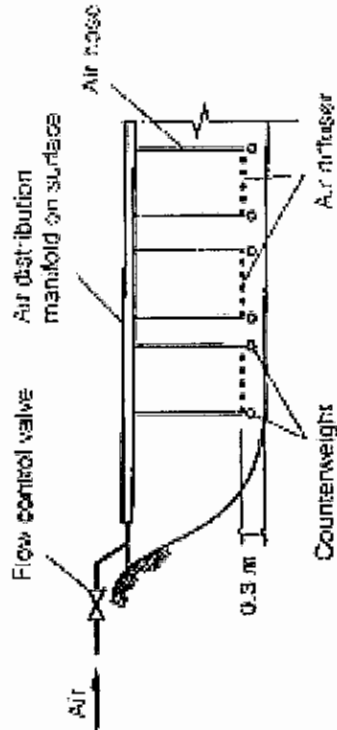
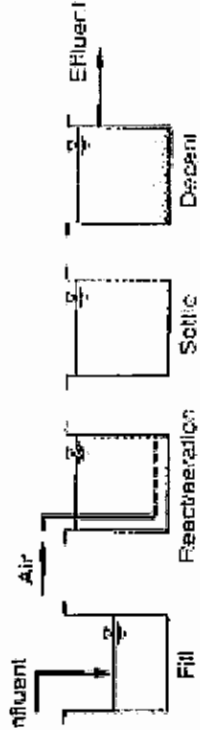
Process	Description
(c) High-rate aeration (see conventional plug-flow)	High-rate aeration is a process modification in which low MLSS concentrations are combined with high volumetric BOD loadings. The high-rate system is characterized by short τ , high sludge recycle ratio, high F/M loading, and relatively low MLSS concentration. High-rate systems produce a lesser effluent quality, in terms of BOD and TSS concentration, as compared to conventional plug-flow or complete-mix systems. Because of the high loading used, more care must be taken to keep a stable operation. Adequate mixing and aeration are very important.
PLUG-FLOW (d) Step feed	 Step feed is a modification of the conventional plug-flow process in which the settled wastewater is introduced at 3 to 4 feed points in the aeration tank to equalize the F/M ratio, thus lowering peak oxygen demand. Generally, three or more parallel channels are used. Flexibility of operation is one of the important features of this process because the apportionment of the wastewater feed can be changed to suit operating conditions. The concentration of MLSS may be as high as 5000 to 9000 mg/L in the first pass, with lower concentrations in subsequent passes as more influent feed is added. The step-feed process has the capability of carrying a higher solids inventory, and thus a higher SRT for the same volume as a conventional plug-flow process. The step-feed process can also be operated in the contract-stabilization mode by feeding only the last pass, and high wet-weather flows can be bypassed to the last pass so that the solids load to the secondary clarifier can be minimized.
(e) Contact stabilization	Contact stabilization uses two separate tanks or compartments for the treatment of the wastewater and stabilization of the activated sludge. The stabilized activated sludge is mixed with the influent (either raw or settled) wastewater in a contact zone. The contact zone detention time is relatively short (30 to 60 min.), and the MLSS concentration in the

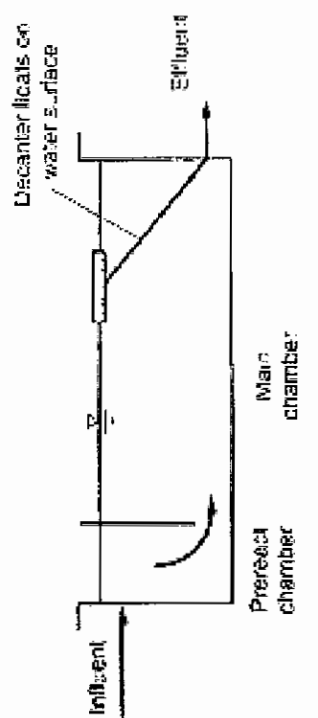
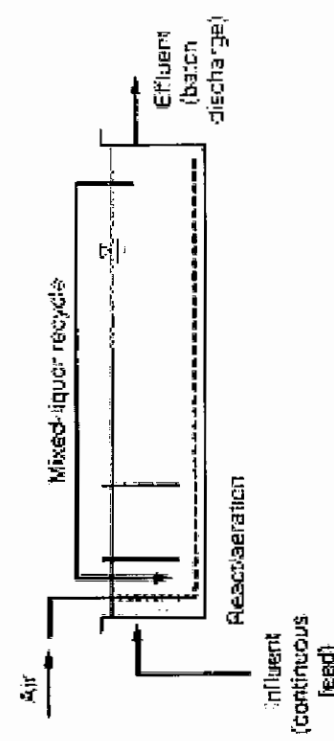
Process	Description
	contact zone is lower than that in the stabilization zone. Rapid removal of soluble BOD occurs in the contact zone, and colloidal and particulate organics are captured in the activated-sludge floc for degradation later in the stabilization zone. In the stabilization zone, return activated sludge (RAS) is aerated and the detention time is in the order of 1 to 2 h to maintain a sufficient SRT for sludge stabilization. Because the MLSS concentration is so much higher in the stabilization zone, the contact-stabilization process requires much less aeration volume than complete-mix of conventional plug-flow processes for the same SRT. The process was developed for BOD removal, and the short contact time limits the amount of soluble BOD degraded and $\text{NH}_4\text{-N}$ oxidation.
(f) Two-sludge 	The two-sludge process is a two-stage system using high-rate activated sludge for BOD removal followed by a second stage for nitrification, which is operated at a longer SRT. A portion of the wastewater influent may be bypassed around the first stage to provide BOD and suspended solids for the nitrification process and promote flocculation and solids capture in secondary clarification. The main reason to separate the BOD removal stage from the nitrogen removal stage is to treat toxic substances in the first stage, and thus protect the more sensitive nitrifying bacteria. With better industrial pretreatment programs in place today, BOD removal and nitrification are done more commonly in a single-sludge process.
(g) High-purity oxygen	A staged enclosed reactor is used in the high-purity oxygen activated-sludge process (McWhirter, 1978). Three or four stages are generally used and the influent wastewater, RAS, and high-purity oxygen are added to the first stage. The headspace gas and mixed liquor flow concurrently from stage to stage. The oxygen partial pressure in the headspace may range from 40 to 60 percent in the first stage to 20 percent in the last stage. At high oxygen partial pressure, higher

Process	Description
	volumetric oxygen transfer rates are possible to so that pure oxygen systems can have a higher MLSS concentration and operate at a shorter τ and higher volumetric organic loadings than conventional processes. The rate of oxygen addition is about 2 to 3 time greater than that by conventional aeration systems. Onsite oxygen generation equipment is needed to provide the pure oxygen gas for the process, making the process operation more complex than conventional activated-sludge processes. Nitrification ability is limited with the high-purity oxygen processes due to the accumulation of carbon dioxide in the gas headspace, which causes low pH in the mixed liquor (less than 6.5). Major advantages for pure oxygen systems are the reduced space requirement and greatly reduced quantities of off-gas if odor control and VOC control are required.
(h) Kraus process 	The Kraus process is a variation of the step aeration process used to treat nitrogen-deficient industrial wastewater. Digester supernatant is added as a food source to a portion of the return sludge in a separate aeration tank designed to nitrify. The resulting mixed liquor is then added to the main plug-flow aeration system. Besides providing nitrogen, nitrate is available to serve as an electron acceptor in the event of oxygen limitations.

Process	Description
(i) Conventional extended aeration	The extended aeration process is similar to the conventional plug-flow process except that it operates in the endogenous respiration phase of the growth curve, which requires a low organic loading and long aeration time. Because of the long SRTs (20 to 30 d) and τ's on the order of 24 h, aeration equipment design is controlled by mixing needs and not oxygen demand. The process is used extensively for preengineered plants for small communities. Generally, primary clarification is not used. Secondary clarifiers are designed at lower hydraulic loading rates than conventional activated-sludge clarifiers to better handle large flowrate variations typical of small communities. Although the biosolids are well stabilized, additional biosolids stabilization is required to permit beneficial reuse.
EXTENDED AERATION (i) Oxidation ditch	The oxidation ditch consists of a ring-or-oval-shaped channel equipped with mechanical aeration and mixing devices. Screened wastewater enters the channel and is combined with the return activated sludge. The tank configuration and aeration and mixing devices promote unidirectional channel flow, so that the energy used for aeration is sufficient to provide mixing in a system with a relatively long hydraulic retention time. The aeration / mixing method used creates a velocity from 0.25 – 0.30 m/s (0.8 – 1.0 ft/s) in the channel, which is sufficient to keep the activated sludge in suspension. At these channel velocities, the mixed liquor completes a tank circulation in 5-15 min., and the magnitude of the channel flow is such that it can dilute the influent wastewater flow by a factor of 20-30. As a result, the process kinetics approach that of a complete-mix reactor, but with plug flow along the channels. As the wastewater leaves the aeration zone, the DO concentration decreases and denitrification may occur. Brush-type or surface-type mechanical aerators are used for mixing and aeration (see Sec. 5-12 in Chap. 5). Secondary sedimentation tanks are used for most applications, and in some cases intrachannel clarifiers have been used.

Process	Description
(k) Orbal™ 	The Orbal™ process is a variation of the oxidation ditch and uses a series of concentric channels within the same structure. Wastewater enters the larger outer channel and mixed liquor flows typically towards the center of the structure through at least two more channels before entering an internal clarifier or a distribution box. Disk aerators mounted on a horizontal shaft provide aeration. Channel depths range up to 4.3 m (14 ft.). One version of the Orbal design (Bionutre™) limits the aeration rate in the first channel so that both nitrification and denitrification (anoxic condition) occur
(l) Countercurrent aeration system (CCAS™) 	In the CCAS process, a unique aeration system is employed in which air diffusers are mounted at the bottom of a revolving bridge in a circular aeration tank. Because of the circulating motion of the bridge, which is moving faster than the aeration tank contents, fine bubbles are dispersed in a sweeping motion behind the travelling bridge. When the air is turned off, the movement of the diffusers creates enough mixing energy to keep the tank contents in suspension. The process is operated at a DO ranging from 0.7 to 1.0 mg/l. The low DO concentration is sufficient for nitrification at the long SRT, while allowing anoxic conditions to develop to promote denitrification. The system is normally designed with extended aeration SRTs.

Process	Description
(m) Bioloc™ process 	Bioloc is a proprietary process that combines long solids retention times with submerged aeration in earthen basins. Fine bubble membrane diffusers are attached to floating aeration chains that are moved across the basin by the air released from the diffusers. Aeration basins are typically 2.4 to 4.6 m (8 to 15 ft.) deep. The process can be designed for nitrification since the SRT ranges from 40 to 70 d. The F/M ratio ranges from 0.04 to 0.1 and the MLSS range is from 1500 to 5000 mg/L. A variation of the standard process, known as the "wave oxidation modification," allows biological nitrification and denitrification to occur simultaneously by using timers to cycle the air flowrate to each aeration chain. Either an internal or external clarifier can be used.
SEQUENTIALLY OPERATED SYSTEMS (n) Sequencing batch reactor (SBR) 	The SBR is a fill-and-draw type of reactor system involving a single complete-mix reactor in which all steps of the activated-sludge process occur. For municipal wastewater treatment with continuous flow, at least 2 basins are used so that one basin is in the fill mode while the other goes through react, solids settling, and effluent withdrawal. An SBR goes through a number of cycles per day; a typical cycle may consist of 3-h fill, 2-h aeration, 0.5-h settle, and 0.5-h for withdrawal of supernatant. An idle step may also be included to provide flexibility at high flows. Mixed liquor remains in the reactor during all cycles, thereby eliminating the need for separate secondary sedimentation tanks. Decanting of supernatant is accomplished by either fixed or floating decanter mechanisms. The τ's for SBRs generally range from 18 to 30 h, based on influent flowrate and tank volume used. Aeration may be accomplished by jet aerators or coarse bubble diffusers with submerged mixers. Separate mixing provides operating flexibility and is useful during the fill period for anoxic operation. Sludge wasting occurs normally during the aeration period.

Process	Description
(o) Batch decant reactor, intermittent cycle extended aeration system (ICEAS™) 	The ICEAS process, developed in Australia, is another type of SBR process used for treating flow rates up to 500,000 m³/d. Influent wastewater is fed continuously through the same cycles of react, settle, and decant as in an SBR. The influent is fed into one side of a baffled chamber (a prereact zone) so the flow does not disturb the mixed liquor during the settling and decant period. Wastewater flows continuously through openings at the bottom of the baffle wall and into the main react zone where BOD and nitrification occur. After aeration and settling, separated liquid is removed by an automated, time-controlled decant mechanism. Sludge wasting is also accomplished during this phase.
(p) Cyclic activated-sludge system (CAAS™) 	The CAAS process uses three baffled zones in an approximate volumetric proportion of 1:2:20, and mixed liquor is recycled from Zone 3 to Zone 1. Nitrification occurs because of the long SRTs used. Nitrate reduction is claimed to occur at significant levels in the sludge blanket during the settle and decant periods, as well as in the aeration period by operation at low DO concentrations. As in the ICEAS process, the influent wastewater is fed continuously while the effluent is removed on a batch basis.

Significant features and limitations of various activated sludge processes that affect process selection in certain applications are summarized in **Table 6.16** below:

Table 6.16: Advantages and Limitations of Activated-sludge processes

Process	Advantages	Limitations
Complete mix	Common, proven process Adaptable to many types of wastewater Large dilution capacity for shock and toxic loads Uniform oxygen demand Design is relatively uncomplicated Suitable for all types of aeration equipment	Susceptible to filamentous sludge bulking
Conventional plug flow	Proven process May achieve a somewhat higher level of ammonia removal than the complete-mix process Adaptable to many operation schemes including step-feed, selector design, and anoxic / aerobic processes	Design and operation for tapered aeration is more complex May be difficult to match oxygen supply to oxygen demand in first pass
High rate	Requires less aeration tank volume than conventional plug flow Uses less aeration energy	Less stable operation; produces lower-quality effluent Not suitable for nitrification Sludge production is higher High peak flows can disrupt operation by washing out MLSS
Contact Stabilization	Requires smaller aeration volume Handles wet-weather flows without loss of MLSS	Has little or no nitrification capability Operation somewhat more complex
Step feed	Distributes load to provide more uniform oxygen demand Peak wet-weather flows can be bypassed to the last pass to minimize high clarifier solids loading Flexible operation Adaptable to many operating schemes including anoxic/aerobic processes	More complex operation Flow split is not usually measured or known accurately More complicated design for process and aeration system
Extended aeration	High-quality effluent possible Relatively uncomplicated design and operation Capable of treating shock / toxic loads Well-stabilized sludge; low biosolids production	Aeration energy use is high Relatively large aeration tanks Adaptable mostly to small plants
High-purity oxygen	Requires relatively small aeration tank volume	Limited capability for nitrification

Process	Advantages	Limitations
Oxidation ditch	Emits less VOC and off-gas volume	More complex equipment to install, operate, and maintain
	Generally produces good settling sludge	Nocardia foaming
	Operation and DO control are relatively uncomplicated	High peak flows can disrupt operation by washing out MLSS
	Adaptable to many types of wastewater	
	Highly reliable process; simple operation	Large structure, greater space requirement
	Capable of treating shock / toxic loads without affecting effluent quality	Low F/M bulking is possible
	Economical process for small plants	Some oxidation ditch process modifications are proprietary and license fees may be required
	Uses less energy than extended aeration	Requires more aeration energy than conventional CMAS and plug-flow treatment
	Adaptable to nutrient removal	Plant capacity expansion is more difficult
	High-quality effluent possible	
	Well-stabilized sludge; low biosolids production	
Sequencing batch reactor	Process is simplified; final clarifiers and RAS pumping are not required	Process control more complicated
	Compact facility	High peak flows can disrupt operation unless accounted for in design
	Operation is flexible; nutrient removal can be accomplished by operational changes	Batch discharge may require equalization prior to filtration and disinfection
	Can be operated as a selector process to minimize sludge bulking potential	Higher maintenance skills required for instruments, monitoring devices, and automatic valves
	Quiescent settling enhances solids separation (low effluent SS)	Some designs use less efficient aeration devices
	Applicable for a variety of plant sizes	
Countercurrent aeration	High-quality effluent possible	Fine screening is required to prevent diffuser fouling
	Oxygen transfer efficiencies are higher than conventional aeration systems	Process is proprietary
	Well-stabilized sludge; low biosolids production	Significant downtime of aeration unit for maintenance will affect plant performance
	Process design can be modified to accommodate nutrient removal	Good operator skills required.

6.3.7 Disinfection

Disinfection refers to the partial destruction of disease-causing organisms. All the organisms are not destroyed during the process. The fact that all of the organisms are not destroyed differentiates disinfection from sterilization, which is the destruction of all organisms. In the field of wastewater treatment, the four categories of human enteric organisms of the greatest consequence in producing disease are bacteria, protozoan oocysts and cysts, helminths, and viruses.

6.3.7.1 Regulatory Requirements for Wastewater Disinfection

In earlier years of 20th century, treatment objectives were concerned primarily with (1) the removal of colloidal, suspended, and floatable material, (2) the treatment of biodegradable organics, and (3) the elimination of pathogenic organisms, but generally with unspecified treatment goals. Later on, to achieve the objective of restoring and maintain the chemical, physical and biological integrity of the receiving waters (rivers, lakes or other water sources that receives treated wastewater), regulations were defined in terms of allowable Fecal Coliform (FC) bacteria in treated effluent besides the other parameters such as BOD, TSS, pH etc.

The recommendation of National River Conservation Directorate for the standards for coliform organisms in treated effluent depending on the discharge application, are presented below:

Parameter	Unit	Discharge on	Standard
Fecal Coliform	MPN/100 ml	Water bodies	Desirable : 1000 Permissible : 10,000
		Agriculture (for produce not eaten raw)	

The Ministry of Urban Development and Poverty Alleviation constituted in the year 2004 a Committee to determine norms for coliform level in treated wastewater specific to the stretch of the river Yamuna in Delhi. The committee has recommended that the fecal coliform in treated wastewater discharged into Yamuna, shall not exceed 2500 MPN/100ml.

6.3.7.2 Characteristics of an Ideal Disinfectant

The characteristics for an ideal disinfectant are reported in **Table 6.17**. As shown, an ideal disinfectant would have to possess a wide range of characteristics. Although such a compound may not exist, the characteristics set forth in **Table 6.17** should be considered in evaluating proposed or recommended disinfectants. It is also important that the disinfectant be safe to handle and apply, and that its strength or concentration in treated waters be measurable. The latter consideration is an issue with the use of ozone and UV disinfection where no residual is measured.

Table 6.17: Characteristics of an ideal disinfectant

Characteristic	Properties / response
Availability	Should be available in large quantities and reasonably priced
Deodorizing ability	Should deodorize while disinfecting
Homogeneity	Solution must be uniform in composition
Interaction with extraneous material	Should not be absorbed by organic matter other than bacterial cells
Noncorrosive and nonstaining	Should not disfigure metals or stain clothing
Nontoxic to higher forms of life	Should be toxic to microorganisms and nontoxic to humans and other animals
Penetration	Should have the capacity to penetrate through surfaces
Safety	Should be safe to transport, store, handle, and use
Solubility	Must be soluble in water or cell tissue
Stability	Should have low loss of germicidal action with time on standing
Toxicity to microorganisms	Should be effective at high dilutions
Toxicity at ambient temperatures	Should be effective in ambient temperature range

6.3.7.3 Disinfection Methods

Disinfection is most commonly accomplished by the use of

- Chemical Agents
- Physical Agents

Chemical agents generally used include halogenic compounds (chlorine, bromine etc) and Ozone of the halogenic compounds, Chlorine is most commonly used.

Physical disinfectants include heat, light and sound waves. The most common disinfectant under this category is Ultraviolet (UV) radiation.

A comparison of characteristics of commonly used disinfectants is presented in **Table 6.18**:

Table 6.18: Comparison of ideal and actual characteristics of commonly used disinfectants

Characteristics	Chlorine	Sodium Hypochlorite	Calcium Hypochlorite	Chlorine dioxide	Ozone	UV radiation
Availability/Cost	Low Cost	Moderately low cost	Moderately low cost	Moderately low cost	Moderately high cost	Moderately high cost
Deodorizing ability	High	Moderate	Moderate	High	High	na
Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	na
Interaction with extraneous material	Oxidizes organic matter	Active Oxidizer	Active Oxidizer	High	Oxidizes organic matter	Absorbance of UV radiation
Noncorrosive and Nonstaining	Highly corrosive	Corrosive	Corrosive	Highly corrosive	Highly corrosive	na
Nontoxic to higher forms of life	Highly toxic to higher life forms	Toxic	Toxic	Toxic	Toxic	Toxic
Penetration	High	High	High	High	High	Moderate
Safety concern	High	Moderate	Moderate	High	Moderate	Low
Solubility	Moderately	High	High	High	High	na
Stability	Stable	Slightly unstable	Relatively stable	Unstable, must be generated as used	Unstable, must be generated as used	na
Toxicity to microorganisms	High	High	High	High	High	High
Toxicity at ambient temperatures	High	High	High	High	High	High

6.3.7.4 Comparison of Disinfection Technologies

The advantages and disadvantages of most commonly used technologies for disinfection of wastewater (i.e., chlorine, chlorine dioxide, ozone, and UV) are presented in **Table 6.19**. The germicidal effectiveness of different disinfection technologies depends on various factors such as wastewater characteristics, type of organism, dosage, contact time etc. It is recommended to conduct site-specific testing to evaluate the effectiveness of alternative disinfection technologies and to establish appropriate dosing ranges.

Table 6.19: Advantages and Disadvantages of Disinfection Technologies

Advantages	Disadvantages
CHLORINE	
1. Well-established technology	1. Hazardous chemical that can be a threat to plant workers and the public; thus strict safety measures must be employed.
2. Effective disinfectant	2. Relatively long contact time required as compared to other disinfectants
3. Chlorine residual can be monitored and maintained	3. Combined chlorine is less effective in inactivating some viruses, spores, cysts at low dosages used for coliform organisms
4. Combined chlorine residual can also be provided by adding ammonia	4. Residual toxicity of treated effluent must be reduced through dechlorination
5. Germicidal chlorine residual can be maintained in long transmission lines	5. Formation of trihalomethanes and other DBPs
6. Availability of chemical system for auxiliary uses such as odor control, dosing RAS lines, and disinfection plant water systems	6. Release of volatile organic compounds from chlorine contact basins
7. Oxidizes sulfides	7. Oxidizes iron, magnesium, and other inorganic compounds (consumes disinfectant)
8. Relatively inexpensive (cost is increasing with implementation of Uniform Fire Code regulations)	8. Oxidizes a variety of organic compounds (consumes disinfectant)
9. Available as calcium and sodium hypochlorite considered to be safer than chlorine gas	9. TDS level of treated effluent is increased
	10. Chloride content of the wastewater is increased
	11. Acid generation; pH of the wastewater can be reduced if alkalinity is insufficient
	12. Increased safety regulations, especially in light of the Uniform Fire Code
	13. Chemical scrubbing facilities may be required to meet Uniform Fire Code regulations
UV	
1. Effective disinfectant	1. No immediate measures of whether disinfection was successful

Advantages		Disadvantages	
2.	No residual toxicity	2.	No residual effect
3.	More effective than chlorine in inactivating most viruses, spores, cysts	3.	Less effective in inactivating some viruses, spores, cysts at low dosages used for coliform organisms
4.	No formation of DBPs at dosages used for disinfection	4.	Energy-intensive
5.	Does not increase TDS level of treated effluent	5.	Hydraulic design of UV system is critical
6.	Effective in the destruction of resistant organic constituents such as NDMA	6.	Relatively expensive (price is coming down as new and improved technology is brought to the market)
7.	Improved safety compared to the use of chemical disinfectants	7.	Large number of UV lamps required where low-pressure low-intensity systems are used
8.	Requires less space than chlorine disinfection	8.	Low-pressure low-intensity lamps require acid washing to remove scale
9.	At higher UV dosages than required for disinfection, UV radiation can be used to reduce the concentration of tract organic constituents of concern such as NDMA	9.	Lack of chemical system that can be used for auxiliary uses such as odor control, dosing RAS lines, and disinfection of plant water systems

CHLORINE DIOXIDE

1.	Effective disinfectant	1.	Unstable, must be produced onsite
2.	More effective than chlorine in inactivating most viruses, spores, cysts, and oocysts	2.	Oxidizes iron, magnesium, and other inorganic compounds (consumes disinfectant)
3.	Biocidal properties not influenced by pH	3.	Oxidizes a variety of organic compounds
4.	Under proper generation conditions, halogen-substituted DBPs are not formed	4.	Formation of DBPs (i.e., chlorite and chlorate)
5.	Oxidize sulfides	5.	Potential for the formation of halogen-substituted DBPs
6.	Provides residuals	6.	Decomposes in sunlight
		7.	Can lead to the formation of odors
		8.	TDS level of treated effluent is increased
		9.	Operating costs can be high (e.g., must test for chlorite and chlorate)

OZONE

1.	Effective disinfectant	1.	No immediate measure of whether disinfection was successful
2.	More effective than chlorine in inactivating most viruses, spores, cysts, and oocysts	2.	No residual effect

Advantages	Disadvantages
3. Biocidal properties not influenced by pH	3. Less effective in inactivating some viruses, spores, cysts at low dosages used for coliform organisms
4. Shorter contact time than chlorine	4. Formation of DBPs
5. Oxidizes sulfides	5. Oxidizes iron, magnesium, and other inorganic compounds (consumes disinfectant)
6. Requires less space	6. Oxidizes a variety of organic compounds (consumes disinfectant)
7. Contributes dissolved oxygen	7. Off-gas requires treatment
	8. Safety concerns
	9. Highly corrosive and toxic
	10. Energy-intensive
	11. Relatively expensive
	12. Highly operational and maintenance-sensitive
	13. Lack of chemical system that can be used for auxiliary uses such as dosing RAS lines
	14. May be limited to plant where generation of high-purity oxygen already exists

6.3.8 Wastewater Reclamation and Reuse

Continued population growth, contamination of both surface water and groundwater, uneven distributions of water resources, and periodic droughts have forced water agencies to search for new sources of water supply. Use of highly treated wastewater effluent, now discharges to the environment from municipal wastewater treatment plants, is receiving more attention as a reliable water resource. In many parts of the county, water reuse is already an important element in water resources planning and implementation. While water reuse is a viable option, water conservation, efficient use of existing water supplies, and new water resources development and management are other alternatives that must be evaluated.

6.3.8.1 Definition of Terms

Terms used frequently in the field of water reclamation, recycling, and reuse are summarized in **Table 6.20**. It should be noted that the definitions given have evolved from several water reuse regulations and in response to questions raised by consumers and the public at large.

Table 6.20: Definition of terms used in water reuse applications

Term	Description
Beneficial uses	The many ways water can be used, either directly by people, or for their overall benefit. Examples include municipal water supply, agricultural and industrial applications, navigations, fish and wildlife, and water contact recreation.
Direct potable reuse	A form of reuse by the incorporation of reclaimed water directly into a potable water supply system, often implying the blending of reclaimed water with potable water.

Term	Description
Direct reuse	The use of reclaimed water which has been transported from the wastewater reclamation plant to the water reuse site without intervening discharge to a natural body of water, including such uses as agricultural and landscape irrigation.
Dual distribution system	Two sets of pipelines for water delivery, one for potable water and another for reclaimed water
Indirect potable reuse	Potable reuse by incorporation of reclaimed water into a raw water supply, allowing mixing and assimilation by discharge into an impoundment or natural body of water, such as in a domestic water supply reservoir or groundwater.
Indirect reuse	Use of reclaimed water indirectly by passing through a natural body of water or use of groundwater that has been recharged with reclaimed water
Nonpotable water reuse	All reuse applications that do not involve either indirect or direct potable use
Planned reuse	Deliberate direct or indirect use of reclaimed water, without relinquishing control over the water during its delivery.
Potable water reuse	An augmentation of drinking water supplies directly or indirectly by reclaimed water that is highly treated to protect public health.
Reclaimed water	Water that, as a result of wastewater treatment, is suitable for a direct beneficial use or a controlled use that would not otherwise occur
Recycled water	Reclaimed water that has been used beneficially. The term recycled water is used synonymously with reclaimed water.
Unplanned reuse	Reuse of treated wastewater following discharge (control relinquished), such as in the diversion of water from a river downstream of a discharge of treated wastewater.
Water reclamation	Treatment or processing of wastewater to make it reusable. Also, this term is often used to include delivery of reclaimed water to place of use and its actual use.
Water recycling	The use of wastewater that is captured and redirected back into the same water use scheme. Recycling is practiced predominantly in industries, such as manufacturing, and normally involved only one industrial plant or one use.
Water reuse	The use of treated wastewater for a beneficial use, such as agricultural irrigation and industrial cooling.

6.3.8.2 Wastewater Reuse Applications

In the planning and implementation of water reclamation and reuse, the reclaimed water application will usually govern the wastewater treatment needed to protect public health and the environment, and the degree of reliability required for the treatment processes and operations. The seven principal categories

of municipal wastewater reuse are listed in **Table 6.21** in descending order of projected volume of use along with potential constraints for their application.

Table 6.21: Categories of municipal wastewater reuse and potential issues / constraints

Wastewater reuse categories			Issues / constraints
1.	Agricultural irrigation Commercial nurseries	Crop	• Surface and groundwater contamination if not managed properly. • Marketability of crops and public acceptance
2.	Landscape irrigation Parks School yards Freeway medians Golf courses Cemeteries Greenbelts Residential		• Effect of water quality, particularly salts, on soils and crops. • Public health concerns related to pathogens (e.g., bacteria, viruses, and parasites) • Use area control including buffer zone may result in high user costs
3.	Industrial recycling and reuse Cooling water Boiler feed Process water Heavy construction		• Constituents in reclaimed water related to scaling, corrosion, biological growth, and fouling • Public health concerns, particularly aerosol transmission of pathogens in cooling water • Cross connection of potable and reclaimed water lines
4.	Groundwater recharge Groundwater replenishment Saltwater intrusion control Subsidence control		• Possible contamination of groundwater aquifer used as a source of potable water • Organic chemicals in reclaimed water and their toxicological effects • Total dissolved solids, nitrates, and pathogens in reclaimed water
5.	Recreational/environmental uses Lakes and ponds Marsh enhancement Stream-flow augmentation Fisheries Snowmaking		• Health concerns related to presence of bacteria and viruses (e.g., enteric infections and ear, eye and nose infections) • Eutrophication due to nitrogen and phosphorus in receiving water • Toxicity to aquatic life
6.	Nonpotable urban uses Fire protection Air conditioning Toilet flushing		• Public health concerns about pathogens transmitted by aerosols • Effects of water quality on scaling, corrosion, biological growth, and fouling • Cross connection of potable and reclaimed water lines
7.	Potable reuse Blending in water supply reservoirs Pipe-to-pipe water supply		• Constituents in reclaimed water, especially trace organic chemicals and their toxicological effects • Aesthetics and public acceptance • Health concerns about pathogen transmission, particularly enteric viruses

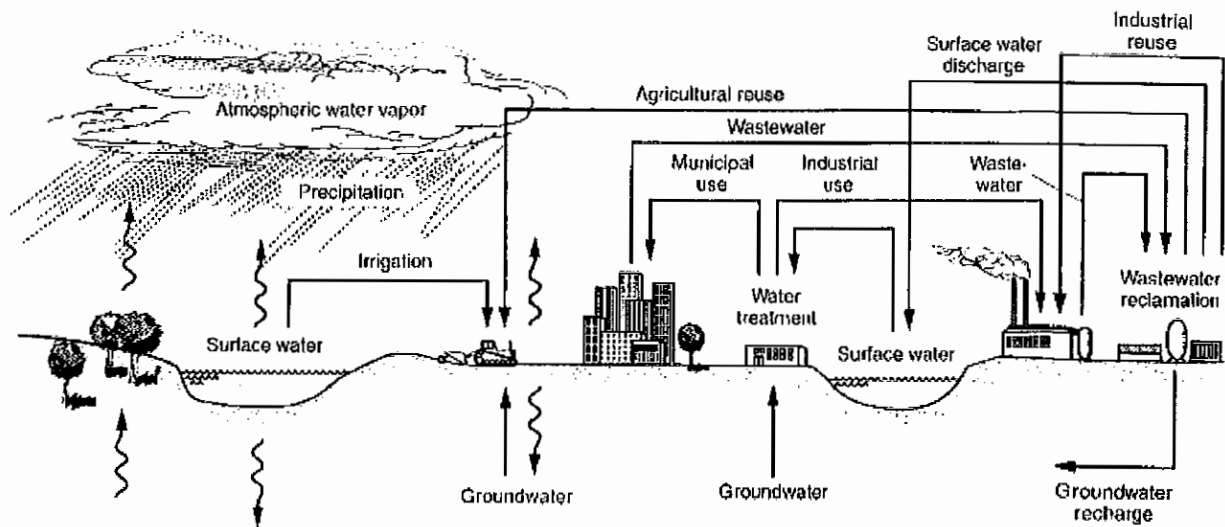


Figure 6.9: The role of engineered treatment, reclamation, and reuse facilities in the cycling of water through the hydrologic cycle

The required water quality for reclaimed water depends on intended reuse application. Typical performance data for selected treatment process combinations are presented in **Table 6.22**:

Table 6.22: Treatment levels achievable with various combinations of unit operations and processes used for wastewater reclamation

Treatment process	Typical effluent quality, mg/L except turbidity, NTU						
	TSS	BODs	COD	Total N	NH ₃ -N	PO ₄ -P	Turbidity
Activated sludge + granular medium filtration	4-6	< 5-10	30-70	15-35	15-25	4-10	0.3-5
Activated sludge + granular medium filtration + carbon adsorption	< 5	< 5	5-20	15-30	15-25	4-10	0.3-3
Activated sludge/nitrification, single stage	10-25	5-15	20-45	20-30	1-5	6-10	5-15
Activated sludge / nitrification – denitrification separate stages	10-25	5-15	20-35	5-10	1-2	6-10	5-15
Metal salt addition to activated sludge + nitrification/denitrification + filtration	≤ 5-10	≤ 5-10	20-30	3-5	1-2	≤ 1	0.3-2
Biological phosphorus removal	10-20	5-15	20-35	15-25	5-10	≤ 2	5-10
Biological nitrogen and phosphorus removal + filtration	≤ 10	< 5	20-30	≤ 5	≤ 2	≤ 2	0.3-2
Activated sludge + granular medium filtration + carbon adsorption + reverse osmosis	≤ 1	≤ 1	5-10	< 2	< 2	≤ 1	0.01-1
Activated sludge / nitrification – denitrification and phosphorus removal + granular medium filtration + carbon adsorption + reverse osmosis	≤ 1	≤ 1	2-8	≤ 1	≤ 0.1	≤ 0.5	0.01-1
Activated sludge / nitrification –	≤ 1	≤ 1	2-8	≤ 0.1	≤ 0.1	≤ 0.5	0.01-1

Treatment process	Typical effluent quality, mg/L except turbidity, NTU						
	TSS	BODs	COD	Total N	NH ₃ -N	PO ₄ -P	Turbidity
denitrification and phosphorus removal + microfiltration + reverse osmosis							

6.3.8.3 Level III : Advanced Treatment

Advanced wastewater treatment processes are those beyond traditional secondary treatment. In order to attain a high quality reclaimed water we propose coagulation-flocculation-settling followed by filtration and chlorination/UV disinfection. The type and the extent of advanced treatment shall further vary depending on the treated effluent reuse or disposal in surface water body or land.

6.3.8.4 Alternate Treatment

Where sewage flows are low and/or land availability is not limited, waste stabilization ponds can be followed by constructed wetlands. In this case coagulation-flocculation-settling cannot be considered.

6.4 SLUDGE TREATMENT AND DISPOSAL

Wastewater sludge originates from the process of treatment of wastewater. Due to the treatment processes involved in the treatment, the sludge tends to concentrate poorly biodegradable trace organic compounds as well as potentially pathogenic organisms (viruses, bacteria etc.) present in wastewaters.

Sludge is, however rich in nutrients such as nitrogen and phosphorous and contains valuable organic matter that can be usefully applied / spread in the areas where soil is depleted or is deprived of useful nutrient due to soil erosion. The organic matter and nutrients available in sludge are the two main elements that can be very useful for spreading on land as a fertiliser or an organic soil improver. In addition to sludge as a useful fertilizer, sludge can also be used as a fuel due to presence of Biochemical Energy Potential (BEP) with the development of new technologies and various other possible uses.

6.4.1 Sludge Management- Existing Scenario in Delhi

Presently the excess bio solids generated from activated sludge (comprising of Primary Clarification + Conventional Activated Sludge Plant, including extended aeration plants at a few locations as well as Physico Chemical Clarification (PCT) followed by Aerobic fixed film reactors) is digested and dewatered on sludge drying beds/ mechanical dewatering. Bio solids after dewatering are disposed as organic manure with limited requirement at present as the bio solids generated is much higher than the requirement for urban landscape and agriculture because the points of use have reduced and the use points for agriculture have drifted far away. Excess biosolids are disposed within treatment plant premises.

6.4.2 General Trends, Drivers and Considerations: The current trend in sewage sludge

Treated sludge should be considered as a resource, rather than disposing it as an unwanted residual. Sludge is increasingly recognized as a resource and alternative beneficial uses e.g. as a fertilizer or soil conditioner for land application and as a fuel and/or raw material for the manufacture of cement are being explored and adopted. The rate of sludge utilization has been increasing in recent years. This is mostly due to lack of landfill space, increased costs and environmental concerns associated with the landfilling of sludge, a ban on ocean dumping and prohibition of direct land application of raw sludge. The approach for utilization of sludge depends on the nature of the sludge, available land and applicable regulations in the country concerned. Green House Gas (GHG) emissions from sludge treatment and the increased emphasis on climate change mitigation measures is an increasingly important factor in decisions on sludge treatment and utilisation.

6.4.3 Planning and Management Mechanisms

Most governments have set goals to maximize the beneficial use of sludge, which requires careful planning and evaluation of alternative approaches for sludge utilization programs and in the design of sludge treatment facilities. Sludge planning involves a wide range of technical, financial, political, legislative and social issues. In general, a sustainable sludge management plan needs to be represented which shall include the following indicators but not limited to:

- Assess current performance in sludge management, focusing on sludge stream, planning structure and regulatory framework
- Review and evaluate alternative feasible sludge management options
- Outline future objectives and targets for sludge management
- Define the roles and responsibilities in the implementation of management plan including those government authorities and the private management sector
- Consider and determine the financing strategy
- Identify monitoring mechanisms needed to review implementation and achievement

In addition to the technical constraints as mentioned above, comprehensive decision-making tools, such as Life Cycle Analysis (LCA), Life Cycle Inventory (LCI), and Strategic Environmental Assessment (SEA) need to be ascertained for environmental and economic assessment of different sludge management strategies. Concerns about global warming are also of rising importance for the selection of sludge treatment technologies. The current global focus on energy efficiency and sustainability regarding sludge management has resulted in an interest in minimizing the carbon footprints of sludge management.

To sum up, sludge planning strategies in a given situation are traditionally determined primarily by economic circumstances whilst taking into account constraints imposed by available technology and legislation. In the future, for developed countries at least, assessment of the overall sustainability of sludge management will likely become the dominant decision-making approach.

6.4.4 Regulatory Frameworks and Guidelines

Sludge policies and disposal / utilization standards are normally established at a national level and are legal requirements. Some local governments enact more stringent requirements that apply within their jurisdictions. Even if specific laws on sludge utilization do not exist, most countries have developed standards which limit sludge application rate, and the levels of pathogen and heavy metals present in the sludge. With regard to incineration and landfilling, regulations are usually not specific to sludge disposal but apply to whatever form of waste is being handled, and they are applied to control incineration gas emissions and potential secondary contamination from landfills.

6.4.5 Economic Considerations

Sludge treatment is normally managed as part of wastewater treatment and hence so to its financing and the cost recovery from users. Government ownership and financing of infrastructure is dominant – although in some countries such as the UK and France private sector financing is commonplace. There is a definite trend for increased private sector involvement.

The level of cost recovery from user charges varies between the different countries surveyed, with a trend towards increased cost recovery in line with the polluter pays principle. This trend is compatible with policies to encourage reductions in waste volumes and GHG emissions.

The current trend is for a move towards full cost recovery as occurs in UK, France, some other European countries and parts of Australia (e.g. NSW). The reason is that full cost recovery promotes economic

efficiency by giving waste generators the incentive to reduce waste. Full cost recovery is therefore fully compatible with the emerging emphasis on waste reduction and the creation of fully sustainable economies.

In several countries a trend of centralized treatment of dewatered sludge from a number of sewage treatment plants was observed in order to take advantage of advanced technology and to take advantage of economies of scale in infrastructure provision, operations and regulatory monitoring.

6.4.6 Public Concerns and the Promotion of Sludge Utilization

Although there is a trend of considering sludge as a resource instead of a waste, implementation of sludge utilization projects may not be successful should the authorities not properly address the human health and safety, and environmental concerns of the general public. Public education and marketing of the beneficial properties of sludge products is another key issue to be addressed for a successful sludge management program. Public concerns on health and safety issues in sludge application are raised mainly in respect of land application, particularly with regard to pathogen content and heavy metal concentrations, which can lead to secondary pollution in food crops, soil and groundwater. Among the environmental concerns, odor nuisance is a key complaint or objection associated with sludge utilization, particularly with land applications. In addition, GHG emission, which has been recognized as the main cause of climate change, is an emerging factor being considered for the selection of sludge treatment methods and management practices in response to the global warming phenomenon.

In recent developments in the US and Europe, GHG emissions from sludge treatment is now considered as one of the evaluation criteria when evaluating sludge treatment technologies. In some European countries, the practice of landfilling of organic waste is being prohibited to reduce GHG emissions, whilst other countries are using economic incentives in the form of taxes on emissions and/or allowance on renewable energy to reduce the release of GHG.

A common means of allaying public concerns is for independent monitoring and regulatory enforcement to be carried out, and details of monitoring programs and results to be made freely available – normally on the internet. Implementation of non-governmental quality assurance program can enhance public confidence in the sludge program, in particular with the use of independent audit and certification systems following the best practices developed using the results of scientific research. Another approach that has been successful in the implementation of sludge utilization programs is the cooperation between the authorities and stakeholders to develop the sludge management plan or establish of the sludge monitoring standards.

6.4.7 Sludge Treatment Technologies

The general practice worldwide is for sludge to be stabilised and dewatered as a minimum level of treatment, even in the less developed countries. Traditional Anaerobic digestion is the most common method of stabilisation but lime stabilisation, aerobic digestion and storage in stabilisation ponds are also commonly used – especially on smaller WWTP. A relatively new and increasingly favoured technology is the use of thermally assisted anaerobic digestion. Lime destabilisation appears to be on the decline and replaced by more modern technologies, as the sludge produced is less marketable. Mechanical dewatering technologies such as centrifuges, belt or filter presses are generally preferred in the initial dewatering of sludge to typically between 70 to 80% water content. In most developed countries, sludge (especially sludge generated at the larger facilities) is further stabilized through heat drying such that it can be used for a wider range of applications.

The most commonly used treatment technologies are discussed in following sections.

6.4.7.1 Sludge Thickening (Conditioning) and Dewatering

Thickening (conditioning) and dewatering is a sludge pre-treatment process to separate water from sludge solids, reduce sludge volume and prepare sludge for subsequent treatment. Water content of sludge can be reduced to 95~97% after thickening and dewatering.

A typical sludge pre-treatment process is shown in **Figure 6.10**.

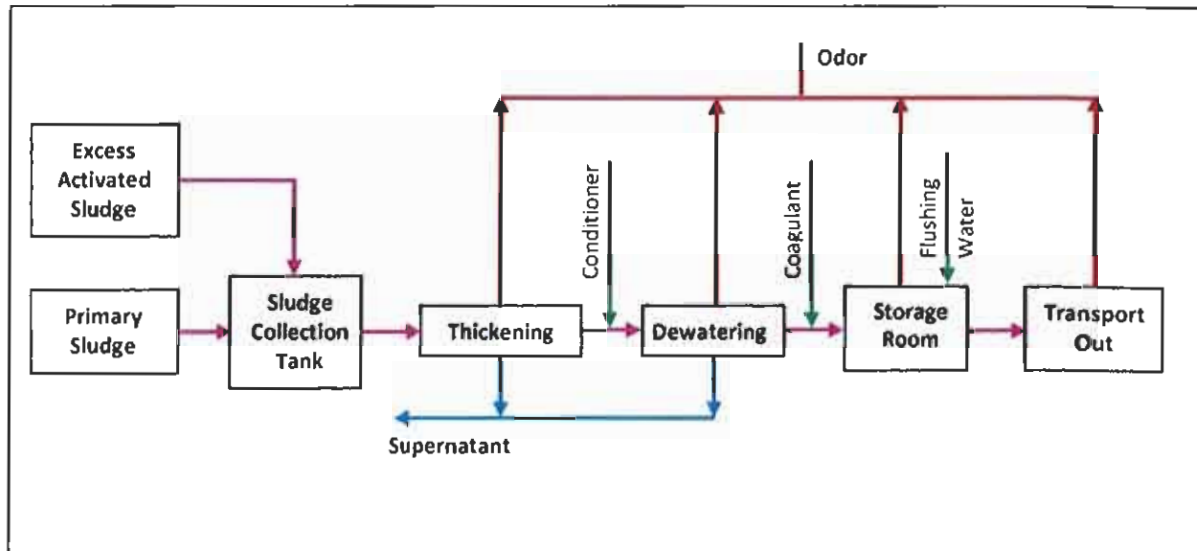


Figure 6.10: Schematic Diagram of Sludge Pre-treatment Process

Table 6.23: Comparison of various sludge de-watering technologies

Treatment	Description	Contaminant Removal	Advantages	Disadvantages
Filter Press	In this batch process, the liquid sludge is pumped through a filter and retained on a filter cloth that may need the addition of a filter aid. Polymer can be added to improve dewatering.	Compacts sludge to reduce storage, transport and disposal costs. Particularly good if cake is considered a hazardous material due to contaminants such as heavy metals.	Produces the highest cake concentrations. Operating costs can be lower than other methods especially when storage and transport are considered. Filtrate (liquid) quality can be better (lower in contaminants) than other dewatering methods.	Initial costs can be high. Requires maintenance to ensure all cake is removed from the filter cloth after each load. Some systems are not automated and manual labour is required to remove the cake.
Belt filterpress	Liquid sludge is applied between two belts which are pressed together to remove the water to produce "cake". This is a continuous	Compacts sludge to reduce storage, transport and disposal costs.	Reduced costs of the disposal of sludge. Reduced footprint compared with large dewatering ponds.	May not be economical at low flow rates as equipment costs are high. May cause odour problems but can be controlled. 20

Treatment	Description	Contaminant Removal	Advantages	Disadvantages
	process. Polymer can be added to improve dewatering.		Reduces storage and transportation costs of cake. Cake can be composted if not contaminated by substances such as heavy metals or plastics. Labour requirements low and maintenance simple. 18 Quick start up and shut down. Less noise than centrifuge. 19	Oils and greases can cause problems with the filters. Sharp objects may damage the filter belt. Belt washing can be time consuming. Self-cleaning belt filter presses are available. 21
Vacuum filters	A vacuum is applied to a filter pulling wastewater through and retaining the solids in a cake on the media.	Compacts sludge to reduce storage, transport and disposal costs.	More compact than drying beds. Continuous process.	Not appropriate for dilute sludge due to the high amount of energy required to remove the water.
Centrifuge	A rotating cylinder with a conical end allows solids to fall to the end and water discharge from the other end. Polymer can be added to improve dewatering.	Compacts sludge to reduce storage, transport and disposal costs.	Low space requirements. Can handle both dilute and thick sludge. Many different types are available.	Unsuitable for high flow rates.
Drying beds	Drying beds are large areas onto which liquid sludge is discharged. Solar drying beds are shallow concrete beds exposed to the sun which evaporates the water from the sludge to produce cake for disposal. Alternatively, the beds can be sand drying beds with the sludge applied on a bed of sand and the liquid filtering through the sand to a drain. Dry	Solar beds appropriate for alum and ferric sludges. Compacts sludge to reduce storage, transport and disposal costs.	Low operating costs. Yields can be improved through the addition of polymer.	Require large areas. Retention time within the beds can be significant especially for dilute sludge and during periods of wet weather. Contaminated run-off during wet weather can be difficult to contain.

Treatment	Description	Contaminant Removal	Advantages	Disadvantages
	sludge can be removed manually or mechanically.			
Land spreading	Application of the biosolids component of sludge onto land. Biosolids can be further processed into granulated product for application as a fertiliser.	Removes the need for disposal of sludge to landfill.	Low disposal costs. Returning nutrients to the soil.	Requires dewatering first. Contaminants in the sludge may prevent land spreading, such as heavy metals. Onsite composting may not be possible due to space restrictions and transport of waste to composting facility may be costly.

Table 6.24: Power and Chemical Consumptions of Various Thickening Options

Thickening Options	Sludge Type	Solid Content after Thickening (%)	Power Consumption (kWh/tDS)	Chemical Consumption (kgPAM/tDS)
Gravity	Primary Sludge	8 - 10	1.3 - 2.9	0
Gravity	Surplus Activated Sludge	2 - 3	4.4 - 13.2	0
Centrifugal	Surplus Activated Sludge	5 - 7	200 - 300	0
Belt Thickener	Surplus Activated Sludge	3 - 5	30 - 120	0.2 - 2
Drum Thickener	Surplus Activated Sludge	4 - 8	50 - 100	3 - 7.5
Rotary Screw Thickener	Surplus Activated Sludge	4 - 8	50 - 100	3 - 7.5
Floatation	Surplus Activated Sludge	3 - 5	100 - 240	0

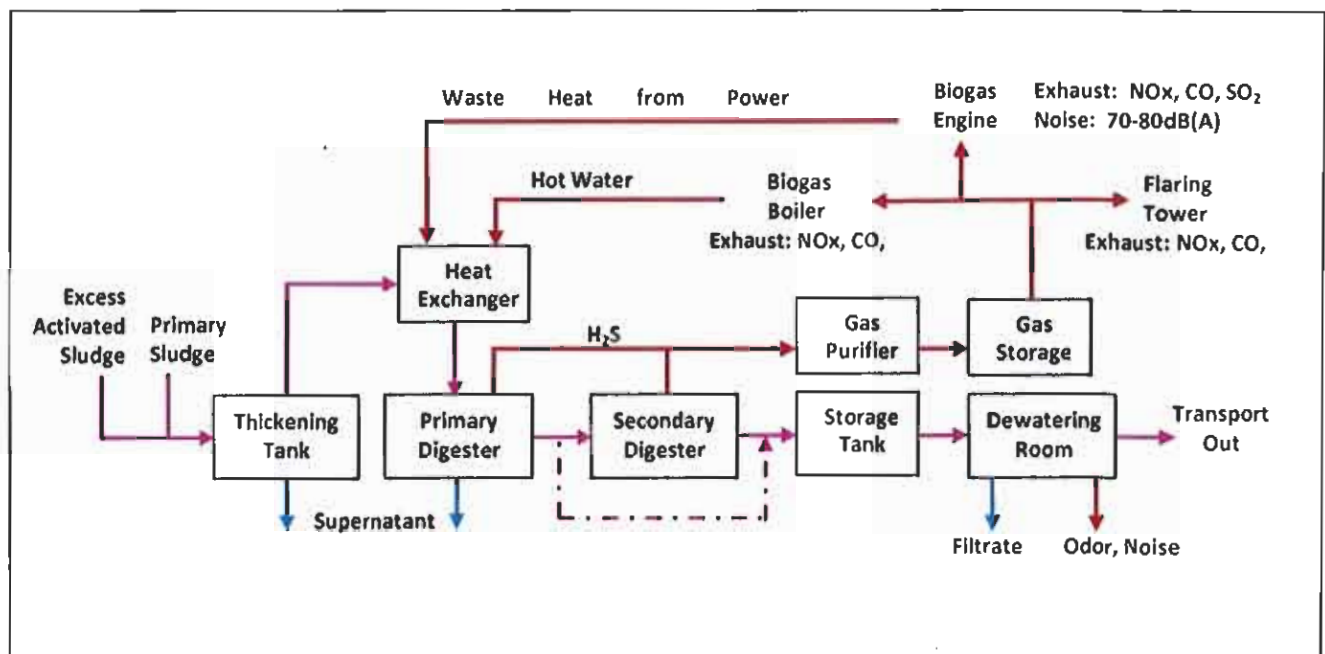
Table 6.25: Power and Chemical Consumptions of Various Dewatering Options

Dewatering	Power Consumption (kWh/tDS)	Chemical Consumption (kgPAM/tDS)
Plate Presser	15 - 40	0.2 - 0.6
Belt Presser	5 - 20	0.3 - 0.5
Centrifuge	30 - 60	0.1 - 0.4

6.4.7.2 Anaerobic digestion

This is the most widely used sludge stabilization technology. It reduces the sludge volume as well as stabilizes organic content of the sludge, and produces biogas as by-product for power generation. About 35 – 50% of volatile solids of sludge are decomposed during the anaerobic digestion process.

Anaerobic digestion degrades the organics in sludge which are easy to decay and generate odour. The process reduces the sludge volume, pathogens and odor, and improves the dewaterability of sludge. In terms of digestion temperature, anaerobic digestion can be categorised into thermophilic anaerobic digestion and mesophilic anaerobic digestion. In terms of the operation mode, anaerobic digestion can be categorised as single-stage digestion and two-stage digestion. The typical process of anaerobic digestion is shown in **Figure 6.11**.

**Figure 6.11: Schematic Diagram of Anaerobic Digestion Process**

6.4.7.3 Lime stabilization

The process involves addition of dry alkaline chemicals to partly dewatered sludge cake to raise the pH and temperature of the mixture, so that the environment becomes unsuitable for the survival of most pathogens and other microorganisms. After lime stabilization, the sludge can be used as backfill soil or cover soil for landfill as well as raw material for cement production, brick manufacturing and road construction. This treatment process, however, is of decreasing popularity due to the limited product applications and the availability of more advanced treatment methods.

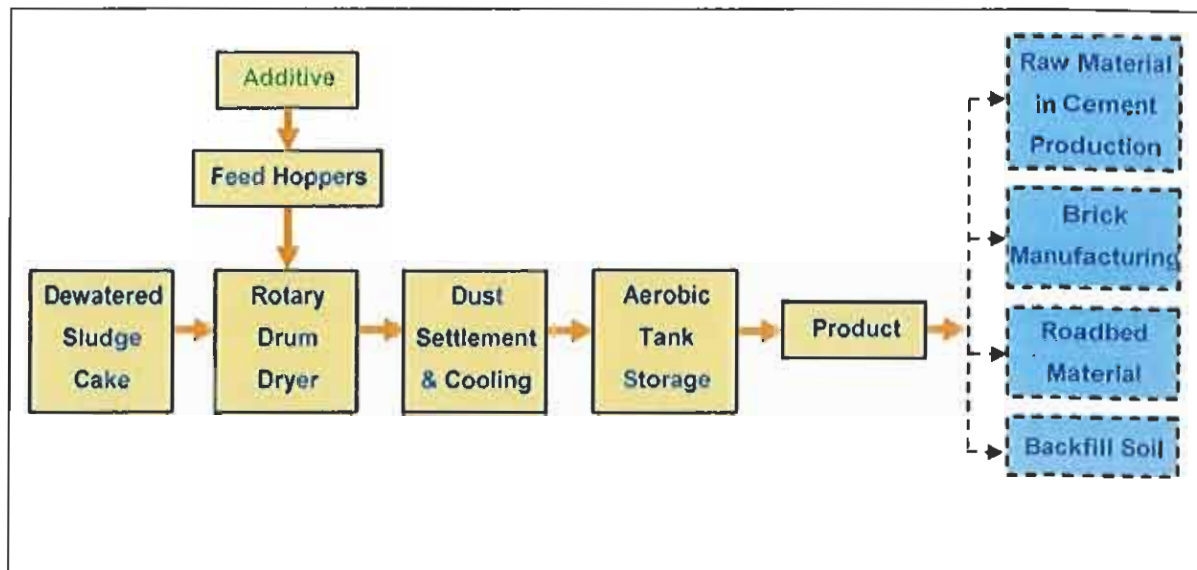


Figure 6.12: Schematic Diagram of Lime Stabilization

6.4.7.4 Composting

It is an aerobic microbial process that converts the organic waste of dewatered sludge, into a stable humus-like substance that can be beneficially used as a soil conditioner. In addition, sludge can be co-composted with other organic wastes to increase its nutrient content thereby improving the marketability of the sludge product. Such practices are common in most of the nations surveyed.

Sludge composting is a bio-chemical fermentation process which happens under conditions with controlled moisture, oxygen and nutrients level as well as temperature, pH etc. With the bio-fermentation, the organics within sludge are degraded and are composted to become fertilizer.

In general, the categorization of composting process options is as below:

- 1) in terms of movements of materials and supplies, sludge composting can be categorized as either static composting or dynamic composting;
- 2) in terms of oxygen supply, it can be categorized as either aerobic composting or anaerobic composting
- 3) in terms of pile temperature, it can be categorized as either mesophilic composting or thermophilic composting
- 4) in terms of piling type, it can be categorized between use of open-air composting or composting in reactors
- 5) the fermentation stages are primary fermentation and secondary fermentation

The choice of composting process is affected greatly by process requirements, technological difficulties, treatment capacities, available land etc. For instance, anaerobic composting has long production cycle, odor issues and large land footprint.

Dynamic composting requires a high degree of mechanization, sophisticated design, advanced construction technologies, relatively skilled operators, and high capital investment and operational cost. Therefore, in many projects, multiple types of composting are used combination. In China, big composting projects normally adopt the thermophilic aerobic static windrow composting process. Primary fermentation stage technologies mainly include: composting with mechanical turning, aerated static composting and intelligent auto-controlled composting. Bulking agents used for windrow composting are

mainly waste from pruning, leaves and other gardening waste or bran, chaff, straw, sawdust and other suitable industrial or agricultural waste.

6.4.7.5 Heat drying

It involves the application of heat to further remove water from dewatered sludge. Heat drying can reduce the moisture content of the sludge to achieve up to about 95% solids concentration. Heat dried sludge also has a high organic content (65 – 85%), which can be used to improve soil conditions. The heat dried sludge is also sometimes used as a fuel by cement industry and power plant in some regions, but this is not common.

6.4.7.6 Incineration

Incineration is the burning of the organics of dewatered sludge to oxidized compounds: carbon dioxide, water vapour, nitrogen oxides, sulphur dioxide and inert ash. The two types of incinerators commonly used are multiple hearth incinerators and fluidized bed incinerators. Multiple hearth incinerators were common prior to 1990. Since that time, fluidized bed incinerators have been more popular because of better combustion and exhaust gas quality which enables them to meet the stringent air emission controls.

Incineration is used to oxidize and destroy the organics in sludge under high temperature conditions inside the incinerator. After incineration, the sludge is degraded to ash with minimal water content.

Heat drying is often used as a pretreatment process before sludge incineration to improve energy recovery and reuse efficiency in the incineration process. A typical process of incineration is shown in **Figure 6.13**. The heat for the drying process is usually provided by waste heat from the incineration process. Available drying technologies include rotary drum dryer, fluidized bed dryer and belt dryer. Almost all the currently used drying technologies can meet the requirements for incineration pretreatment. Fluidized bed is the most commonly used incineration technology. Its various types include bubbling fluidized bed incinerator, circulating fluidized bed incinerator and rotary fluidized bed incinerator.

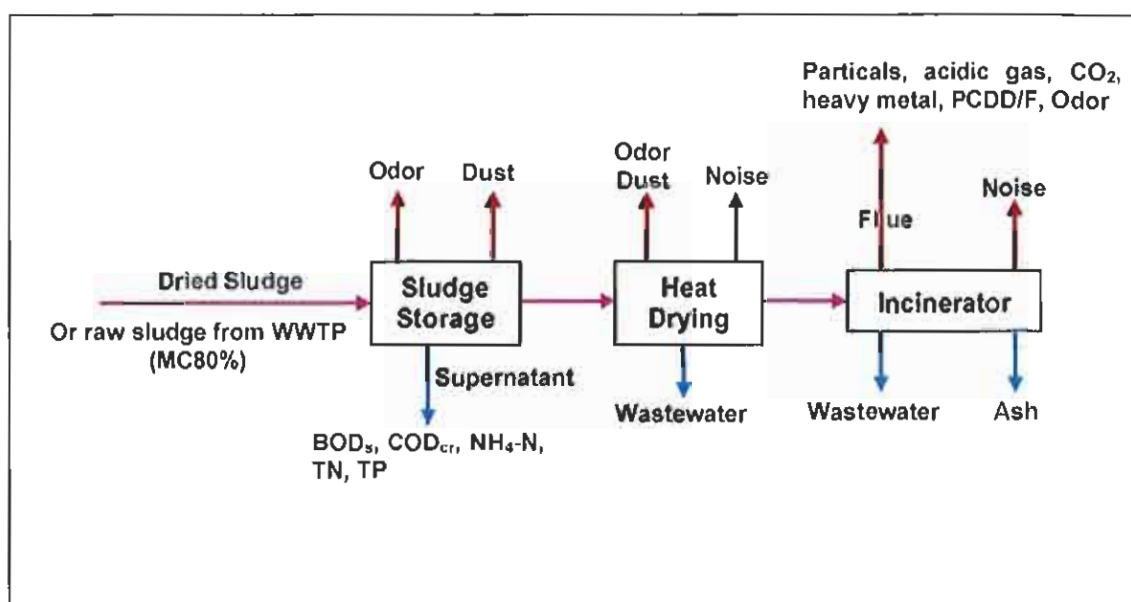


Figure 6.13: Schematic Diagram of Drying and Incineration Process

Incineration of sludge is generally categorized between mono-incineration and co-incineration. Sludge co-incineration in municipal waste incineration plants, thermal power plants or cement kilns where sludge is

mixed with other fuel, waste or materials is more popular in some countries e.g China than mono-incineration, where the sludge is incinerated on its own.

The major components of capital investment for a sludge incineration project include the costs of new sludge storage facilities, sludge dryer and the incineration system. The operational cost comprises of utility fees, equipment maintenance and staff salary. If dried sludge is co-incinerated in a thermal power plant, the major capital investment is the drying equipment to make it suitable for the co-incineration.

Recently, some new sludge technologies have been used in the sludge treatment viz. **thermal hydrolysis, gasification/pyrolysis and oxidation.**

6.4.8 Sludge Utilization / Disposal

The term “sludge utilization” is generally understood as the use of dewatered sludge, including digested sludge and undigested sludge, for any beneficial use instead of disposal of the solid residuals at a landfill.

6.4.8.1 Landfilling

Landfilling has been a long-term practice adopted for disposal of digested and dewatered sludge but has been decreasing in popularity in recent years in view of the GHG emitted from the anaerobic degradation of landfilled sludge. Recovery of landfill gas for power production is an emerging trend where landfilling is still being carried out.

Sludge can be disposed of in sludge landfill alone (mono-landfill) or can be mixed with other municipal or industrial solid waste (co-landfill) and disposed of in a municipal landfill or specialized industrial landfill. In terms of landfill type, a sludge landfill can also be categorized as either a sanitary landfill or simple landfill, depending on the environmental protection facilities installed at the site (such as landfill lining to prevent leakage to the groundwater aquifer and a leachate treatment plant). In general, landfill is a relatively simple disposal method with low capital, low operational cost and less requirement for maintenance.

6.4.8.2 Land application

Land application involves the utilization of nutrient content of sludge as fertilizer, soil conditioner on farmland, garden, landscape, woodland etc. Sludge application to soil varies from the application of stabilized and dewatered sludge to the application of sludge-derived compost or heat-dried sludge pellets.

6.4.8.3 Use in the Manufacture of Construction Materials

Sludge can be used as a raw material in manufacturing of construction materials, such as bricks, ceramsite, cement and concrete. Use of sludge in construction material manufacturing is an important form of beneficial sludge utilization. The major applications are using sludge in brick manufacturing and cement production. There are two main methods for brick-making. One is to directly use the dried sludge, and the other is to use sludge ash. For the former, the sludge composition should be adjusted to be similar to the composition of clay. The strength of the sludge brick can equal to the common red brick when the mix ratio is 1:10 of sludge and clay. For the latter, as composition of sludge ash is similar to clay, it is only necessary to add a certain amount of clay and silica sand. Using sludge in brick-making can reduce the clay consumption as well as recover the calorific value of the organic compounds in the sludge.

Heat dried sludge pellets are used as an alternative fuel in cement kilns, or carbonized to char and syngas under pyrolysis or gasification processes for power generation.

6.4.9 Institutional Arrangements and the Management Mechanism

The management of sludge treatment, disposal and utilization involves several sectors, including urban planning, municipal development, environment protection, landscaping, agriculture, industry, etc. At present there is a need for overall coordination between various stakeholders to achieve sustainable sewage sludge treatment and management for its disposal and utilization. Though any of the implied technology carries its benefits yet equivalent environmental impact also needs to be ascertained. The table below represent likely environmental impact of various Sludge treatment process for which suitable mitigation measures can be implied appropriately.

Sludge Treatment, Disposal and Utilization – Process	Potential Environmental Impact
Thickening and Dewatering	Where a primary sedimentation tank is built in WWTP, intermittent sludge discharge requires sludge storage before thickening and dewatering. Currently open sludge storage tanks are constructed in most WWTPs and concentrations of odor pollutants and other air pollutants (ammonia, methane, hydrogen sulfide) are high. Offensive odor can also be found in sludge dewatering chambers. Supernatant from sludge thickening and centrifugate can also introduce environmental problems. Separate nitrogen and phosphorus removal is required because of their high concentrations in supernatant and centrifugate due to their anaerobic condition. In addition, sludge dewatering equipment, especially high speed centrifuges, is major noise source during operation.
Anaerobic Digestion	Major pollutants from anaerobic sludge digestion include odor, supernatant digested sludge, and waste gas or fumes from power generation. Biogas generated during anaerobic digestion is composed of methane (60-65%), CO ₂ , H ₂ S and water, and desulphurizing and dewatering processes are needed for methane utilization. There is risk of explosion when methane content is 5-15% in the air, and additionally H ₂ S is toxic. Therefore, attention should be paid to methane safety. Major pollutants from methane power generators are carbon monoxide and nitrogen oxide. Wastewater from anaerobic digestion usually returns to the primary sedimentation tank for treatment together with the influent, but higher nitrogen and phosphorus concentrations can increase the pollutant load of the influent. Air pollutants from anaerobic digestion, including odor and hydrogen sulphide, are potential concerns.
Composting	Major pollutants from fermentation processes are odor pollutants including free ammonia, hydrogen sulphide, methyl thiol and amine, which are caused by uneven aeration or from forced draft. Open fermentation facilities will generate leachate containing pollutants such as COD _{cr} , BOD ₅ , SS, total nitrogen, total phosphorus, and pathogens. Aerobic fermentation equipment will generate noise ranging from 70 to 85dB(A). Fermentation processes will also generate dust.
Landfilling	Sludge landfilling potentially creates a lot of problems including (i) considerable land occupation and damage to the ecological environment; (ii) generation of large quantities of leachate that may cause groundwater and surface water pollution; (iii) landfill gas can result in air pollution and cause damage to surrounding buildings and plants; and (iv) GHG emission has an adverse impact on climate change.

Sludge Treatment, Disposal and Utilization – Process	Potential Environmental Impact
Land Application	Pollutant discharge from land application, to some extent, depends on sludge composition and the application pattern, as well as application frequency, application rate and baseline condition of the land. Major pollutants associated with land application include heavy metals and their compounds, saline matters, organic pollutants like PCBs, pathogens, odor and hazardous gas. These pollutants will cause soil, water and air pollution and could enter the food chain. Studies on the existence of heavy metal in seven kinds of municipal sewage sludge and a risk assessment of agricultural applications in Guangzhou indicate that copper, zinc and manganese concentrations are high in all the kinds of sludge tested, and these heavy metals have a high migration capacity. Agricultural application of these kinds of sludge creates a risk of ecological damage. Studies on adverse impact of forest application in Kunming reveal that large amount of hazardous components in sludge result in similar adverse impacts as other applications, such as potential heavy metal accumulation in forest soil, residual traces of PCBs, organic chlorine pesticides and PAHs in soil, as well as leaching loss of nitrogen and phosphorus.
Construction Material	Potential problems with construction material applications depend on sludge composition, processing method and use of the end product. During construction material application, a portion of the heavy metals contained in the sludge enter construction material together with the ash and residuals. Usually the solidified heavy metals lose migration capacity and will not enter the environment with leachate. Thus, construction material application will not cause significant environmental damage. However, application sites should be properly selected depending on heavy metal contents and their leachable characteristics. For the production of construction materials, usually 1000°C or higher temperature is applied for better control of dioxin/furan, and volatile or semi-volatile organic matters in the waste gas, while total suspended particulates will not cause air pollution as long as proper waste gas control measures are taken.
Incineration	Sludge incineration generates large quantities of fumes. Fume generation (oxygen content 11%) is generally 4500~6000m³ per ton sludge comprising particulates, acid gas and other gases (HCl, HF, HBr, HI, SO₂, NO_x, NH₃) heavy metals (Hg, Cd, Ti, As, Ni, Pb), CO, hydrocarbon (VOCs, PCDD/F, PCB), and odor pollutants. Wastewater generated by sludge incineration facilities generally includes wastewater from wet or semi-set fume purification equipment, boiler discharge, cooling water from wet cooling facilities, road cleaning sewage and rain water, leachate from dewatered sludge storage and transfer, and various discharges from residual treatment and storage. This kind of wastewater commonly includes high salt, heavy metal and organic contents. Solid wastes generated by sludge incineration include three kinds: (i) fly ash and residual directly from the incinerator; (ii) residual from the fume treatment facility; and (iii) sludge from the wastewater treatment process. Various heavy metals accumulated in sludge have two migration approaches, solidification in residuals or diffusion to the air through fly ash. The leachable characteristics and environmental impact of different heavy metals vary as a result of sludge incineration.

Sludge Treatment, Disposal and Utilization – Process	Potential Environmental Impact
Others	Sludge transportation may also introduce environmental problems. Sludge volumes may be high and create difficulties for transportation depending on water content and extent of stability. Transportation capacity, use of open containers, and local road conditions also possibly cause environmental concerns. Use of special enclosed tankers is encouraged for sludge transportation instead of open trunk. In addition, unstabilized sludge generates offensive odor. Odor control measures and careful transportation measures should be taken at the sludge treatment site, storage site and during land application.

6.5 Combined sewer, Low Cost Sewer and On-Site treatment options

Small Bore sewers and combined sewer options with on-site treatment were studied for congested area. However due to failure of these technologies on account of techno-economical and feasibility considerations the options were excluded from the Master Plan. Major aspects that were in against of the technologies are as follows:

Disadvantages of Combined Sewer Systems

- The sewers are considerably larger in diameter in case of combined sewers running far below capacity for most part of the year.
- The load on treatment plant increases as sewerage system conveys storm water as well to waste water treatment plants.
- The combined sewer, if not properly designed gets easily silted and it may even become foul in dry weather
- During ordinary heavy storms, the combined sewers may overflow and it may thus put public health in danger.
- The storm water is unnecessary polluted due to mixing of sewage with the storm water.
- The system proves to be uneconomical when pumping is required for the lifting of sewage.

Disadvantages of Small Bore Sewers Systems

- Maintenance Issues as frequent cleaning is required for small bore sewer.
- Periodic evacuation and disposal of solids from each interceptor tank with-in the system
- Sludge management issues.
- Special precautions are required to be taken to prevent illegal connections.

Disadvantages of On-Site Treatment options

- Quality Control issues
- Poor management & operation of Treatment Plants
- Safe Effluent disposal concerns
- Scum Formation in Septic Tanks
- Poor effluent qualities

CHAPTER - 7

APPROACH AND METHODOLOGY FOR GIS DATA INTEGRATION AND HYDRAULIC MODELING

CHAPTER - 7: APPROACH AND METHODOLOGY FOR GIS DATA INTEGRATION AND HYDRAULIC MODELING

7.1 PLANNING AND DESIGNING

The base year for the Sewerage Master Plan is 2011 with the planning horizon year 2031. The design-planning horizon for sewerage works is 20 years with five year incremental plan. The flows reaching the various trunks and mains in the year 2031 has been estimated, based on the population and wastewater generation factor.

Wherever required, options for construction of new WWTPs & WWPSs or capacity augmentation of existing WWTPs & WWPS have been considered for ultimate design year. A design life of 15 years has been considered for mechanical and electrical equipment's at Wastewater Pumping stations (WWPSs) and Wastewater Treatment Plants (WWTPs). Life of civil works has been considered as 50 years.

The need for new sewerage infrastructure and/or capacity augmentation of sewerage networks depends on projected population growth and estimated wastewater flow for the design year. "Planning capacity" for the design year intends to maintain the infrastructure capacity above the projected population and wastewater generation loadings.

In the design of sewerage system, the decisive parameters are location, size, slope, depth of sewers and other appurtenances to be laid such as manholes, junctions or any other structure to minimize turbulence and to save the head loss for preventing deposits. The aim of the design is not only to make the sewer system functional but also to build the system at lowest cost ensuring durability throughout its life.

7.2 NETWORK ALIGNMENT

The planning and alignment of network is the foremost important step in building of hydraulic model. The output results of hydraulic modeling depend on how well the network has been planned and laid. In general, the internal and peripheral sewers have been designed sloping in the same direction as that of the ground and will be connected ultimately to trunk sewers in order to maintain gravity flow of sewage to the discharge point. The discharge point may be a WWTP or a WWPS or even a trunk or an intercepting sewer. The network has been planned and drawn using SewerGEMS Sanitary in AutoCAD mode, as shown in **Figure 7.1** below. The following factors have been considered while planning and drawing the network:

- General road alignment plan of the area
- Contours generated from topographical survey maps
- Prescribing limits to the zonal boundaries
- Selection of an outlet or disposal point
- Direction of sewage flow to the outfall in the subject area
- Location of existing and proposed trunk and main sewers

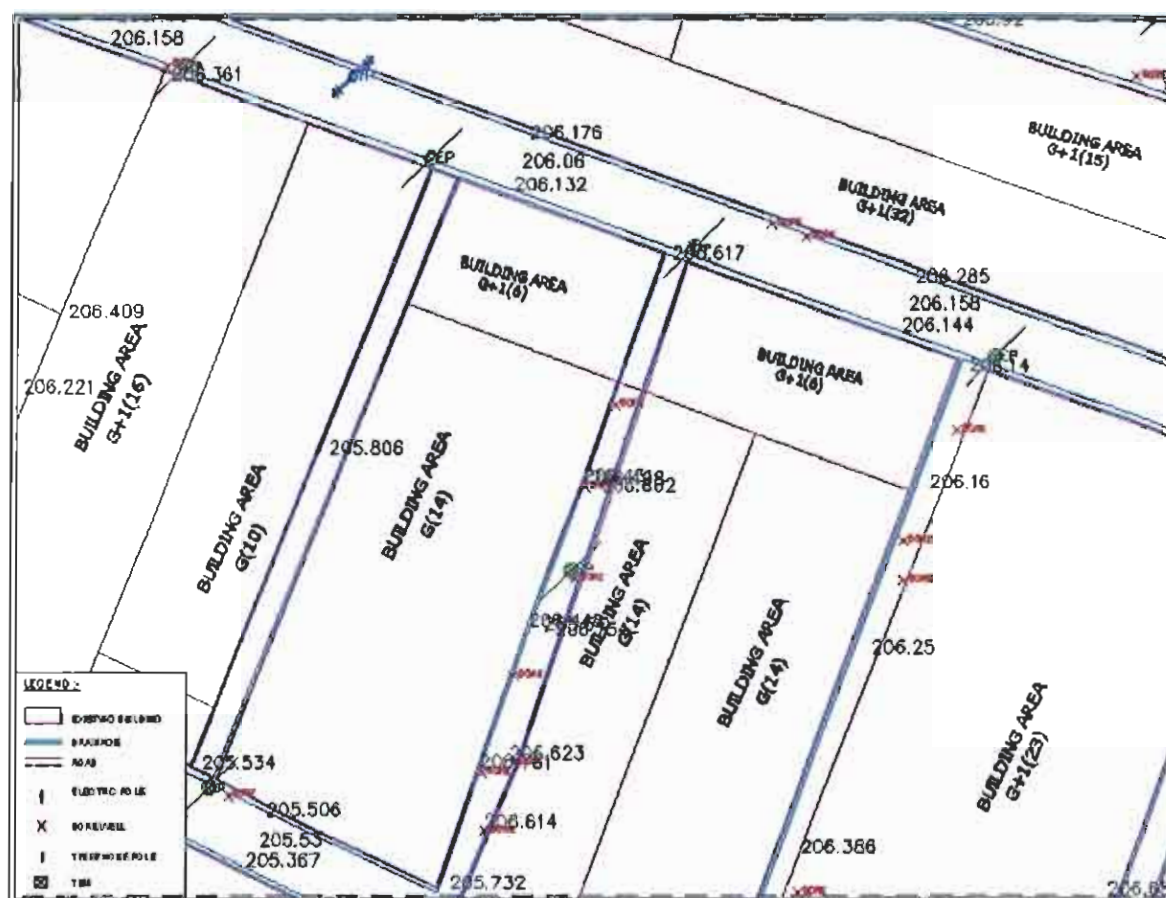


Figure 7.1: Procedural Details of Network Layouts

7.3 BUILDING MODEL FROM GEOSPATIAL DATA

The proposed highly integrated approach of the system architecture can facilitate mutual supplementary coupling of GIS and hydraulic model. It can make use of powerful hydraulic analyzing capability to complement GIS which is deficient of modeling functionality; also such coupling can bring spatial visualization strength of GIS to the fullest extent to facilitate interpretation and analysis of the modeled results.

The network asset database which has been generated in ARCGIS/AutoCAD is imported into SewerGEMS to generate sewerage hydraulic model. The details of survey data integrated with GIS for hydraulic modeling is shown in following *Figure 7.2* and *Figure 7.3* below.

The integrated survey data has been utilized to generate the present population of the respective area and future population of the year 2031 has been projected using various population projection methods as discussed in Chapter 5.

The integrated survey data and projected population has been transferred to hydraulic model in SewerGEMS by using various tools of SewerGEMS like Model builder, TRex, Load builder etc. The following figure shows the data transfer procedure & how it is integrated into GIS and AutoCAD.

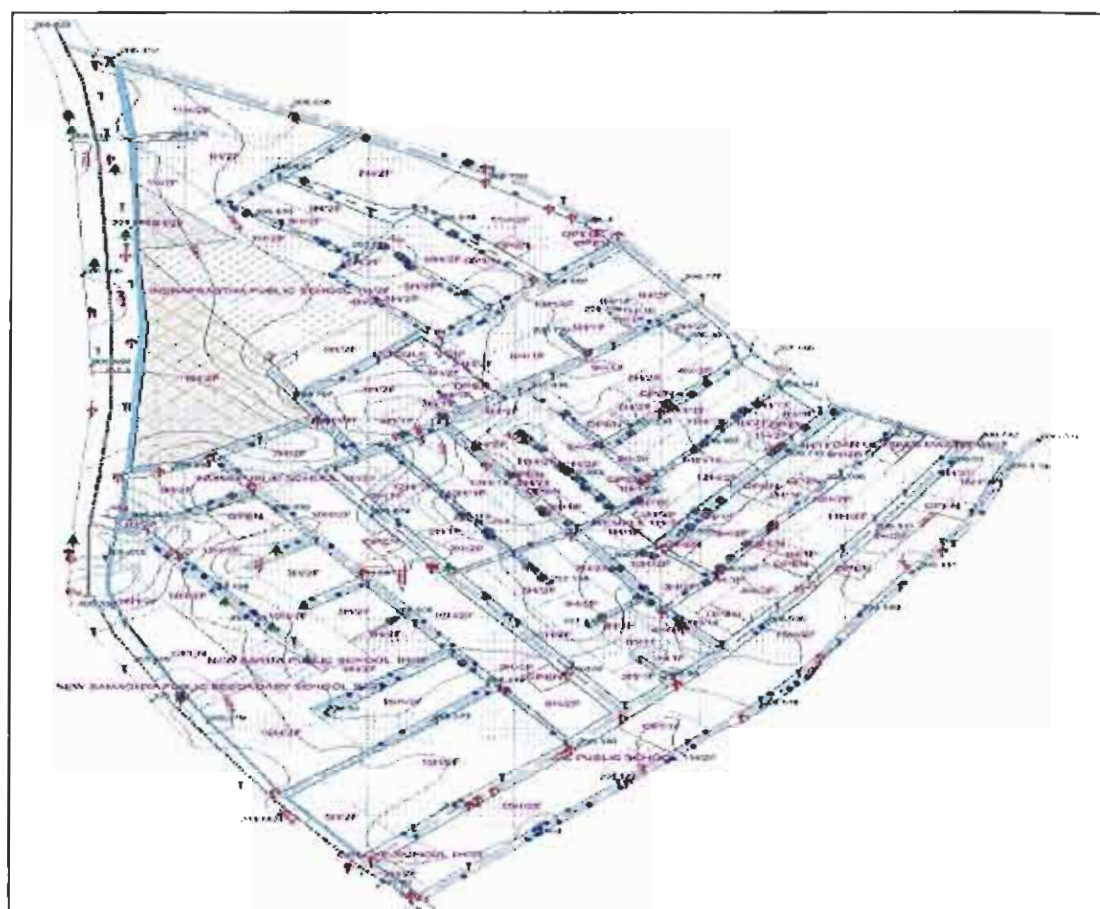


Figure 7.2: Details of Survey data Integrated with GIS

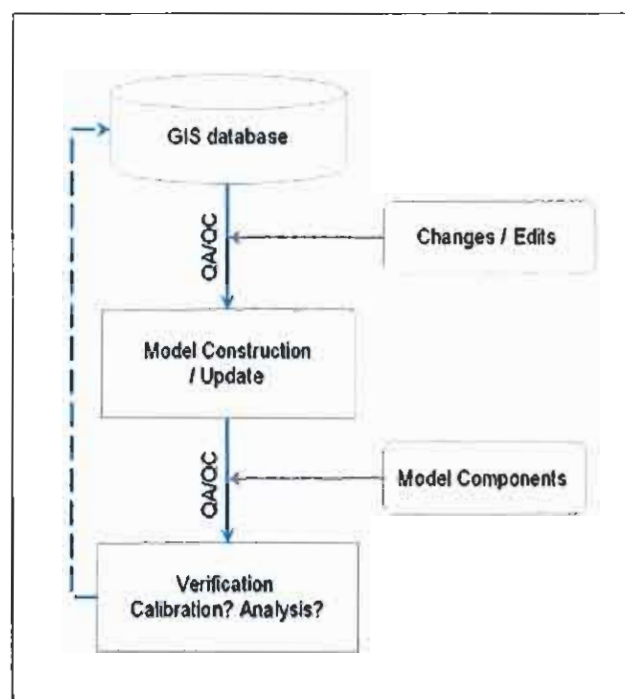


Figure 7.3: Data transfer from GIS interface to SewerGEMS interface

Model Builder

The module Model Builder of SewerGEMS permits the use of existing GIS assets to construct a new SewerGEMS model from scratch or update an existing SewerGEMS model. Using Model Builder module, the tables and fields contained within the existing data source are mapped to element types and attributes in the SewerGEMS model. The SewerGEMS model has been created either in stand-alone mode or in an existing ESRI ArcMap project.

TRex

The module TRex of SewerGEMS permits the use of existing GIS asset files (ex. DEM) to provide topographical behavior to the network layout.

Load Builder

Load Builder is a tool used to assign flows to elements in Bentley SewerGEMS. The power of Load Builder is that it can take loading information from a variety of GIS based sources such as customer meter data, system flow meter or polygons with known population or land use and assign those flows to elements. Load Builder is oriented to the types of data available to describe dry weather flows and other methods in Bentley SewerGEMS that are more amenable to wet weather flows.

7.4 HYDRAULIC MODELING

The primary purpose of the hydraulic modeling of sewerage systems is to assess the hydraulic adequacy of the existing and planned sewerage systems under various planning scenarios in due consideration of the sewage flows.

SewerGEMS and GIS models of the existing and future sewerage networks in the study area have been constructed under the current study to achieve the purpose. The hydraulic models have been fully verified and calibrated by site constraints, and simulations have been carried out for present and future scenarios.

Under this study, three (3) hydraulic modeling scenarios have been developed, namely Base Scenario 2011, Intermediate Scenario 2021 and Ultimate Scenario 2031. However, simulation in five year increments has also been carried out. Details of model construction methodology and assumptions are included in the following sections.

7.4.1 Model Construction

Data Incorporation

SewerGEMS Sanitary (Select Series 2) Version has been used to develop the hydraulic and GIS models of the sewerage systems. The model build processes has been undertaken in line with the general requirements and current best practices. Information regarding the existing sewerage system has been obtained from Delhi Jal Board from subsequent site visits. The detailed data collection process is mentioned in Chapter 4 of the report. Various attributes acquired from Topographical Survey like building count, floor count, building type, road width, land use, ground elevation, property edge lines etc. has been converted into .shp (GIS integrated shape file) layers and then these layers have been used for building model in Sanitary SewerGEMS.

Population Projections and Flow Allocations

The hydraulic model thus generated is executed to acquire per capita load information by Theissen Polygon method. The method allocates each manhole with its contributing population along with unit flow factors corresponding to the flow types being assigned.

The sewage flow conveyed by a particular sewer section represents the total of inflows to the sewer from the upstream systems and the inflows from connected terminal manholes of nearby developments. Inflows from the upstream systems are related to the cumulative, contributing population of all the upstream sub-catchments.

Regarding the proposed sewerage network in the study area, apportioning of flows have been based on SMP survey details and planned land use as shown in the DDA Master Plan. The details of integration of data from GIS to SewerGEMS while constructing model has been covered in GIS and Hydraulic Modeling Integration Approach Report under this study and the same has been briefed in **Figure 7.4** below:



Figure 7.4: Procedural Flow Chart of Sanitary SewerGEMS

Model Structure

In general, models have been constructed to facilitate the performance assessment of existing as well as proposed sewerage infrastructure. The sewerage models include the existing trunk sewerage networks within the respective sewerage catchments. The integration of existing and planned models includes different sets of model networks constructed for the proposed sewerage systems to unsewered area and population projections at the corresponding design years of 2011, 2021 and 2031 respectively.

7.4.2 Modeled Data Verification

Verification is the process of checking the model against independent data to determine its accuracy whilst calibration is the process of adjusting model parameters to make the model fit with measured conditions.

The data from the survey conducted under this study have formed the basis for model verification and calibration. The details of the survey results have been reported in *Field Investigation Approach Methodology and Data – First Tranche & Second Tranche Reports*. The summary of the findings has been presented in Chapter 4 of the report.

Based on the projected population and unit flow factors recommended in this study, the dry weather flows contributed from each sub-catchment has been calculated using Load Builder tool of Sanitary SewerGEMS for model simulations.

7.4.3 Performance Assessment

The hydraulic model created has been used to carry out the performance assessment of the existing and proposed sewerage systems with the following conditions:

- Average dry weather flow (ADWF) condition to check the minimum velocities;
- Peak dry weather flow (PDWF) conditions to identify the surcharged pipes for further scrutiny and possible upgrading;

Average Dry Weather Flow Condition

The scenario for average dry weather flow condition was executed based on the population projection and the unit flow factors for different types of population.

Peak Dry Weather Flow Condition

The scenario for peak dry weather flow condition was executed based on the population projection and peaking factor to different types of population. The details of the peaking factors are provided in Chapter 6 of the report.

Performance Assessment

The hydraulic adequacy of the existing and planned sewerage systems has been assessed using the SewerGEMS hydraulic models based on the flow data established from updated population under the various scenario.

The hydraulic models of the various sewerage catchments under the different scenarios have been executed for the specified designed constraints especially on depth, d/D and velocity. Results from the different scenarios executed have been analyzed to determine the following performance of the systems, as shown in **Table 7.1** below:

- Velocity check
- Capacity check
- Flooding check

Table 7.1: Performance Parameters of a Sewerage System

Condition	Velocity Check		Capacity Check	Flooding Check
	Minimum	Maximum		
ADWF	✓			
PDWF	✓	✓	✓	✓

In accordance with Sewerage Manual published by CPHEEO, the minimum velocity shall be 0.6 m/s for present peak flows and 0.8 m/s for the design peak flows while the maximum velocity at peak flow shall be limited to 3.0 m/s. However, the above criteria have been reviewed and analyzed performance parameter wise, as appropriate.

The pipes have been classified as under-capacity where the projected flow exceeds the full-bored capacity of the pipe and/or pipe surcharged due to backwater effect. Flooding or overflow refers as water level at the manhole exceeds the cover level.

The sustainable objective of Sewerage Master Plan is to prevent any surcharge condition in design year of 2031, while implementing sewerage scheme. In addition to the sewers, the performance assessment of existing WWPs and WWTPs has also been conducted based on the results obtained after hydraulic modeling of sewers within the respective sub-catchments.

CHAPTER - 8

RAMIFICATIONS OF SEWERAGE MASTER PLAN - 2031

CHAPTER - 8: RAMIFICATIONS OF SEWERAGE MASTER PLAN - 2031

8.1 PROPOSED DRAINAGE AND SUB-DRAINAGE ZONES

The demarcation/delineation of various drainage zones and sub-drainage zones has been carried out based on the existing six (6) major drainage zones and certain zoning criteria/constraints, which have been described further. The boundaries of proposed drainage zones are delineated on the following criteria/constraints:

- Topography of NCT of Delhi
- Natural boundaries like river Yamuna, canals/drains and habitation pattern
- Major Highways and Railways
- Utilization of existing sewer network, WWPSs, pumping mains, WWTPs
- Future sewage generation from the catchments
- Permissible depth of outfall sewer, length of main/trunk sewer and pumping main etc.

Similarly, the boundaries of sub drainage zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs, pumping mains and the direction of gravity flow of sewage to arrive at the most economical and practically (on-site) feasible sewer network alignment. The proposed sub drainage zones have been formulated considering the following criteria/constraints:

- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTPs and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPSs/ WWTP
- Hydraulic analysis and condition assessment of existing sewerage assets
- Feasibility implications
- Delineation based on contours of respective sub-drainage zone

Based on the above described physical constraints and zoning criteria, the whole NCT of Delhi has been delineated into 12 (twelve) drainage zones excluding Cantonment and Airport area. The proposed drainage zones are further delineated into various WWTP and sub drainage zones as shown in **Figure 8.1 & Figure 8.2** below:

- Shahdara Drainage Zone (SHD)
- Okhla Drainage Zone (OKH)
- Keshopur Drainage Zone (KSP)
- Rohini- Rithala Drainage Zone (RR)
- Coronation Pillar Drainage (COR)
- Dwarka Drainage Zone (DWK)
- Najafgarh Drainage Zone (NJF)
- Nilothi Drainage Zone (NLT)
- Narela Drainage Zone (NRL)
- South Delhi Drainage Zone (SD)
- Outer South Delhi Drainage Zone (OSD)
- Kanjhawala-Bawana (KB)

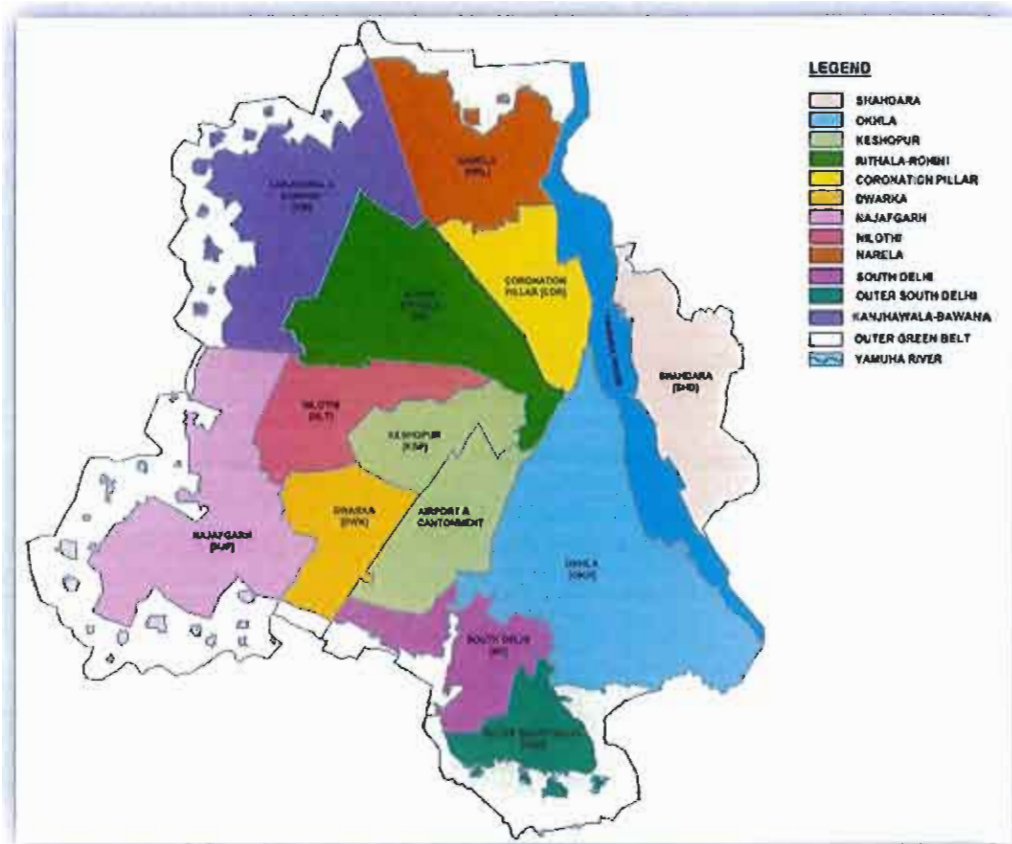


Figure 8.1: Proposed Drainage Zones – NCT Delhi

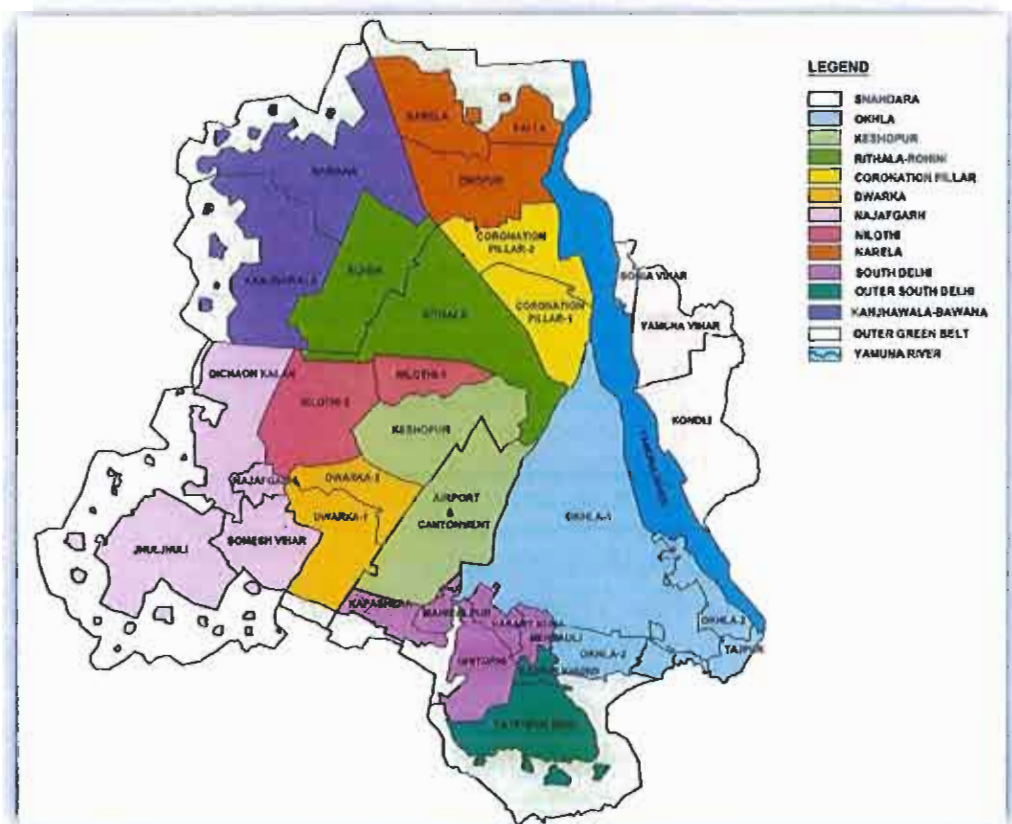


Figure 8.2: Proposed Sub-Drainage Zones – NCT Delhi

The following **Table 8.1** describes in detail the proposed delineated zones and sub zones. Each sub zone has been delineated based upon the wastewater generation from the sub zone and existing/proposed WWTP/WWPS capacity. The catchment for each sub zone has also been described below in the table.

Table 8.1: Proposed Drainage Zones – NCT Delhi

Sl. No.	Drainage Zone	Sub Drainage Zone
Zone 1	Shahadra (SHD)	Yamuna Vihar (YV)
		Sonia Vihar (SV)
		Kondli (KN)
Zone 2	Okhla (OKH)	Okhla (OK)
		Tajpur (TP)
Zone 3	Keshopur (KSP)	Keshopur (KP)
Zone 4	ROHINI-RITHALA (RR)	Rithala (RT)
		Rohini (RH)
Zone 5	CORONATION PILLAR (COR)	Coronation Pillar (CP-1)
		Coronation Pillar (CP-2)
Zone 6	DWARKA (DWK)	Dwarka (DK-1)
		Dwarka (DK-2)
Zone 7	NAJAFGARH (NJF)	Najafgarh (NJ)
		Jhuljhuli (JH)
		Dhichaon kalan (DK)
		Somesh Vihar (SV)
Zone 8	NILOTHI (NLT)	Nilothi (NT-1)
		Nilothi (NT-2)
Zone 9	NARELA (NRL)	Narela (NR)
		Palla (PL)
		Zindpur (ZP)
Zone 10	SOUTH DELHI (SD)	Mahrauli (MH)
		Vasant Kunj (VK)
		Ghitorni (GH)
		Mahipalpur (MP)
		Kapashera (KH)
Zone 11	OUTER SOUTH DELHI (OSD)	Fatehpurberi and Chandanhola (FC)
		Rajpur Khurd (RK)
Zone 12	KANJHAWALA-BAWANA (KB)	Kanjhawala (KJ)
		Bawana (BW)

8.2 ZONE WISE WASTEWATER GENERATION

The zones have been primarily delineated based on the wastewater generation from each zone/sub zone, the capacity of existing WWTP/s & WWPS/s and land availability for any additional WWTP/WWPS, if required. This section presents the sewage flow for each drainage/sub drainage zone for the various planning scenarios. The estimated flows are based on the population projection as described in Chapter 5 and the set of recommended unit flow are based on the design guidelines as described in Chapter 6.

The population of NCT Delhi has been projected using DDA's zones and census data in Chapter 5 and distribution of projected population is done by correlating the proposed Drainage Zones with DDA Zone map (as shown in **Figure 8.3** below) for data integration purposes such as computing population density, projecting population figures for each zone, understanding the land use pattern in each zone etc. **Table 8.2** below describes the quantum of wastewater generation from each drainage zone.

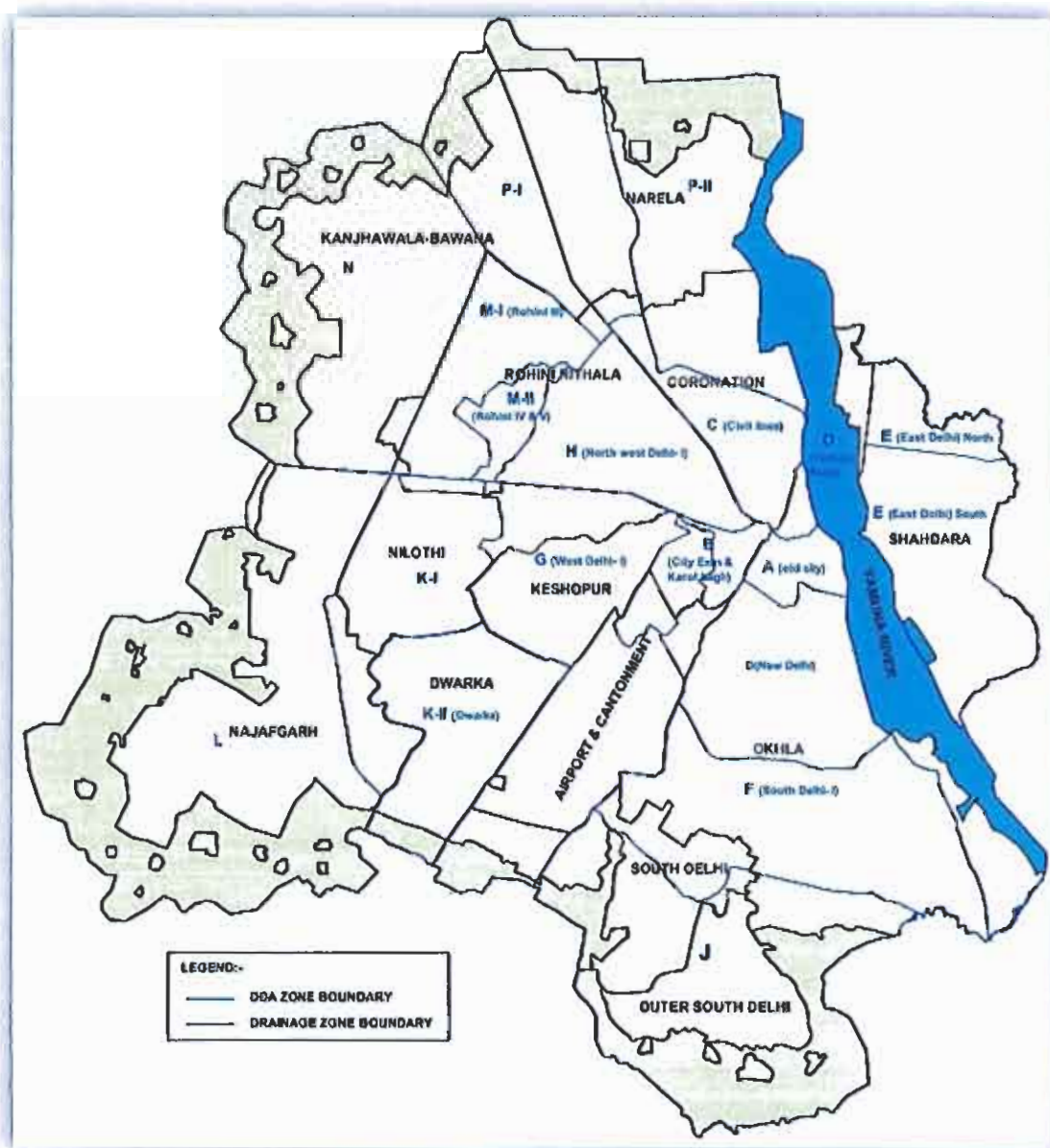


Figure 8.3: Drainage Zone and DDA Zone Boundary

Table 8.2: Zone wise Estimated Wastewater Generation of NCT of Delhi

Sl. No.	Drainage Zone	Waste Water Generation (MGD)		
		2011	2021	2031
1	Shahdara	110.0	126.0	142
2	Okhla	137.0	162.0	187
3	South Delhi	23.0	34.0	40.4
4	Outer South Delhi	10.0	20.0	49.2
5	Narela	26.0	42.7	59.3
6	Coronation	55.0	67.5	79.9
7	Najafgarh	43.0	65.3	87.5
8	Nilothi	45.0	52.8	60.66
9	Kanjhawala-Bawana	35.5	69.6	103.6
10	Rohini-Rithala	95.0	107.5	120
11	Dwarka	38.4	49.2	60
12	Keshopur	62.0	67.0	72
TOTAL (MGD)		679.9	863.4	1,061.6

Note: The wastewater generation as shown in the table includes estimation of sewage generation for sewerage areas based on zonal PPH, existing plant capacities, their utilization and integration with sewage generation from unsewered areas.

Table 8.3: Details and Phasing for proposed WWTPs

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP Location	Existing/ UC/ Planned by DJB WWTP Capacity (MGD)	Proposed WWTP Under SMP-2031		
					As per Present Habitation Occupancy		As per DDA- 2021
					Phase-I MGD	Phase-II MGD	Phase-III MGD
1	SHAHDARA	KN	Kondli	90			
		YV	Yamuna Vihar	45			
		SV	Sonia Vihar		7		
2	OKHLA	OK	Okhla	170			
		TP	Tajpur		10	7	
3	SOUTH DELHI	MH	Mehrauli	5			
		KH	Kapashera	5			6.4
		VK	Vasant Kunj	5			
		GH	Ghitorni	5		9	
		MH	Mahipalpur		3	2	
4	OUTER SOUTH DELHI	FC	Fatehpurberi and Chandanhola		5	5	29.2
		RK	Rajpurkhurd		5	5	
5	NARELA	NR	Narela	10			10
		PL	Palla		6		
		ZP	Zindpur		10	5	18.3

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP	Existing/ UC/ Planned by DJB WWTP Capacity	Proposed WWTP Under SMP-2031		
					As per Present Habitation Occupancy		As per DDA-2021
			Location	(MGD)	Phase-I MGD	Phase-II MGD	Phase-III MGD
6	CORONATION PILLAR	COR1	Coronation Ph I, II & III	40			
			Timarpur	6			
		COR2	Coronation Ph IV	40			
7	NAJAFGARH	NJF	Najafgarh	5			3
		DK	Tikri Kalan		2.7	2.0	7.3
			Mit Rao		5.6	3.5	
			Dichaon Kalan		5.6	4.0	
		JH	Kazipur		1.1	1.0	4.6
			Khera Dabar Extn		0.9	1.0	
			Shikarpur		0.6	0.5	
			Zafarpur		1.1	1.0	
			Samaspur Khalsa		2.2	1.0	
			Pandwala Kalan		2.2	1.0	
			Jhul Jhuli		2.8	1.0	
			Rawta Village		0.8	1.0	
		SV	Tajpur Khurd		8.0	4.0	5.1
			Goyala vihar		2.5	2.0	
			Badu Sarai		1.4	2.0	
8	NILOTHI	Nilothi-2	Nilothi	60			
			Bakkarwala	0.66			
9	KANJHAWALA-BAWANA	Bawana	Katewara		2.6	2	15
			Daryapur		1.7	2	
			Bawana Village		2.8	2	
			Sultanpur Dabbas		1	2	
			Pooth Khurd		3.8	2	
			Bankner		4.3	2	
			Bawana		9	2.8	
		Kanjhawala	Salahpur Majra		1	3	25.5
			Kanjhawala Village		6	5	
			Sawda Gaon		1.5	2	
			Ghewera		1.7	2.9	
10	ROHINI-RITHALA		Rithala	80			
			Rohini	15			25
11	DWARKA		Dwarka	40			20
12	KESHOPUR		Keshopur	72			
Sub-Total (MGD)				693.66	118.9	85.7	169.4

Sl. No.	Drainage Zone	Sub Drainage Zone	WWTP	Existing/ UC/ Planned by DJB WWTP Capacity	Proposed WWTP Under SMP-2031		
			Location		As per Present Habitation Occupancy		As per DDA-2021
					Phase-I MGD	Phase-II MGD	Phase-III MGD
Total Proposed Waste Water Treatment Capacity (MGD)					374.0		

Note: WWTP capacities and phasing for design year include Existing/ Planned WWTP capacities and proposed capacities for un-sewered areas as per SMP-2031. The constraints for finalization of capacities and phasing of WWTPs depends on habitation, land availability, implementation of DDA Master Plan and policy level decisions.

8.3 ZONE WISE PROPOSED SEWERAGE SCHEMES

Sewerage Schemes for various zones have been prepared considering the following aspects:

- Existing Sewerage Infrastructure
- Proposed Sewerage Infrastructure under various projects
- Development Plans for a particular area
- Population projections and amount of waste water generation
- Land availability for proposed sewerage infrastructure
- Site feasibility

A synopsis of each of the sewerage scheme for the 12 drainage zones is provided in **Table 8.4** below:

Table 8.4: Synopsis of the Sewerage Schemes for the Drainage Zones of NCT of Delhi

Drainage Zone	Proposed Scheme
Zone 1: Shahdara Drainage Zone (SHD)	The Sewerage Scheme of drainage zone is designed and planned with respect to the catchment of existing WWTP of Yamuna Vihar and Kondli. Planning also done using proposed interceptor sewer line and existing Wazirabad Road Sewer (WRS) line in drainage zone. A WWTP is proposed for Sonia Vihar catchment.
Zone 2: Okhla Drainage Zone (OKH)	The sewage generated from the unsewered catchment has been proposed to cater to existing Okhla WWTP and Molarband WWTP. Another WWTP has been proposed at Tajpur.
Zone 3: Keshopur Drainage Zone (KSP)	This drainage zone is mostly sewered discharging sewage to the Keshopur WWTP via existing Pumping stations. The unsewered pockets are proposed to be integrated to the existing sewer lines discharging to existing WWTP.
Zone 4: Rohini-Rithala Drainage Zone (RR)	The sewage generated from unsewered pockets in Rohini Catchment has been proposed to cater to existing Rohini WWTP. The sewage generated from Rithala Catchment has been proposed to discharge to existing sewerage infrastructure.

Drainage Zone	Proposed Scheme
Zone 5: Coronation Pillar Drainage (COR)	The entire unsewered catchment of Drainage Zone convey sewage to the proposed 111 MGD capacity WWPS and proposed sewer under Interceptor Sewer Project. The wastewater from 111 MGD pumping station will finally discharge to existing Coronation Pillar WWTP. Proposed interceptor sewer has been utilized while integrating with proposed infrastructure.
Zone 6: Dwarka Drainage Zone (DWK)	The scheme for Dwarka Drainage Zone is proposed with integration to the existing sewerage Infrastructure.
Zone 7: Najafgarh Drainage Zone (NJF)	Integration of existing sewerage infrastructure is proposed for the unsewered areas. The remaining unsewered areas within the drainage zone has been planned & designed.
Zone 8: Niloti Drainage Zone (NLT)	The Sewerage Scheme of drainage zone is designed and planned with respect to the catchment of existing WWTP of Niloti. Proposed interceptor sewer has been utilized while integrating with proposed infrastructure.
Zone 9: Narela Drainage Zone (NRL)	The scheme has been proposed to divert flows from this zone to existing Narela WWTP of 10 MGD capacity. The sewage generated through unsewered catchment is planned to discharge to the proposed two WWTPs in the Sub Drainage Zone at Palla and Zindpur.
Zone 10: South Delhi Drainage Zone (SD)	Sewage from Mahipalpur Sub Drainage zone has been planned to convey towards proposed WWTP. The sewage generated from Ghitorni Catchment has been planned to discharge to existing WWTP of 5 MGD. The sewage generated from Mehrauli Catchment has been planned with respect to the existing WWTP of 5 MGD in the Sub Drainage Zone. Sewage generated from Vasant Kunj Sub Drainage Zone is being conveyed to existing Vasant Kunj WWTP. Sewage from Kapashera Sub Drainage zone has been planned to convey towards WWTP at Kapashera.
Zone 11: Outer South Delhi Drainage Zone (OSD)	The Sewerage Scheme has been planned and designed for this drainage zone. Two WWTPs are proposed to cater the sewage flow generated from this drainage zone.
Zone 12: Kanjhawala-Bawana (KB)	The sewage generated from Bawana & Kanjhawala Catchment has been planned to cater proposed WWTPs in this drainage zone.

The SMP Final Report has been framed as the key submission of the study comprising approach and methodology, population projections, review & analysis of existing and planned sewerage infrastructure, planning for proposed sewerage schemes with integration approach, outcome of feasibility study and cost estimates to arrive at implementation & investment plans.

The overall report has been formulated in six (6) volumes. Volume I covers Executive summary whereas Main Report is covered under Volume II. The full development of separate sewerage schemes for various drainage zones of NCT of Delhi are attached as Annexure 1 to 12 in Volumes III, IV and V. Volume VI represents Maps for Drainage Zone wise proposed infrastructure, unsewered areas of Delhi as per Group of Colonies (GOCs) and Map for overall proposed infrastructure comprising Schemes and Drainage Zones.

The structure of Master Plan Report is represented as follows:

VOLUME – I	EXECUTIVE SUMMARY
VOLUME – II	MAIN REPORT
VOLUME – III	ANNEXURE (1 TO 4)
	ANNEXURE - 1 Shahdara Drainage Zone (SHD)
	ANNEXURE - 2 Coronation Pillar Drainage (COR)
	ANNEXURE - 3 Narela Drainage Zone (NRL)
	ANNEXURE - 4 Rohini-Rithala Drainage Zone (RR)
VOLUME – IV	ANNEXURE (5 TO 8)
	ANNEXURE - 5 Kanjhawala-Bawana (KB)
	ANNEXURE - 6 Keshopur Drainage Zone (KSP)
	ANNEXURE - 7 Nilothi Drainage Zone (NLT)
	ANNEXURE - 8 Dwarka Drainage Zone (DWK)
VOLUME – V	ANNEXURE (9 TO 12)
	ANNEXURE - 9 Najafgarh Drainage Zone (NJF)
	ANNEXURE - 10 Okhla Drainage Zone (OKH)
	ANNEXURE - 11 South Delhi Drainage Zone (SD)
	ANNEXURE - 12 Outer South Delhi Drainage Zone (OSD)
VOLUME – VI	MAPS
	1. Twelve Drainage Zones of Delhi
	2. Sub-Drainage Zones
	3. Proposed Infrastructure for Shahdara Drainage Zone
	4. Proposed Infrastructure for Coronation Pillar Delhi Drainage Zone
	5. Proposed Infrastructure for Narela Drainage Zone
	6. Proposed Infrastructure for Rohini-Rithala Drainage Zone
	7. Proposed Infrastructure for Kanjhawala-Bawana Drainage Zone
	8. Proposed Infrastructure for Keshopur Drainage Zone
	9. Proposed Infrastructure for Nilothi Drainage Zone
	10. Proposed Infrastructure for Dwarka Drainage Zone
	11. Proposed Infrastructure for Najafgarh Drainage Zone
	12. Proposed Infrastructure for Okhla Drainage Zone
	13. Proposed Infrastructure for South Delhi Drainage Zone
	14. Proposed Infrastructure for Outer South Delhi Drainage Zone
	15. Delhi Sewerage Master Plan - 2031

8.4 SEWERAGE MANAGEMENT REGULATIONS & DEVELOPMENT CONTROLS

The aim of this Plan is to ensure waste water conveyance systems and treatment meets acceptable environmental and health performance standards.

Specific objectives of sewerage management include the following:

- I. **Prevention of public health risk** – Sewage contains bacteria, viruses, parasites and other disease-causing organisms. Contact with effluent should be minimized or eliminated, particularly for children. Insects can also act as vectors for disease where they have access to effluent. Residuals, such as composted material, should be handled carefully. Treated sewage should not be used on edible crops that are consumed raw. Treated sewage should be disposed in a safe manner. There should be no flooding of sewage water on ground.

- II. **Protection of surface water** – Surface waters should not be contaminated by any flow from conveyance/ treated systems and land application areas (including effluent, rainfall run-off and contaminated groundwater flow).
- III. **Protection of groundwater** – Groundwater should not be contaminated by any flow from the conveyance systems/ treatment systems or land application areas.
- IV. **Protection of land** – The land should not be contaminated by any flow from treated systems, effluent, rainfall run-off or contaminated groundwater flow.
- V. **Conservation and reuse of resources** – The resources in domestic wastewater (including nutrients, organic matter and water) should be identified and utilised as much as possible within the bounds posed by the other performance objectives; water conservation should be practised and wastewater production should be minimized.
- VI. **Protection of community amenity** – Such plans and regulations should enhance the local amenity – special consideration should be given to aesthetics, odour, dust, vectors and excessive noise.

To achieve above mentioned objectives the competent authorities shall handle the following matters:

1. Set up the development policies and schemes for the Sewer.
2. Set up the Sewerage rules and regulations and examine compliance.
3. Review and examine the development plan for the Sewerage system in Delhi.
4. Monitor and supervise the construction, management, and development for the Sewerage system in municipality and Delhi.
5. Administration of technique and the training of the Sewer operation and maintenance people.
6. Research and develop the sewerage techniques.
7. Coordinate the structure, construction and management of the Sewers in situations of multi-municipality and city.
8. Promote measures for conservation, recycling and reuse of water.

8.5 IMPLEMENTATION AND INVESTMENT PLANS

8.5.1 Implementation Plan

Tentative Implementation Plan has been prepared for proposed sewerage schemes as represented below in **Table 8.5**

Table 8.5: Implementation Plan for proposed sewerage schemes

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
SHD	Yamuna Vihar	YV1	SHD-YV1-KP	Kardampuri GOC				
SHD	Yamuna Vihar	YV1	SHD-YV1-BM	Buland Masjid				
SHD	Yamuna Vihar	YV1	SHD-YV1-WJN	West Jyoti Nagar				
SHD	Yamuna Vihar	YV2	SHD-YV2-Z1	YV2Z1 Part of Karawal Nagar				
SHD	Yamuna Vihar	YV2	SHD-YV2-Z2	YV2Z2 Part of Mustafabad				
SHD	Yamuna Vihar	YV3	SHD-YV3	SHD YV3 Part of Saboli				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
SHD	Yamuna Vihar	YV3	SHD-YV3-P2	SHD-YV3 Phase-II				
SHD	Sonia Vihar	SV	SHD-SV	Sonia Vihar GOC				
SHD	Kondli	KN1	SHD-KN1-SG	Shashi Garden				
SHD	Kondli	KN1	SHD-KN1-RG	Rani Garden				
SHD	Kondli	KN1	SHD-KN1-WVN	West Vinod Nagar				
SHD	Kondli	KN1	SHD-KN1-SM	Shanti Muhalla				
SHD	Kondli	KN1	SHD-KN1-MS	Makki Sarai				
SHD	Kondli	KN1	SHD-KN1-JC	Janta Colony				
SHD	Kondli	KN2	SHD-KN2	Kondli GOC				
SHD	Yamuna Vihar	YV1	SHD-YV1-AN	Ashok Nagar				
OKH	Okhla	OK2	OKH-OK2-BHP1	Batla House Phase I				
OKH	Okhla	OK2	OKH-OK2-BHP2	Batla House Phase II				
OKH	Okhla	OK2	OKH-OK2-SB	Shaheen Bagh				
OKH	Okhla	OK2	OKH-OK2-MSJ	Maidangarhi & Saidullajab				
OKH	Okhla	OK2	OKH-OK2-MSJ2	Maidangarhi Phase II				
OKH	Okhla	OK2	OKH-OK2-TKD	Tuglakabad				
OKH	Okhla	OK2	OKH-OK2-SVP1	Sangam Vihar GOC Ph I				
OKH	Okhla	OK2	OKH-OK2-SVP2	Sangam Vihar GOC Ph II				
OKH	Okhla	OK2	OKH-OK2-PP	Pulprehladpur				
OKH	Okhla	OK2	OKH-OK2-MK	Madanpur Khadar				
OKH	Okhla	OK2	OKH-OK2-ALI	Aligaon				
OKH	Okhla	OK2	OKH-OK2-GA	Gautampuri Awas				
OKH	Okhla	OK2	OKH-OK2-MN	Malviya Nagar GOC				
OKH	Tajpur	OK2	OKH-OK2-TP	Tajpur GOC				
COR	Coronation Pillar	CP2	Cor-CP2-SP	Samaypur GOC				
COR	Coronation Pillar	CP2	Cor-CP2-WB	Wazirabad GOC				
COR	Coronation Pillar	CP2	Cor-CP2-BL	Bhalaswa GOC				
COR	Coronation Pillar	CP2	Cor-CP2-SRP	Saroop Nagar GOC				
COR	Coronation Pillar	CP2	COR-CP2-SNT	Sant Nagar GOC				
COR	Coronation Pillar	CP2	Cor-CP2-GV	Gandhi Vihar				
COR	Coronation Pillar	CP2	Cor-CP2-GP	Gopalpur				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
NRL	Narela	NR	NRL-NR-SNG	Singhu				
NRL	Narela	NR	NRL-NR-HKB	Hamidpur, Khampur, Bakholi				
NRL	Narela	NR	NRL-NR-KU	Kureni GOC				
NRL	Palla	PL	NRL-PL	Palla GOC				
NRL	Palla	PL	NRL-BKP	Bakhtawar GOC				
NRL	Zindpur	ZP	NRL-ZP	Zindpur GOC				
SD	Mahrauli	MH	SD-MH	Mehrauli				
SD	Mehrauli	MH	SD-MH-CM	Chhatarpur Village and Manglapuri				
SD	Ghitorni	GH	SD-GH	Ghitorni				
SD	Mahipalpur	MP	SD-MP	Mahipalpur				
SD	Ghitorni	GH	SD-GH-AN	Ayanagar GOC				
SD	Kapashera	KH	SD-KH-BWE	Bijwasan				
SD	Kapashera	KH	SD-KH	Kapashera GOC				
SD	Vasantkunj	VK	SD-VK-KG	Kishangarh				
OSD	Fatehpurberi	FC	OSD-FB	Fatehpurberi GOC				
OSD	Rajpurkhurd	RK	OSD-RK	Rajpur Khurd GOC				
DWK	Dwarka	DK2	DWK-DK2-ME	Mahaveer Enclave GOC				
DWK	Dwarka	DK2	DWK-DK2-VM	Vijay Enclave Mahaveer Vihar				
DWK	Dwarka	DK2	DWK-DK2-KGC	Kakrola GOC				
DWK	Dwarka	DK2	DWK-DK2-SC	Sitapuri II, Chanakya Place II				
DWK	Dwarka	DK2	DWK-DK2-BP	Bindapur GOC				
DWK	Dwarka	DK2	DWK-DK2-MV	Madhu Vihar GOC				
DWK	Dwarka	DK2	DWK-DK2-SAD	Sadh Nagar				
DWK	Dwarka	DK2	DWK-DK2-IP	Indra Park				
DWK	Dwarka	DK2	DWK-DK2-DV	Dabri Village				
DWK	Dwarka	DK2	DWK-DK2-SM	Shahbad Mohdpur				
DWK	Dwarka	DK2	DWK-DK2-RN	Raj Nagar Ext				
DWK	Dwarka	DK2	DWK-DK2-BWW	Bijwasan West				
DWK	Dwarka	DK2	DWK-DK2-SN	Sainik Nagar GOC				
DWK	Dwarka	DK2	DWK-DK2-NPB	Nala Par Basti				
DWK	Dwarka	DK2	DWK-DK2-PP	Pochanpur				
DWK	Dwarka	DK2	DWK-DK2-RGN	Raghu Nagar				
DWK	Dwarka	DK2	DWK-DK2-TP	Toganpur				
RR	Rithala	RT1	RR-RT1-SN	Sanjay Nagar				
RR	Rithala	RT2	RR-RT2-BV	Budh Vihar GOC				

D Zone	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-2021	2022-2027	2027-2031
RR	Rithala	RT3	RR-RT2-RP	Rajdhani Park				
RR	Rohini	RH2	RR-RH2-KI	Kirari GOC				
RR	Rohini	RH2	RR-RH2-BP	Begumpur GOC				
RR	Rohini	RH2	RR-RH2-SB	Sahibabad GOC				
RR	Rohini	RH2	RR-RH2-RV	Raja Vihar				
KB	Kanjhawala	KJ	KB-KJ-SM	Salahpur Majra GOC				
KB	Kanjhawala	KJ	KB-KJ-KV	Kanjhawala GOC				
KB	Kanjhawala	KJ	KB-KJ-NP	Nizampur GOC				
KB	Kanjhawala	KJ	KB-KJ-GV	Ghwera GOC				
KB	Bawana	BW	KB-BW-BP	Baljitpur GOC				
KB	Bawana	BW	KB-BW-PK	Pooth Khurd GOC				
KB	Bawana	BW	KB-BW-ST	Sanooth GOC				
KB	Bawana	BW	KB-BW-NB	Nayabans GOC				
KSP	Keshopur	KP2	KSP-KP2-BN	Bhupinder Singh Nagar Group of Colonies				
NLT	Nilothi	NT2	NLT-NT2-KMR	Kamruddin Nagar				
NLT	Nilothi	NT2	NLT-NT2-MG	Mohan Garden				
NLT	Nilothi	NT2	NLT-NT2-VP	Vikaspuri				
NLT	Nilothi	NT2	NLT-NT2-UV	Uday Vihar				
NLT	Nilothi	NT2	NLT-NT2-SE	Shiv Enclave, Nilothi				
NLT	Nilothi	NT2	NLT-NT2-NNR	NNR Trunk Sewer				
NLT	Nilothi	NT2	NLT-NT2-NV	Nihal Vihar				
NLT	Nilothi	NT2	NLT-NT2-RN	Ranhola GOC				
NJF	Najafgarh	NJ	NJF-NJ-IP	Prem Nagar GOC				
NJF	Jhuljhuli	JH	NJF-JH	Jhuljhuli Village GOC				
NJF	Dichaon kalan	DK	NJF-DK	Dichaon Kalan GOC				
NJF	Dichaon kalan	DK	NLT-DK-TK	Tikri Kalan GOC				
NJF	Somesh Vihar	SV	NJF-SV	Somesh Vihar GOC				

8.5.2 Investment Plan

Cost estimates have been prepared for provision of sewerage facilities for unsewered areas in NCT of Delhi. Total Investment anticipated for stipulated sewerage assets is INR 19500 Crores. Summary of the cost estimates prepared is listed in **Table 8.6**.

Table 8.6: Summary of Cost Estimates for proposed sewerage schemes

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Yamuna Vihar (20 + 25 TBC by June 2014)	-	-	Kardampuri GOC	14.5	HDPE				
			Buland Masjid	1.9	HDPE	Buland Masjid	LS	1.5	2.30
			West Jyoti Nagar	1.5	HDPE				
			YV2Z1 Part of Karawal Nagar	112.2	HDPE				
			YV2Z2 Part of Mustafabad	97.8	HDPE				
			SHD YV3 Part of Saboli	55.4	HDPE	Milan Garden	LS	0.3	0.34
Sonia Vihar (0 +7)	7	44.38				Meet Nagar	LS	1.3	0.97
						Saboli	LS	0.5	0.67
			SHD-YV3 Phase-II	11.8	HDPE	Harsh Vihar	WWPS	4.0	11.17
			Ashok Nagar	4.3	HDPE				
			Sonia Vihar GOC	77.6	DWC	Sonia Vihar	WWPS	4.3	10.97
						Rajiv Nagar	WWPS	12.0	11.50
Kondli (90 + 0)	-	-				Bediabad	LS	1.5	0.73
			SHASHI GARDEN	0.5	HDPE				
			RANI GARDEN	1.6	HDPE				
			WEST VINOD NAGAR	5.5	HDPE				
			Shanti Muhalla	1.0	HDPE				
			MAKKI SARAI	0.7	HDPE	Makki Sarai	LS	0.1	0.40
			Janata Colony	0.6	DWC	Janata Colony	LS	0.5	0.64
			Kondli GOC	48.5	HDPE				

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Coronation Pillar 40 MGD existing (10 MGD Reconstruction already planned) + 40 (Already planned) + 6 at Timarpur	-	-	Samaypur GOC	109.1	HDPE				
			Wazirabad GOC	70.1	HDPE				
			Bhalaswa GOC	25.9	HDPE				
			Saroop Nagar GOC	140.4	DWC	Gurunank Dev Colony	WWPS	14.0	17.00
						Amrit Vihar	WWPS	5.0	8.41
Narela (10 + 10)	10	63.40				Burari	WWPS	3.0	7.97
						Ajit Vihar	LS	1.5	0.86
			Sant Nagar GOC	225.2	DWC				
			Gandhi Vihar	3.7	DWC	Gandhi Vihar	WWPS	2.0	6.72
			Gopalpur	3.7	HDPE				
Palla (0 + 6)	6	38.04	Singhu	5.4	DWC	Singhu	WWPS	1.0	6.86
			Hamidpur, Khampur, Bakholi	30.8	DWC	Hamidpur	WWPS	1.5	8.03
						Khampur	WWPS	1.0	6.91
						Bhakoli	WWPS	2.0	10.35
			Kureni GOC	55.9	HDPE	Shahpur Garhi	LS	0.5	1.14
Zindpur (0 + 33.3)	33.3	211.13	Palla GOC	22.4	DWC	Tajpur Kalan	WWPS	1.5	7.59
						Akbarpur	WWPS	3.0	8.77
						Jangola	LS	1.5	2.03
			Bakhtawarpur GOC	16.1	DWC	Bakhtawarpur	WWPS	8.0	8.96
			Zindpur GOC	154.7	DWC	Hiranki	WWPS	2.0	6.58
						Kadipur	WWPS	7.0	16.36
						Zindpur	WWPS	22.0	14.88

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Okhla (170 + 0)	-		BATLA HOUSE P1	75.1	HDPE	Okhla Vihar	WWPS	4.0	11.05
						Harkesh Nagar	WWPS	2.0	5.64
			BATLA HOUSE P2	53.9	HDPE	Batla House Ph 2	WWPS	8.0	17.30
			SHAHEEN BAGH	54.6	HDPE				
			MAIDANGARHI & Saidullajab	79.9	HDPE				
			MAIDANGARHI II	40.47	DWC	Sainik Farm 1	LS	0.3	0.34
						Sainik Farm 2	LS	0.3	0.50
			TUGLAKABAD	21.8	DWC	Tuglakabad Fort	WWPS	4.5	10.27
			SANGAM VIHAR GOC Ph I	166.7	DWC				
			SANGAM VIHAR GOC Ph II	227.7	DWC				
			PULPEHLADPUR	43.4	HDPE				
			MADANPUR KHADAR	35.8	DWC	Madanpur Khadar	WWPS	10.5	23.39
			ALI GAON	22.1	DWC	Aligaon	LS	0.5	0.67
			GAUTAMPURI AWAS	14.9	HDPE				
			Malviya Nagar GOC	13.0	DWC				
			TAJPUR GOC	286.3	DWC	Tajpur	WWPS	39.0	55.00
Tajpur (0 + 17)	17	107.78				Jaitpur	WWPS	9.0	10.64
Mehrauli (5 + 0)	-		Mehrauli	66.9	HDPE	Meethapur	LS	4.0	7.96
			Chhatarpur Village & Manglapuri	12.8	DWC	Lado Sarai	WWPS	2.5	10.41
Vasant Kunj (5 + 0)	-		Kishangarh GOC	1.53	DWC				

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Ghitorni (5 + 9)	9	57.06	Ghitorni	41.4	HDPE	Rangpuri Pahari	LS	1.0	0.71
						Ghitorni	WWPS	8.0	7.87
			Ayanagar GOC	45.0	DWC	Aya Nagar LS	LS	0.5	0.38
						Aya Nagar WWPS	WWPS	5.0	15.97
						Gadaipur WWPS	WWPS	2.5	11.17
Mahipalpur (0+5)	5	31.70	Mahipalpur GOC	43.0	DWC	Rangpuri	WWPS	5.0	7.64
Kapashera (5 + 6.4)	6.4	40.58	Bijwasan	7.52	DWC	Bijwasan	WWPS	3.0	12.05
			Kapashera GOC	29.9	DWC	Salahpur Khera	LS	0.5	1.41
Nilothe (40 + 20 U/C)	-		Kamruddin Nagar	76.4	DWC	Kamruddin Nagar	WWPS	5.5	9.69
			Mohan Garden	203.0	HDPE				
			Vikaspuri	104.7	HDPE				
			Uday Vihar	16.6	DWC				
			Shiv Enclave, Nilothe	57.3	DWC				
			NNR Trunk Sewer	29.4	HDPE				
			Nihal Vihar	103.7	HDPE				
			Ranholi GOC	239.5	DWC	Baprola	WWPS	10.0	19.64
Dwarka (20 + 20 U/C + 20 Pr.)	20	126.80	Mahaveer Enclave GOC	64.4	HDPE				
			Vijay Enclave Mahaveer Vihar	-	HDPE				
			Kakrola GOC	69.4	DWC				
			Sitapuri II, Chanakya Place II	6.9	HDPE				

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
			Bindapur GOC	28.7	HDPE				
			Madhu Vihar GOC	61.3					
			Sadh Nagar	11.4	DWC				
			Indra Park	8.7	DWC				
			Dabri Village	29.3	DWC				
			Shahbad Mohdpur	13.0	DWC	Shahbad Mohdpur	LS	2.0	0.97
			Raj Nagar Ext	38.9	DWC				
			Bijwasan West	7.5					
			Sainik Nagar GOC	24.2	DWC				
			Nala Par Basti	2.1	DWC				
			Pochanpur	9.9	DWC				
			Raghu Nagar	16.6	DWC				
			Toganpur	0.7	DWC				
	Rithala (80 + 0)	-		Sanjay Nagar	1.2	HDPE			
			Budh Vihar GOC	94.4	HDPE				
			Rajdhani Park	12.1	HDPE				
Rohini (15 + 25)	25	158.50	Kirari GOC	270.4	DWC	Rasulpur	LS	1.5	1.28
						Pratap Vihar	WWPS	41.0	76.78
						Prem Nagar	WWPS	6.5	9.75
						Bhagya Vihar	WWPS	9.0	19.96
			Begumpur GOC	158.0	DWC				

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Fatehpurberi & Chandanhola (0 + 39.2)			Sahibabad GOC	51.6	DWC	Shiv Vihar	LS	1.5	0.83
						Sector 27	WWPS	2.0	7.87
						Jain Colony	WWPS	1.5	6.94
			Raja Vihar	4.7	DWC	Raja Vihar	WWPS	1.5	7.49
	39.2	248.53	Fatehpurberi & Chandanhola	90.8	DWC	Jaunapur LS 1	LS	0.5	0.73
						Mandi LS 2	LS	0.5	0.94
						Mandi LS 3	LS	0.5	1.07
						Bhati Mines LS 4	LS	0.2	0.33
						Sanjay Nagar LS 5	LS	0.2	0.34
						Jaunapur PS 1	WWPS	3.0	9.63
						Chandanhola PS 2	WWPS	7.0	17.05
						Asola PS 3	WWPS	6.0	12.25
						Gwal Pahari PS 4	WWPS	2.0	7.40
						Dera PS 5	WWPS	3.5	10.22
Rajpurkhurd (0 + 10)	10	63.40	Rajpurkhurd	66.2	DWC	Bhati Mines PS 6	WWPS	2.5	9.29
						Sanjay Colony PS 7	WWPS	1.0	9.59
Keshopur (72 + 0)	-		Bhupinder Singh Nagar GOC	4.5	HDPE	Chattarpur Enclave	WWPS	8.0	12.33
Kanjhawala (0 + 55)	55	387.06	Salahpur Majra GOC	19.9	DWC	Rajpurkhurd	WWPS	10.0	11.74
			Kanjhawala GOC	148.7	DWC				
						Salahpur Majra	WWPS	8.0	
						Kanjhawala Village	WWPS	22.0	

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Packaged Plants with integrated Terminal WWPS			Nizampur GOC	19.2	DWC	Sawda Gaon	WWPS	7.0	
			Ghewra village	20.3	DWC	Ghewera WWPS	WWPS	9.0	
Bawana (0 + 48.6) Packaged Plants with integrated Terminal WWPS	48.6	339.79	Baljitpur GOC	64.5	DWC	Katewara	WWPS	9.0	
						Daryapur	WWPS	8.0	
			Pooth Khurd GOC	75.4	DWC	Bawana PS	WWPS	10.0	
						Bawana LS	LS	1.5	0.82
						Sultanpur Dabbas	WWPS	6.0	
						Pooth Khurd	WWPS	12.0	
			Sanooth & Nayabans GOC	128.0	DWC	Vishal Enclave	LS	1.5	0.87
						Bankner	WWPS	13.0	
Najafgarh (5 + 3)	3	19.02				Sanooth	WWPS	10.0	17.94
						Homabi kalan	WWPS	7.0	16.52
						Kher Khurd	WWPS	5.0	14.39
			Prem Nagar	82.2	DWC				
Jhuljhuli (0 + 26.5) Packaged Plants with integrated Terminal WWPS	26.5	186.49	Jhuljhuli	372.3	DWC	Kazipur	WWPS	5.0	
						Khera Dabar Extn	WWPS	5.0	
						Shikarpur	WWPS	3.0	
						Zafarpur	WWPS	5.0	
						Samaspur Khalsa	WWPS	7.0	
						Pandwala Kalan	WWPS	7.0	
						Jhul Jhuli	WWPS	8.0	

Sub Zone & Treatment Capacity (Existing + Planned) (MGD)	WWTP		Gravity Sewerage			Pumping Stations			
	Proposed Capacity (MGD)	WWTP Cost (Cr.)	Scheme	Gravity Scheme Cost (Cr.)	Pipe Material	Location	Type	Capacity (MGD)	PS Cost (Cr.)
Dhichaon Kalan (0+28 MGD) Packaged Plants with integrated Terminal WW/PS	28	197.05	Dhichaon kalan GOC	422.3	DWC	Rawta Village	WWPS	4.0	
						Mitraon	WWPS	18.0	
						Dichaon Kalan	WWPS	19.0	
						Jharoda Kalan	LS	1.0	0.91
			Tikri Kalan GOC	82.0	DWC	Baba Haridas Nagar	LS	1.0	1.63
						Tikri Kalan	WWPS	10.0	
						Goyala vihar	WWPS	9.0	
						Badu Sarai	WWPS	6.0	

Total investment of project as evaluated on present basis = INR 10,077 Crores

Break Up of the sewerage infrastructure with following assumptions.

Sl. No.	Item	Cost in INR Crores								
1	Sewerage Network <table border="1"><tr><td>Trunk Sewer (km)</td><td>210</td></tr><tr><td>Peripheral Sewer (km)</td><td>2090</td></tr><tr><td>Internal Sewer (km)</td><td>7507</td></tr><tr><td>Total Network Length (km)</td><td>9807</td></tr></table>	Trunk Sewer (km)	210	Peripheral Sewer (km)	2090	Internal Sewer (km)	7507	Total Network Length (km)	9807	6544
Trunk Sewer (km)	210									
Peripheral Sewer (km)	2090									
Internal Sewer (km)	7507									
Total Network Length (km)	9807									
2	Waste water pumping stations including Rising Mains and associated structures. Cost includes per year O&M and disposal arrangement of treated wastewater.	919								
3	Waste water treatment Plants for ultimate design year Total anticipated capacity : 374 MGD (1698 MLD)	2614								
	TOTAL INVESTMENT OF PROJECT (INR Cr.)	10,077								

Investment plan on five years incremental have been represented as below with escalation factor @ 8.5%.

Work booking factor has been estimated based on tentative implementation plan of prioritized projects.

Year	Work Booking factor	Anticipated Investment required (INR Cr)	Average escalations Year	Escalated Amount (INR Cr.)
Upto Yr 2016	0.15	1511.54	2	1,779.43
2016-21	0.45	4534.63	5	6,818.53
2022-2027	0.30	3023.09	11	7,416.14
2027-31	0.1	1007.70	15	3,425.91
TOTAL (INR Cr.)				19,440.00

Grand Total investment amount in INR: 19,440 (Say INR 19,500 Crores)

The Investment Plan in co-relation with implementation plan has been represented as below:

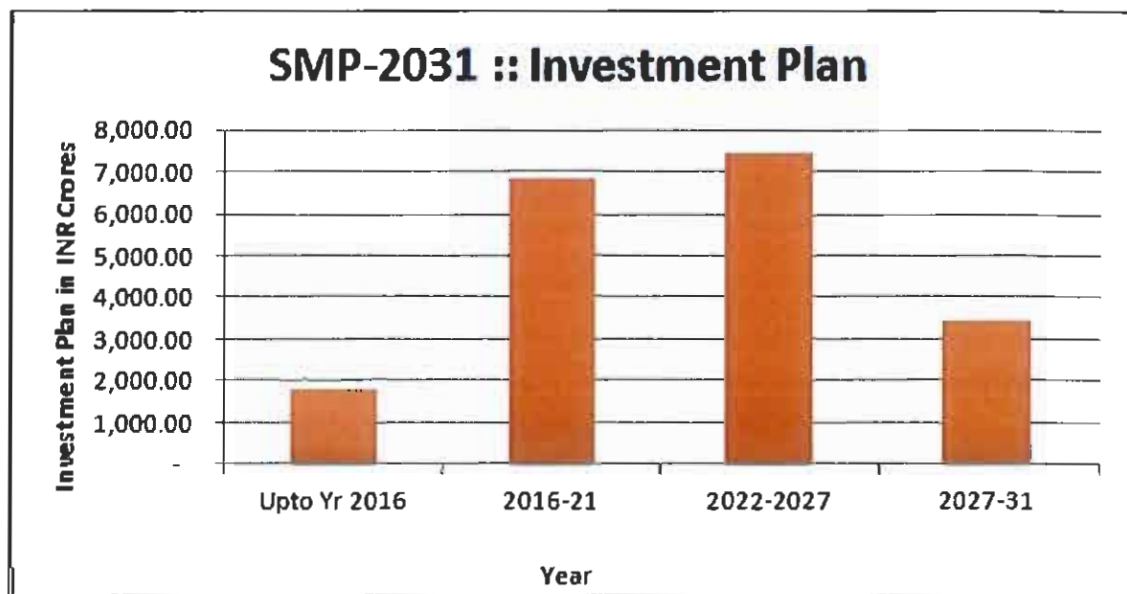


Figure 8.4: Investment Plan for proposed sewerage schemes

8.6 FINANCIAL MANAGEMENT PLAN

DWB Act mandates preparation of budget during each financial year. Budget is an official document annually prepared describing budget appropriation by budget account and service category. The budget is prepared in two parts mainly (i) Non Plan / Revenue budget (ii) Plan /Capital budget to separate operating expenses from capital expenses.

In this light, the annual Statement of Accounts comprising Income and Expenditure Account and Balance Sheet as well as Fund Flow Statement as a complementary document, are annually prepared, placed before Board for approval and after Board's approval, forwarded to the Government of NCT of Delhi. The accounts of the Board are audited annually by the Comptroller and Auditor General of India (CAG) and the audit report is laid before the Legislative Assembly of the National Capital Territory of Delhi.

DJB has introduced institutional and financial reforms and had switched over to Double Entry Accrual based accounting since 2003 – 04 vide the Board resolution in July 2004. DJB approved the revised formats as per the comments of the CAG in July 2005.

DJB has switched over to new online Financial management System w.e.f. 31/03/2013.

Income sources are governed by budgetary support and supplemented by various grants and subsidies. Expenses include those incurred on account of construction and rehabilitation works, operating and maintaining sewerage and water supply network in NCT of Delhi and expense on account of maintaining the routine staff for the same.

Heavy burden of accumulated debts and associated debt servicing, and its carrying over to the following years is a coherent feature and hence one of the major issues to be addressed for DJB's sound and sustainable financial management.

For sustainable Financial Management Plan the following key issues shall be addressed:

(i) budget structure and profitability, (ii) debt position to date, (iii) water and sewerage service cost recovery, (iv) policy implications drawn, and (v) accrual-based accounting system, followed by overview and discussions on the betterment (evolution) of the new pricing scheme. DJB Sewerage Charges are included in Water Bill (generally 60% of Water charges) however sewerage charges are seldom sufficient to cover the O&M cost of sewerage related activities. International Funding Institutions play a vital role in development of sewerage infrastructure in developing countries. The represented Investment Plan can be synchronized with the sanitation improvement funding plans with such IFIs to boost up implementation of sewerage schemes. The recovery on O&M side can be improved by implementing Reuse-Recycle of treated waste water for various direct non-potable uses.

8.7 OPERATION & MAINTENANCE PLANS

Municipal sanitary sewer collection and conveyance systems are an extensive, valuable and complex part of the city's infrastructure. The proper functioning of these wastewater systems is among the most important factors responsible for the general level of good health enjoyed in the city.

Wastewater systems are subject to a variety of operational problems. Depending on the wastewater flow characteristics, surrounding soils condition, and quality of construction, the pipeline can suffer from clogging, scouring, corrosion, collapse, and system's deterioration. The collection system is designed to serve for a specific useful life. Hence, it is necessary to provide adequate operation and maintenance to maximize the benefit throughout its designed useful life.

In the past, during the facility design/build phases, it was uncommon to devote substantial resources to life-cycle Operation and Maintenance (O&M) concerns. As such, even after creating such assets by investing millions of rupees, they were unable to provide the services effectively to the community for which they have been constructed, as they remain defunct or underutilized most of the time.

The lack of proper maintenance, in the past, had often resulted in deteriorated sewers, overflows, cave-ins, hydraulic overloads at treatment plants, and other safety, health, and environmental problems. As one of the most serious and environmentally threatening problems, sanitary sewer overflows are a frequent cause of water quality violations and are identified as a major threat to public health and water quality because of the pathogens, toxic pollutants and nutrients they contain and have become a focus of water quality regulators over the past several years.

However, it is now widely recognized that O&M represents the greatest expense in owning and operating a facility over its life cycle. The accuracy, relevancy, and timeliness of well-developed, user-friendly O&M manuals are increasingly recognized. Hence, it is becoming more common for detailed, facility-specific O&M manuals to be prepared prior to commissioning. The goal is to effectively and efficiently support the life cycle of the facility by eliminating unplanned shutdowns, deterioration of the useful life of systems causing premature replacement of many components, underutilization and realizing life-cycle cost savings.

Benefits of effective O&M program includes but not limited to:

- Ensuring the availability of facilities and equipment as intended
- Maintaining the reliability of the equipment and facilities as designed
- Maintaining the value of the investment
- Obtaining full use of the system throughout its useful life
- Collecting accurate information and data on which to base the O&M of the system
- Cost effectiveness in long as well as short term due to planned maintenance and repairs

Comprehensive facility O&M manuals should include:

- System-level O&M information:
 - Physical Descriptions
 - Functional Descriptions
 - Troubleshooting
 - Preventive Maintenance (Procedures and Schedules)
 - Corrective Maintenance (Repair Requirements)
 - Emergency Maintenance
 - Parts Lists
 - Operation-/Maintenance - Significant Drawings / diagrams
 - Safety Information
- Equipment-specific O&M information

The requirements for the Operations and Maintenance Program are:

- (a) Maintain up-to-date maps of the sanitary sewer system, showing all gravity line segments and manholes, pumping facilities, treatment facilities, pressure pipes and appurtenances.
- (b) Description of management of facilities, schedule of routine inspection, O&M
- (c) Description of response to accidents
- (d) Description of routine preventive O&M activities by staff and contractors, including a system for scheduling regular maintenance and cleaning of the sanitary sewer system with more frequent cleaning and maintenance targeted at known problem areas. The Preventive Maintenance (PM) program should have a system to document scheduled and conducted activities
- (e) Provision of contingency equipments to handle emergencies, and spare/replacement parts intended to minimize equipment and facility downtime.
- (f) Development of a rehabilitation and replacement plan to identify and prioritize system deficiencies and implement short-term and long-term rehabilitation actions to address each deficiency.

The program should include regular visual and TV inspections of manholes and sewer pipes, and a system for ranking the condition of sewer pipes and scheduling rehabilitation. Rehabilitation and replacement should focus on sewer pipes that are at risk of collapse or prone to more frequent blockages due to pipe defects. Finally, the rehabilitation and replacement plan should include a capital improvement plan that addresses proper management and protection of the infrastructure assets. The plan shall include a time schedule for implementing the short- and long-term plans plus a schedule for developing the funds needed for the capital improvement plan;

- (g) Description of O&M reporting, record keeping systems, inspection reporting systems
- (h) Allocation of adequate resources for the O&M works
- (i) Identification and prioritization of structural deficiencies and implementation of program of prioritized short-term and long-term actions to address them
- (j) Provision of training on a regular basis for staff in sanitary sewer system O&M and require contractors to be appropriately trained; and
- (k) Provide equipment and replacement part inventories, including identification of critical replacement parts.

8.8 PUBLIC AND PRIVATE PARTICIPATION PLANS: A UNIQUE APPROACH IN SEWERAGE SCHEME

Public-private partnerships (PPPs) are agreements between the public and private sectors for the provision of services or assets. Unlike traditional procurement contracts, PPPs allocate risks between the partners and create efficiency incentives for the service provider by linking financial reward to specific performance outcomes. For DJB's wastewater services the advantages may include:

- i. Mobilizing private funding to enable increased investment in the services.
- ii. Increased efficiency and reduced costs in the longer term;
- iii. Addressing shortcomings in the quantity and capacity of public sector staff;
- iv. Improving environmental performance;
- v. Improving the maintenance and longevity of the assets;

PPP Options for a sewerage scheme comprising Network along with waste water pumping stations and waste water treatment plant.

Generally projects for sewerage network are executed by **Conventional procurement** method that involves developing the network through conventional works contracts. The primary advantages of these approaches are simplicity, flexibility, and the fact that the network operations would be integrated into DJB's standard operating procedures so there would be no complicated interfaces for DJB and its customers to navigate.

If a new network is being developed along with a new treatment works then PPP solution may be appropriate as listed above. The proposed option for such integrated scheme including waste water treatment plant and waste water pumping station may be **Design Build Finance Own & Operate (DBFOO)**.

The DBFOO model may be viable for a considerable sewerage scheme comprising network, wastewater pumping stations and wastewater treatment plant. They are unlikely to be cost effective for small infill network developments. The accrued advantage of the DBFOO model to the contractor may be that the contract could be designed to provide incentives for the Contractor to aggressively connect new customers to the network. So, rather than being reactive and waiting for new customers to apply for a sewer connection, the contractor would undertake public campaigns to ensure a higher take up than would otherwise have been the case.

This may ensure the efficient collection of sewage to the WWPS / WWTP which in turn can be a source of revenue generation. The treated water may be brought down to higher standards so that it's a source of reuse / recycle option. The matrix of a combined PPP model from collection to alternative treatment processes that may be applied in wastewater reclamation and reuse has been shown as below. This may also imply execution of dual pipe system for non-potable applications. The latter may then reduce stress on clear water supply demand, which is a major thirst for Delhi.

Traditional approaches to laying new networks often involve multiple excavations. First the network is laid, and later individual connections are being installed in response to customer applications. The structured DBFOO model may apprise an executing agency to lay sewerage network and connect individual property connection in an efficient way, which in turn shall be a source of revenue generation to such concessionaire.

DJB would need to be mindful that the management of sewerage assets need to be designed for an asset life of 60 – 100 years; much longer than a typical PPP contract. So the inherent incentives for the DBFOO contractor to build cheap short-lived assets would need to be countered with good quality assurance (QA) by DJB.

8.9 HUMAN RESOURCE PLAN

The Human Resources Plan is to ensure that DJB has the appropriate staff members with the necessary skills to meet current and future requirements. At present, DJB operates under a unified structure headed by the CEO. The operations are spread over the entire area of Delhi which is approximately 1500 sq. km. Given the vast area of operation, it has been difficult to effectively monitor service delivery activities. Further DJB considers that the current structure does not enable accountability and effective monitoring of operation. It is therefore felt that a decentralized structure may be more effective in meeting the objectives of DJB.

In pursuance of the above, a study has been carried out the study for identifying the structural changes which may make DJB more accountable, effective, and efficient in achieving its objective.

The broad scope under the intended study covered exact structure and improvement areas which have been summarized as follows:

8.9.1 Review of Roles and Functions of DJB

Study included the assessment of the roles and functions of DJB to assess the need and criticality of each of the functions which are being currently performed by DJB. This included assessment of systems and policies related to operation and maintenance of water supply and sewerage system, metering, billing including billing cycle, and fee collection; data transfer in the system including reading of meters, generation of bills based on the readings, process of sending the bills to consumers, list of defaulting connections, distribution of revenue into different accounts, and data movement for overall accounting of DJB; assessment of current practices of handling consumers including complaints, grievances, illegal connections, new connections etc.

8.9.2 Review of Existing Organizational Structure and Administrative Processes

Study included the review of current organizational structure and administrative mechanisms followed by DJB including interactions, coordination, information flow, and power flow between different functional departments and across headquarter and zonal office; reporting and sanctioning process; organizational hierarchy and span of control; roles, responsibilities, and power at various levels; and level of transparency, and accountability in the organization.

8.9.3 Financial Management

Current finances of DJB have been reviewed and advised on how to make DJB financially self-sufficient and be able to generate own resources. Legal limits of DWB act and GNCTD act may have been kept in view.

8.9.4 Design of the proposed organization structure for the distribution companies

This included the following:

- Interaction workshop with stakeholders such as consumers (RWA's, NGO's), MCD and DJB employees.
- Segments of organization on the basis of water hydraulic boundary, geographical, functional or a combination of both.
- Restructuring of engineering, revenue and financial set up according to new boundaries.
- Exploration of ways to restructure DJB with pros and cons for review with DJB. Assessment of the strengths/weaknesses of this model.
- Clarity in roles of DJB and the distribution companies

- Set up mechanism for the companies – under statute or company law; standalone companies to be treated at par with DJB (by the regulator) or as “child companies” of DJB? or SPVs formed by private operators on PPP.
- Method of organization of entities.
- Number and size of such entities drawing from administrative and hydraulic boundaries, apart from aspects such as coverage, customer characteristics, investment needs, size (economies of scale), number (facilitation of competition) and future growth.
- Role of GNCTD as owner and (part) financier of DJB e.g. criteria for governance, oversight functions, tools to plan/control the sector (e.g. granting of license to distribution company containing basic obligations, review of 3-5 year business plan to ascertain investment requirements, performance standards, tariffs – possibly as part of regulatory process)
- How will functions of administration, finance, procurement and quality control and be aligned
- Would the distribution companies only operate or also own the assets? Implications for design of incentives and performance agreements in either case.
- Legal status and structure of the distribution companies
- Structure of top management in the O&M entities (including composition of board of directors, qualifications etc.) and extent of financial powers to be available to the top management
- Mode / Method of staff allocation between DJB and distribution companies
- Identification of important staff related issues to be addressed including transfer of benefits, payment of staff salaries, etc.
- Responsibility for procurement for works and management of PPP contracts – role clarity between DJB and distribution companies
- Handling of sewerage command/functions
- Role of private sector, if any, for investing in or managing O&M functions of the distribution entities.
- Exploring more options to be proposed and evaluated
- Provision of political economy analysis.

8.9.5 Improvement in existing process and systems

Study proposed framing practical and implementable recommendations for improvements in processes, systems and interface mechanism covering customer interface, revenue management, vendor procurement and contract award and contract management, Improvements in IT and MIS systems. Development of these systems, processes, and interface mechanism is proposed to be carried out keeping the cultural diversity and heterogeneity in the system (socio economic, level of awareness, extent of willingness to conform to the procedures etc.) in mind. The standardization of processes and development of routines is proposed to be assessed for their applicability including identification of various constraints and challenges, and ways to deal with them. Study requires assessment of proposed participation of private sector in the various stages of the project for identification of the challenges (risks) and methods to eliminate (overcome) these challenges.

CHAPTER - 9

RECOMMENDED OPTIONS FOR TREATED WASTEWATER REUSE AND DISPOSAL

CHAPTER - 9: RECOMMENDED OPTIONS FOR TREATED WASTEWATER REUSE AND DISPOSAL

9.1 INTRODUCTION

Treated wastewater is widely recognised as a valuable and sustainable water resource. Using this reclaimed water instead of fresh water would relieve the over stressed surface and ground water resource by providing increased water security for many users.

9.2 WASTEWATER PATHWAY

A typical pathway of wastewater consists of four phases. Each of these phases has been discussed in the following text:

Wastewater Generation

With increasing urbanization and changing lifestyles, wastewater generation is expected to increase over time. Increase in urban water supply ensures increased water security but it leads to wastewater generation. The depleted fraction of domestic and residential water use is typically only about 20% and the remainder returns to wastewater.

Wastewater Collection

Wastewater is collected through a network of gravity mains, pump stations and force mains and conveyed to the treatment location. Delhi is only partially sewerage, resulting in substantial volumes of wastewater finding their way into surface water networks within city resulting in pollution.

Wastewater Treatment

Wastewater is collected and brought to treatment plant where it is given desired level of treatment before its recycle/reuse and /or returning to a natural water body.

Wastewater Discharge/Use/Recycling

In absence of an efficient wastewater management system wastewater receives little or no treatment and is discharged into a drain, river or lake from which farmers divert it into the fields to grow different crops. The focus now has shifted to recycling wastewater in a number of sectors other than agriculture for various reasons, but only after suitable treatment.

Wastewater Treatment is an expensive process both in terms of money and land. Lack of treatment is the main problem in wastewater re-use and hence a strategy is needed to recover the costs of treatment from the different stakeholders. There is a need to increase the efficiency of recycling to reduce the cost of supply of recycled water so that it competes efficiently with alternate sources of water.

9.3 FRAMEWORK FOR RECYCLING TREATED WASTEWATER

In any society the initial emphasis is on minimising wastewater generation and having its efficient collection, which gradually shifts towards implementing efficient wastewater treatment system for recycling the treated wastewater.

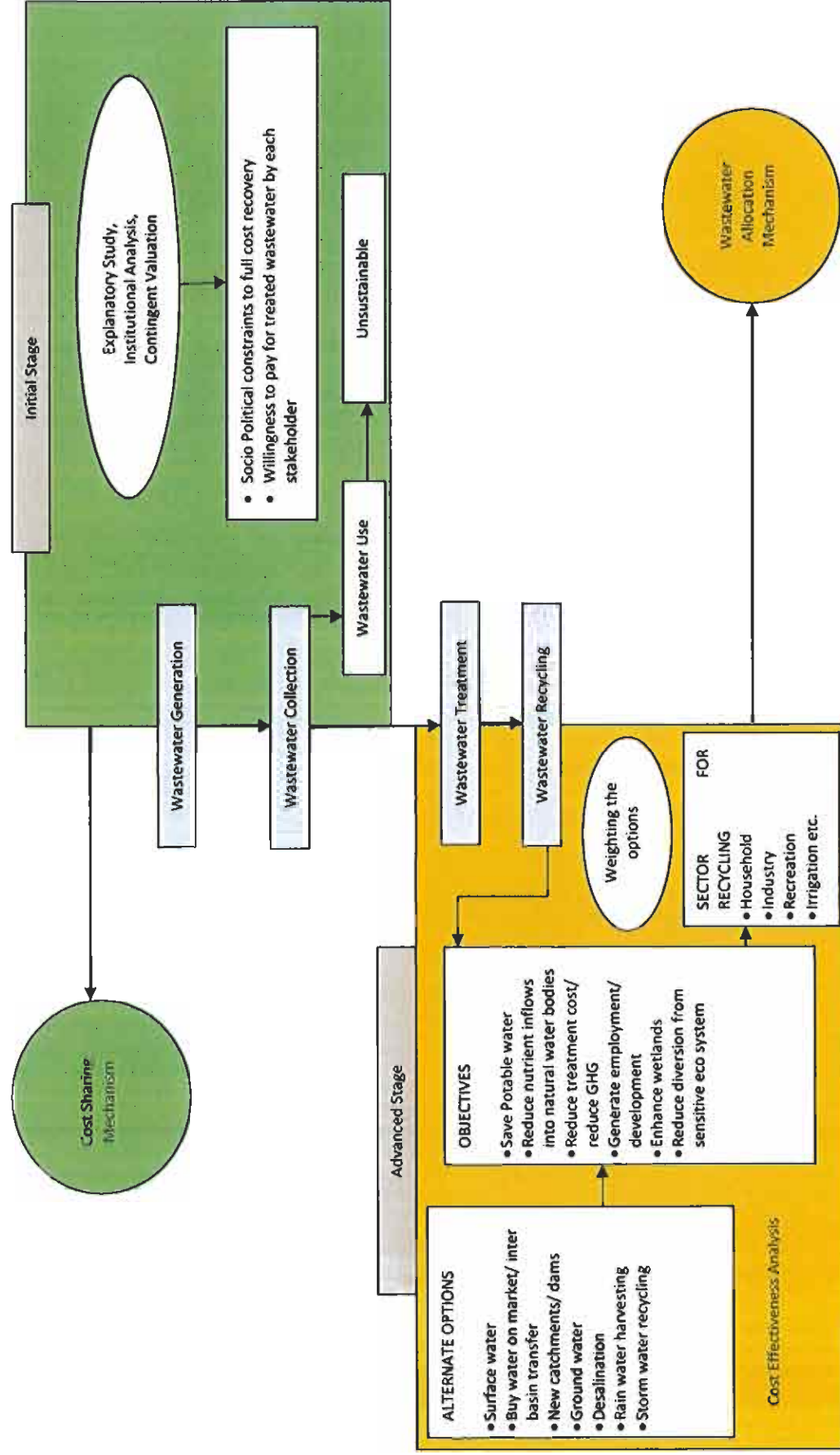


Figure 9.1: Framework for Recycling Wastewater

The efficiency of recycling can be improved through a number of strategies at different levels: at the treatment level through new technologies; managing the demand and supply sides through information dissemination; appropriate pricing; through appropriate allocation among different sectors like domestic, industry, agriculture, recreation and environment.

Figure 9.1 provides a schematic diagram that can act as a framework in recycling treated wastewater. The central component of this approach is the physical pathway through which wastewater is generated, collected, treated and distributed.

9.4 WATER QUALITY CRITERIA BY CPCB

Based on the best use of water it is classified into five classes. **Table 9.1** gives the characteristics/criteria of water desired for each of these designated use.

Table 9.1: Water Quality Criteria by CPCB

Designated Best Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l

9.5 WASTEWATER CHARACTERISTICS AND REUSE

Use of the treated wastewater is designated based on its characteristics. The reuse options depend on the quality of treated wastewater produced after the treatment. The quality and characteristic of wastewater has been related with the type of treatment process adopted.

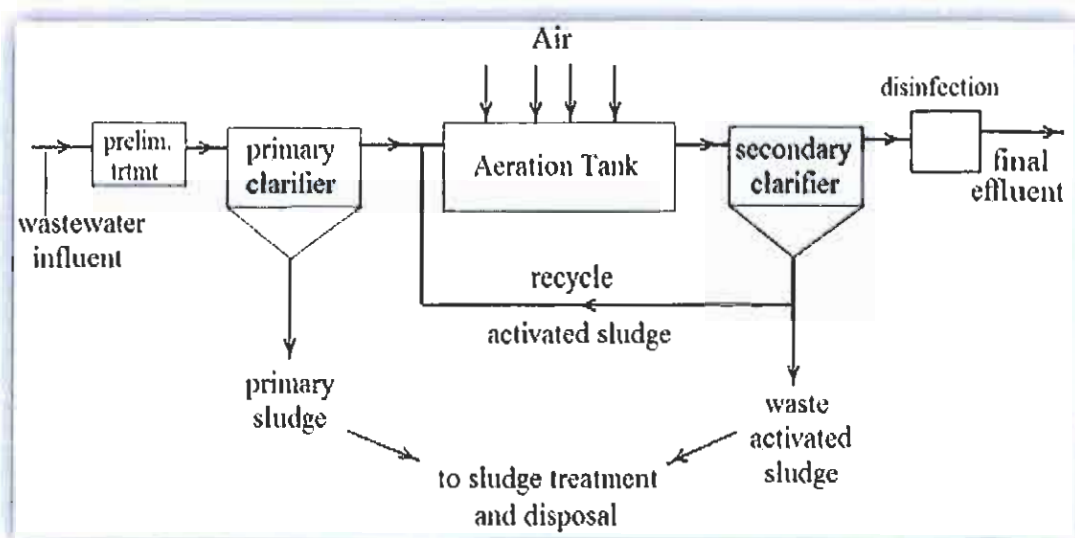


Figure 9.2: Treatment of Wastewater by Activated Sludge Process

The treatment scheme proposed in this project is shown in **Figure 9.2**. The characteristics of raw sewage and the treated wastewater from the project are given in **Table 9.2**.

Table 9.2: Comparative Wastewater Characteristics

Parameter	Raw Wastewater	Treated Wastewater
pH	6-8.5	6-8.5
Total suspended solids (mg/l)	400	<10
Total BOD5 at 20° C (mg/l)	250	<10
Faecal Coliform (MPN/100 ml)	2×10^7	<2500

9.6 POSSIBILITIES OF REUSING WASTEWATER

Treated wastewater can be used for pollution abatement, resource conservation and for reducing the concerns associated with its disposal. There are several options for using treated wastewater. The most suitable options have been discussed below:

Flushing and Facility

The treated wastewater can be used for toilet and urinal flushing purpose but doing this would need a dual b system. Thus, this can be suitably adopted in the upcoming projects. All new development projects should have two distribution lines, one for potable water and other for non-potable water/recycled treated wastewater for toilet flushing.

Reclaimed water can also be used in facility uses such as pump seal water, equipment wash, road washing etc. after removing total suspended solids from treated effluent.

Tokyo is one of the leading cities that is successfully implementing wastewater reuse, such as dual distribution systems and stream augmentation. In a water reuse project in the Shinjuku area of Tokyo, a dual distribution system has been adopted and sand filtered water from the Ochiai Municipal Wastewater Treatment Plant is chlorinated and used as toilet flushing water in 25 high rise business premises and for stream augmentation. The system, which has been successfully operated since 1984, is supplying treated wastewater up to a maximum 8,000m³/day (Tokyo Metropolitan Government, 2001).

Irrigation and Landscaping

Treated wastewater can be used for irrigation of freeway landscapes, golf courses, parks, playgrounds, school yards, agriculture land, residential landscapes etc. Nutrients contained in treated wastewater are beneficial for agricultural use. An irrigation rate of 2m per year (20,000 cum/ha) using treated wastewater (10 mg/l of N and 2 mg/l of Phosphorus) would add 200 kg N/ hectare and 40 Kg of P/ hectare of irrigated land. This not only saves the cost of fertilizer but also leads to conservation of freshwater.

Treated wastewater contains a range of pathogenic organisms, that may contaminate the soil. Therefore, the treated wastewater shall be disinfected to reduce the pathogen level, to make the wastewater fit for agricultural use. Using treated wastewater in irrigation may lead to contamination by pathogenic organisms.

In using treated wastewater for irrigation a detailed analysis of its heavy metal content and electrical conductivity needs to be found too. A detailed soil study needs to be carried out to avoid any increase in soil salinity.

Groundwater Recharge

Treated wastewater can be used to preserve or even increase the volume of groundwater. It is one of the best ways of reusing wastewater particularly since the groundwater table is lowering in almost all parts of Delhi. However, this needs a policy decision for such implementation.

This use requires advanced treatment of treated wastewater from secondary clarifier as without this it may pollute the aquifer, causing health concerns. Direct injection of treated wastewater can access deeper aquifers through an injection well.

For over 35 years, in the Montebello Forebay Ground Water Recharge Project, recycled water has been applied to the Rio Honda spreading grounds to recharge a potable ground water aquifer in south-central Los Angeles County in California (US EPA, 1998).

Construction

Treated wastewater can be used in construction activities like foundation compaction, dust control, water jetting for consolidation of backfill around pipelines and mixing concrete. Reclaimed water can be used to dampen soil for compaction at landfills too. Some constituents in reclaimed water have to be reduced or removed based upon individual application, but the quality of reclaimed water must ensure the safety of the public and construction workers.

Water used for construction purposes should be clean and reasonably free from injurious quantities of deleterious materials such as oils, acids, alkalis, salts and microbial growth. Presently, potable water is being used for construction activities and it is recommended to substitute this by treated wastewater. If needed then additional treatment like softeners may be installed at site to meet the standard construction water quality requirement given by Bureau of Indian Standards.

Fire Protection

Treated wastewater can be used for firefighting and fire protection. It can be used for fire protection in hydrants or in sprinkler systems in commercial or industrial facilities, residential buildings and hotels.

Industries

Manufacturing sectors, such as metal refining, metal products and chemicals can use treated wastewater. All the industrial water requirements for non-drinking and other non-potable demands can be met through recycled wastewater.

The major problem in industrial use of treated wastewater is its high salts and organics content which may lead to corrosion of pipes particularly at the joint part, blockage of a pipe or clogging of a strainer due to formation of iron oxide scale etc.

Cooling water

Treated wastewater can be used for the purpose central air-conditioning of large buildings/ institutions, hotels, commercial centers and large installations by further undertaking some treatment like water softeners etc. Water with hardness less than 50 ppm of CaCO_3 is recommended for air conditioning applications. pH less than 5 is quite acidic and corrosive to ordinary metals and needs to be treated.

Untreated/partially treated water if used in air conditioning system can lead to scale formation, corrosion and organic growth. Hence, it is essential to analyze the supply source for various constituents including dissolved solids. A chemical analysis of water sample should be taken up to ensure the suitability of treated wastewater for its intended use as cooling water.

Ornamental/Recreational

This treated wastewater reuse can be aesthetic such as decorative pools, decorative fountains, ponds, lagoons, and landscape impoundments. Since the treated wastewater in decorative fountains has a greater possibility of human contact than water in landscape impoundments, the highest quality of reclaimed water is required for decorative fountains.

Fisheries and Aquaculture

Treated wastewater from conventional treatment plants can be used for pisciculture and other aquaculture activities. The treated effluent after secondary treatment should be taken to a polishing pond prior to the effluent being discharged into a fishpond. This treated wastewater is rich in nutrients and can be directly used by algae, water plants and lower animals, which then could become fish feed.

The Meguro River, which flows through a residential area in Tokyo, had been abandoned by residents due to the decreasing flow of water and pollution with an unpleasant odour. To solve this issue, the Tokyo Metropolitan Government released water treated with UV radiation into the river. With the drastic improvement in water volume and quality, various living species have returned to the river. After the introduction of highly treated water, many insect and small animal populations have been re-established, and fish such as Japanese trout, striped mullets and gobies also returned to the river. Biodiversity and environmental amenities have thus been restored effectively with wastewater reuse.

9.7 DISPOSAL OF UNUSED RECLAIMED WASTEWATER

The treated wastewater which cannot be reused economically can be taken for final disposal for land application or disposal in surface water body by a separate conveying system. Treated wastewater should not be disposed into the sewer which led to treatment plant as this would add to the capacity of treatment plants. . It should be noted here that prior to disposal of treated wastewater it should be assured that the characteristics of treated wastewater is within the limits of General Standards for Discharge of Environmental Pollutants given by CPCB.

The two options have been discussed in sections below:

Inland Surface Water

Wastewater treated to prescribe effluent standard can be discharged to inland surface waters after disinfection. It must be noted here that nutrient reduction is an increasing need especially where the

effluent is a significant proportion of the total flow. Thus, the effect on the quality and the ecology of the surface water must also be considered.

Care must be taken that disposal of treated wastewater does not change the class and designated best use (as given in table 1.1) of receiving water body. Following considerations to be made in discharging effluent to inland waters:

- Returning effluent to a stream to provide environmental flows only where effluent quality is at least commensurate with ambient water quality objectives
- Avoiding discharges entering potable water supply off-takes and stretches of streams having high environmental value by optimal location of the discharge pipes/points/locations

Land Application

Land application is the discharge of treated wastewater on a piece of land with the primary aim of returning the wastewater to the water cycle by evaporation, evapotranspiration or infiltration. The land application of treated wastewater must consider the following:

- The buildup of any substance in the soil should not preclude sustainable use of the land in the long term
- The effluent is not detrimental to the vegetative cover
- Any change to the soil structure should not preclude the use of the land in the long term
- Any runoff to surface waters or percolation to groundwater should not compromise the agreed environmental values
- No gaseous emissions to cause nuisance odour

Quantum of Reclaimed Water to be Recycled:

It is estimated that implementation of this project will lead to collection of approximately 1105.72 MGD of sewage. Of this, at least 50% of the treated wastewater should be recycled and emphasis should be laid towards increasing it. This will help in improving the environment in addition to conservation of water. Use of reclaimed water in irrigation should be encouraged and government should provide incentives in the form of tax rebates or awards to industries/ installations/ farmers using treated wastewater. If required, enabling provisions in the respective acts of the local bodies may be made by the respective State Governments.

9.8 CONCERNS IN USING RECLAIMED WASTEWATER

Social Acceptability

Presently, there is an obvious lack of social research in understanding the basis of public perception of water use and physiological factors governing their decision making process. Therefore, it is of vital importance to understand the social acceptability of using reclaimed water. The Consultant strongly suggests conducting a social study in order to have a better understanding of public acceptability. This study should include but not limited to the following:

- Understanding of judgment strategies used by people to make their decisions to accept or reject using reclaimed water.
- Identification of factors influencing people's risk perceptions in using recycled water.
- Investigation of the role of trust in the authorities and the limits in scientific knowledge in people's decision making processes to either accept or reject recycled water.

- Examination of the different ways and situations where factors such as health, environment, treatment, distribution and conservation issues can impact on the people's willingness to use recycled water.
- Examination of people's sensitivity with regard to the disgust emotion or "yuck" factor and the probability of avoiding recycled water.
- Understanding of why different sources and uses of recycled water can influence the decisions of people to use recycled water.
- Understanding of how perceived economic advantages in using recycled water can facilitate the decisions of people to use recycled water.
- Examination of the effectiveness of using Planned Behavior in understanding factors that influence the people's willingness to use recycled water.
- Examine consumer attitude towards the environment and acceptability of produce grown with treated wastewater.

The conclusion derived from this study should be incorporated to develop an action plan to bring awareness in people towards better acceptability of reclaimed wastewater.

Other Concerns

- Need for improved understanding of the practice of wastewater use in agriculture
- Conditions required for wastewater markets to function efficiently, specifically commercial feasibility for irrigational use of treated versus untreated wastewater, pricing and supply mechanisms
- Need for a uniform international approach to assess hazards and risks of wastewater use, while providing flexibility for individual countries to vary requirements to suit local circumstances of affordability and risk
- Research directed towards the potential expansion of wastewater irrigated products and their acceptability by consumers
- Need for risk assessment modeling related to soil and human health issues

An analysis of recycled treated wastewater schemes in relation to the broader regional infrastructure planning is needed.

9.9 PRICING RECLAIMED WATER

Recycled/Reclaimed water is often more expensive than existing water supplies. So, a number of issues need to be considered for appropriate pricing and when distribution mechanisms for reclaimed water are being developed. A very low price for wastewater may encourage inefficient use and may lead to the perception that it is a cheap and unlimited resource. On the other hand, if the price is set too close to the price of potable water, uncertain users will tend to use potable water for all purposes.

There should be a realistic cost sharing between polluters of water (households and industries), the government (local, state and national level), funding agencies (as loans or grants from donors and other financial institutions) and users of recycled water (industries, farmers, urban authorities controlling parks etc).

For, a fair pricing following needs to be done:

- Structuring the cost of treatment and distribution infrastructure of treated wastewater for the purpose of recycling
- Private sector participation for commercial viability of recycling wastewater

- Incentives to improve the demand of recycled water

In 1998, in the Kurkumbh Industrial Estate near Pune, India, the government was supplying clean water to the industries at a subsidised rate of Rs. 8 per cubic meter. They built a wastewater recycling plant and wanted industries to recycle their wastewater for reuse. However, the cost of treating and recycling wastewater was Rs. 15 per cubic meter. Hence, industries were not recycling their wastewater but illegally disposing it and contaminating the surface and groundwater resources. When the government increased the price of clean water to Rs. 18 per cubic meter (the true cost of water delivery), the industries willingly sent their wastewater to the treatment plant and bought the recycled water at Rs. 15 per cubic meter. Hence, the policies of the government in pricing water are critical for implementing wastewater management.

9.10 BOTTLENECKS IN RECYCLING TREATED WASTEWATER

- A) Lack of adequate treatment due to insufficient funds is the main problem in recycling treated wastewater
Reason: Rapid increases in wastewater volumes that exceed the installed capacities of the treatment plants and results in poor quality of treated effluent
- B) High capital cost needed for advanced treatment of wastewater
Reason: Poor strategy to share the cost between different stakeholders
- C) Lack in public acceptability towards reusing treated wastewater.
Reason: Inadequate mass awareness, illiteracy, lack of faith in treatment technology etc.

9.11 GREY WATER SYSTEMS

Grey water refers to the water drained from baths, showers, washing machines, and sinks (household wastewater excluding toilet wastes). Contrary to common belief, grey water is not a benign product. It may contain bacteria and other potential pathogens and therefore, needs proper treatment before its intended use for irrigation and other applications.

Grey water is of poorer quality than tap water, but generally of higher quality than black water (toilet wastewater). The advantage of reusing treated grey water is that its treatment is relatively simple and cost effective as compared to black water. Grey water can be used for landscape irrigation and toilet flushing at household levels. Filtered grey water is most suitably used for subsurface irrigation of nonedible landscape plants. Not only does its use on landscapes prevent requirement of fresh water, but grey water may also benefit plants because it often contains nutrients such as nitrogen or phosphorus.

Grey water use may offer financial savings to already overburdened municipal sewage treatment facilities because grey water use diminishes sewer flows, thereby lessening the need to expand such facilities. However, diminished sewer flows may have a downside because grey water use can result in insufficient sewer flows to carry waste to the sewer plant. Another concern is that with increased use of grey water, less effluent water will be available for treatment, resulting in less reclaimed water for municipal uses and downstream appropriators.

In present situation in Delhi, grey water is not been collected and/ or treated separately to be reused, however this practice can be beneficially used for Housing Societies and private developers for following usages:

- Municipal Applications
- Rural Applications/ irrigation purposes
- Rainwater Harvesting

Case Study – Part of Narela Drainage Zone for De-centralized /Recycle/ Re-Use Option

The study area for this report includes Tajpur Kalan, Akbarpur Majra, Jangola where de-centralized treatment solutions is being studied for recycle and re-use options. The proposed WWTP at Palla Village has a capacity to treat 6.0 MGD (27.24 MLD) of wastewater. The waste water from Jangola discharges to Akbarpur Majra. The WWTP receives wastewater from three pumping stations i.e. Tajpur Kalan, Akbarpur Majra and Bakhtawarpur. The details of these pumping stations and the catchment areas are as provided in **Table 9.3**. The treatment technology for this WWTP is proposed to have a provision for advanced wastewater treatment to reclaim high quality water. The footprint requirement for any advanced aerobic treatment technology of the WWTP generally varies between 0.04 ha/MLD to 0.1 ha/MLD. Membrane Bio Reactor (MBR) is one such technology, which could produce a high quality treated effluent with very low BOD, TSS and fecal coliform levels. The area requirement for a 6.0 MGD WWTP based on MBR technology is estimated to be around 1.5 ha. The treated effluent characteristics from such a WWTP can be expected as given in **Table 9.4**.

Table 9.3: Details of Waste Water Pumping Stations for Catchment area of 6.0 MGD WWTP at Palla (Narela)

S.N.	Name / Location of Pumping Station	Capacity of Pumping Station
1	Tajpur Kalan	1.5 MGD
2	Akbarpur Majra	3.0 MGD
3	Jangola	1.5 MGD
4	Bakhtawarpur	8.0 MGD

A thorough study of the proposed treatment plant site has been carried out and several possibilities of reusing the reclaimed water have been worked out. This document discusses the various reuse possibilities of the high quality treated waste water generated from the proposed WWTP in Palla (Narela).

Table 9.4: Suggested Characteristics for Treated Wastewater Reuse

S. N.	Parameter	Treated Water Quality Standards
1	Ph	Between 6 and 9
2	BOD ₅ @ 20 Deg C	≤ 10 mg/l
3	COD	≤ 40 mg/l
4	TSS	< 10 mg/l
5	TN	≤ 10 mg/l
6	Total Coli form	≤ 2500 /100 ml

The indicative calculations and reuse possibilities are enclosed in detail in **Annexure-A**. The following are the reuse possibilities:

REUSE - 1: At the WWTP Site

Treated effluent or reclaimed water can be used for landscaping and horticulture requirements within WWTP premises. The flushing needs within the WWTP can also be met with reclaimed water. Thus, about 0.021 MLD of reclaimed water can be recycle/reused at the treatment plant site itself.

REUSE - 2: Discharge in to the Recharge Pond

Two plots have been identified in the vicinity of WWTP which can be developed into surface water body/recharge pond. The water requirement to make-up the evaporation losses and water infiltrated into the ground is estimated to be around 5.37 MLD. The treated effluent can be effectively used for this make-up water requirement. In the estimation of makeup water lateral infiltration has been ignored. The details of these ponds are provided in **Table 9.5** and their locations are shown in **Annexure B**.

Table 9.5: Surface Water Bodies to be Developed and Maintained Using Reclaimed Water

S.N.	Name of Pond	Surface Area (sq.m)	Water Level (m)	Water Holding Capacity (cum)
1	Tajpur Kalan Pond 1	4458	7	31206
2	Tajpur Kalan Pond 2	4364	7	30548
	Total	8822	-	61745

REUSE - 3: Agricultural Usage

Treated wastewater is a valuable resource for agricultural reuse in irrigation and can be effectively used for the nearby farming areas. In both industrialized and developing countries, treated wastewater has been used successfully for the irrigation of a wide range of crops, including fresh eaten fruits and vegetables.

REUSE - 4: Industrial Usage

Reclaimed water has a great potential for industrial use. The industries can use this water for cooling water and makeup water for different process requirements. This option is a valuable source of revenue for DJB.

Further, most of the industries rely on ground water for their water requirements. Thus, use of reclaimed water would prevent the exploitation of ground water. Moreover, this could be a viable option for industrialization of areas suffering from water scarcity.

DEPLETION OF NATURAL RESOURCES:

The case of Delhi is representative of the situation of many urban water systems in developing metropolises. The low level of service by the public utility has led the upper and middle classes to develop coping strategies based on private groundwater abstraction. These might include direct use of groundwater from a private tube well, development of a private small supply network fed with untreated groundwater, or supply by tanker, groundwater remaining the primary source of raw water in most of those private supply chains. As a consequence, indiscriminate abstraction has led to a rapid fall in water tables across the city, which threatens the sustainability of the system.

The public authority in charge of housing development, the Delhi Development Authority, has not been able to cater the demand. According to various estimates, a proportion of 50% of Delhi's population lives in some kind of informal, unplanned and/or precarious settlement. Among them, more than two million people, representing more than 15% of the total population, live in illegal squatter settlements and face a permanent risk of eviction. The accountability of the municipal utility in charge of water supply and sanitation towards populations living in informal settlements is loosely defined, and most of them do not have a proper connection to the network. According to the Water and Sanitation Program (WSP), more than 40% of the urban poor in India rely only on groundwater resources through hand pumps and shallow wells for their water supply.

In Delhi, The contribution of groundwater towards the municipal supply is around 11% in terms of volume, which represents around 370 Million Liters a Day (MLD).

Although groundwater abstraction is regulated in Delhi, the authorities in charge of the enforcement of the regulation do not have the practical means of controlling private abstraction. As a consequence, water table is falling at an increasing pace in several areas of NCT Delhi. There is huge abstraction of ground water in the vicinity of WWTP. This is constantly adding to the problem of depleting groundwater level in the nearby area. **Figure 9.3** shows the changing groundwater status of Delhi.

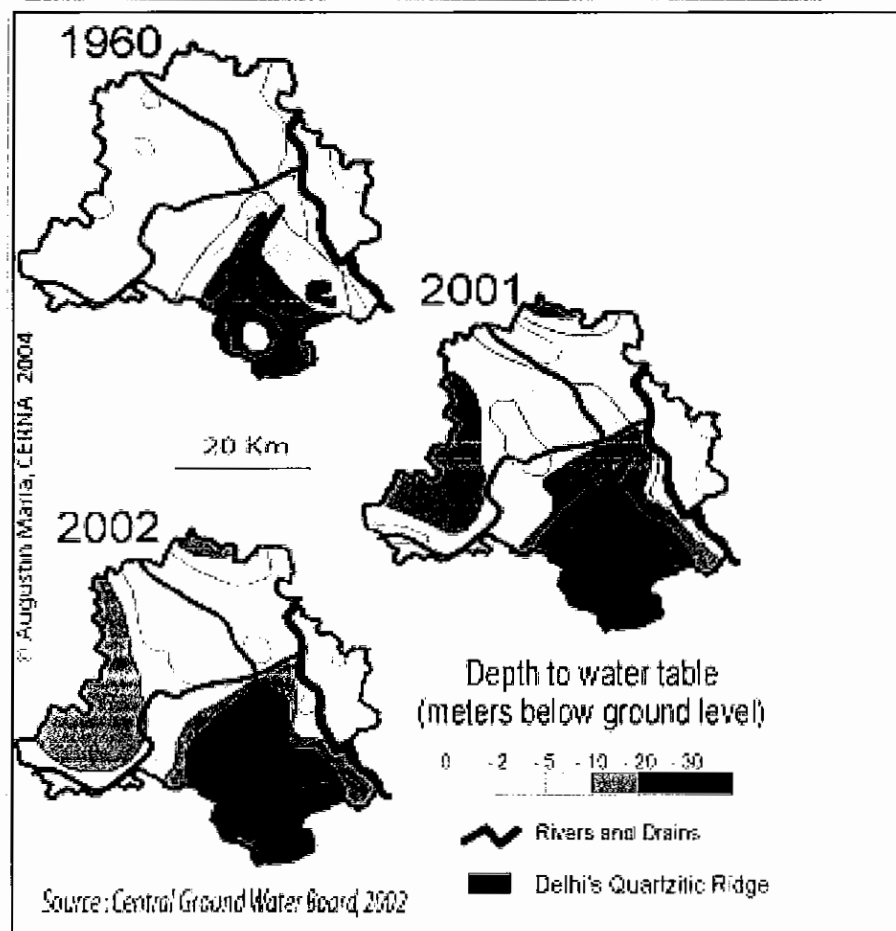


Figure 9.3: Groundwater Status of Delhi

From this figure it is clear that the groundwater in the vicinity of project depleting constantly. Thus, to restore the groundwater table either the groundwater table can be recharged or it can be conserved. Thus, usage of reclaimed water will result in ground water conservation by reducing the abstraction of ground water and also augmenting it by means of recharge pond.

There are several unaccounted tubewells illegally abstracting groundwater. The reclaimed water can be used to meet non potable domestic demand. This would lead to conservation of potable ground water.

The safe and sustainable use of reclaimed water involves:(a) Taking what was regarded as a waste and treating it to a level appropriate for its intended use.

(b) Using the reclaimed water resource in a manner that provides some direct or indirect economic Or Social benefit, whilst still being protective of the environment, public and animal health, and food/produce safety.

Referring to the **Table 9.6**, the total reclaimed water demand for reuse options 1 and 2, is estimated to be around 5.37 MLD. The remaining 20.50 MLD is proposed for reuse option 3 and 4 (for industries, institutions and other irrigational facilities etc.)

Table 9.6: Treated Effluent Reuse options for Palla WWTP

Capacity of WWTP	6	MGD
or,	27.24	MLD
Total quantity of reclaimed water if 5% of water is lost during treatment	25.88	MLD
Reuse 1: At the WWTP Site		
Rate of irrigation for landscaping	5	ltr/sq.m
Land Area to be landscaped	0.4104	Ha
or,	4104	Sq.m
Reclaimed Water Demand	20520	ltr/day
Assuming the total man power at the WWTP site is	20	persons
The institutional need (@ 30 lpcd per person per day)	600	ltr/day
Total Reuse	21120	ltr/day
Reuse 2: Discharge into the recharge ponds		
Total water surface area of pond	8822	Sq m
Rate of evaporation	250	cm/annum
or,	0.685	cm/day
or,	0.0068	m/day
Rate of infiltration (for sandy loam and silt loam)	25	mm/hr
or,	60	cm/day
or,	0.6	m/day
Water lost per day from the top and bottom surface of ponds	5353.62	cum/day
or,	5353625	ltr/day
Total Reuse	5353625	ltr/day
Reclaimed Water use per day	5374745	ltr/day
or,	5.37	MLD
Water Remaining after considering Reuse option 1 and 2	20.50	MLD

The Case Study represents a sample calculation for utilization and reuse analysis of treated waste water. Similar approach may be taken up for other treatment plants, wherever applicable and intended.

CHAPTER - 10

ENVIRONMENTAL REVIEW

CHAPTER - 10: ENVIRONMENTAL REVIEW

10.1 INTRODUCTION

One of the fundamental objectives of developmental planning is to create a sustainable physical and social environment for improving the quality of life. An Environmental Review is intended to identify the potential environmental impacts associated with the construction and operation of the recommended Sewerage Schemes and related works proposed under SMP-2031, and the mitigation measures required. Environmental Review also aims to identify the opportunities for environmental enhancement in the Project area and to provide and develop appropriate management plans and codes of practices for implementing, monitoring and reporting of the environmental mitigation and enhancement measures suggested. Environmental issues addressed include noise, air quality, water quality, waste management and ecology.

The city's environment can essentially be described in terms of Urban Management and the Services Management. The Urban Management pertains to natural features and resources including the elements of air, noise, water and land with reference to open spaces, green area and other surface and sub-surface conditions. The Services Management relates to built environment which includes the environmental infrastructure in the form of water supply, sewerage, solid-waste disposal and transportation network.

The rapid pace of urbanization adversely affected environment specially the water bodies in Delhi. The Central Ground Water Board assessed that total ground water potential in Delhi has reduced from 428 Million cubic meters (Mcm) in 1983 to 292 Mcm in 2003. It indicates an overdraft and reduction of around 136 Mcm during the period of 20 years between 1983 to 2003.

Average annual rainfall in Delhi is 611 mm. The annual rain water harvesting potential has been assessed at 900 billion liters or about 2500 million liters per day. Owing to massive urbanization the run-off water get diverted into storm water drains and sewers which conveyed the rain water into the river Yamuna. If even 25% of the annual rain water harvesting potential could be harvested, it is estimated that it may make available 625 million liters per day and may meet the existing gap in the availability of raw water resources and water requirement.

The increasing respiratory diseases, heart ailments, eye-irritation, asthma etc due to the increasing air pollution is the matter of concern in Delhi. The main sources of air pollution in Delhi are vehicle emission (around 70%), industrial emission (around 20%) and remaining from other sources like Diesel generators and Domestic cooking etc.

10.2 LEGAL POLICY AND INSTITUTIONAL FRAMEWORK

The Government of India has laid down various policy guidelines, regulations, acts and legislations pertaining to sustenance and protection of environment and its various components. The following are the key regulations in India applicable for various development Projects.

- Constitutional Provisions
- The Ancient Monuments and Archaeological Sites and Remains Act, 1958
- Wildlife Protection Act, 1972
- Water (Prevention and Control of Pollution) Act, 1974 and its amendments
- Air (Prevention and Control of Pollution) Act, 1981
- Forest (Conservation) Act, 1980 and its amendments
- The Environment (Protection) Act, 1986

- The Motor Vehicle Act 1988
- Hazardous Wastes (Management & Handling) Rules, 1989
- The Municipal Solid Wastes (Management and Handling) Rules, 2000

The Environment (Protection) Act, 1986

The Environment (Protection) Act, popularly known as EP Act, is an umbrella legislation that supplements existing environmental regulations. Empowered by the EP Act, the Ministry of Environment & Forests (MoEF), Government of India has issued the following notifications regulating siting of Projects and its operation, procuring clearance to establish industries and development of Projects with appropriate EIA studies, coastal zone regulations and other aspects of environment care:

- Empowers the Government of India to make rules to regulate environmental pollution by stipulating standards and maximum allowable limits to prevent air, water, noise, soil and other environmental pollutants
- Prohibits operations that emit pollutants in excess of standards
- Regulates handling of hazardous substances and identifies persons responsible for discharges and pollution prevention
- It deals with offences committed by Government Departments
- Formulated Environmental (Protection) Rules, 1986, Hazardous Wastes (Management and Handling) Rules, 1989 and Manufacture, Storage & Import of Hazardous Chemical Rules, 1989 in accordance with the sections 6, 8 and 25 of EP Act.

Water (Prevention and Control of Pollution) Act, 1974 amended in 1988

The Water (Prevention and Control of Pollution) Act 1974 resulted in the establishment of the Central and State Pollution Control Boards (CPCB and SPCB) whose responsibilities include managing water quality and effluent standards, monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of certain activities.

The Project requires Consent to Establish from the State Pollution Control Board under Water (Prevention and Control of Pollution) Act of 1974.

Air (Prevention and Control of Pollution) Act, 1981

Similar to Water Act, the Air Act vests regulatory authority on the State Pollution Control Boards and empowers them to enforce air quality standards to prevent air pollution in the country. This Act provides for prevention, control and abatement of air pollution. 'Air Pollution' means the presence in the atmosphere of any 'air pollutant', which means any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment. The SPCB is empowered to set air quality standards, monitor, and prosecute offenders under the Air (Prevention and Control of Pollution) Act, 1981. Section 21 of the Act requires an application to be made to the State board to establish or operate any industrial operation.

The Project requires Consent to Establish from the State Pollution Control Board under Water (Prevention and Control of Pollution) Act of 1974.

The Environmental Impact Assessment Notifications and its Amendments

The EIA Notification of MoEF dated of 2009 is silent on the requirement of an environmental clearance for a sewerage network project. However, the consultant suggests conducting an Environmental Examination of this project based on the legal policies and institutional frameworks of the country.

10.3 GUIDELINES AND STANDARDS**Noise**

CPCB gives the ambient noise standard this standard provides the maximum permissible limit of noise during day (6.00 a.m. to 10.00 p.m.) and night (10.00 p.m. to 6.00 a.m.). All attempts should be made to keep the noise generated during construction/operation activity within the prescribed limit.

Table 10.1: Ambient Air Quality Standards in respect of Noise

Area	Category	Limit in dB (A) Leq	
		Day	Night
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone (area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority)	50	40

Noise Pollution (Regulation and Control) Rules, 2000: Sound emitting construction equipments shall not be used or operated during night time in both residential areas and silence zones.

Acoustic enclosure designed for DG sets should meet the stringent MoEF/ CPCB norms of 75 dBA at 1mtr at 75% load under free field conditions.

Air Quality

National Ambient Air Quality Standards (NAAQS) for major air pollutants were notified by the CPCB in April 1994 and revised in 2009. The Ambient Air Quality at Various Locations during Depawali 2011 and 2012 are provide in **Table 10.3** and the NAAQS prescribed specific standards for industrial, residential, rural and other sensitive areas is provided in **Table 10.4**. All attempts should be made to abide by the NAAQS limits during construction/operation of the Project.

Table 10.2: National Ambient Air Quality Standards (NAAQS)

Pollutant	Time Weighted Average	Concentration in ambient Air	
		Industrial, Residential, Rural, Other Areas	Ecologically Sensitive area (GoI specified)
Sulphur Dioxide (SO ₂) µg/m ³	Annual*	50	20
	24 hours**	80	80
Nitrogen Dioxide (NO ₂) µg/m ³	Annual*	40	30
	24 hours**	80	80
Particulate Matter (Size <10 µm) or PM ₁₀ µg/m ³	Annual*	60	60
	24 hours**	100	100
Particulate Matter (Size <2.5 µm) or PM _{2.5} µg/m ³	Annual*	40	40
	24 hours**	60	60
Carbon Mono Oxide (CO) µg/m ³	8 hours**	2	2
	1 hour**	4	4

Note:

*Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

**24 hourly or 1 hourly monitored values, as applicable, shall be compiled with 98% of time in a year. 2% of the time they may exceed the limits but not on two consecutive days of monitoring.

Water Quality

All discharges into public sewer systems, irrigation and inland waters are required to be within the General Standards for Discharge of Environmental Pollutants stated by CPCB. The present ground water and surface water quality status of Delhi is monitored by CPCB are given in **Table 10.3 and Table 10.4** provides the Yamuna river quality monitoring results. The CPCB standards have been provided in **Table 10.5:**

Table 10.3: Status of Ground water pollution in Delhi

S. No	Sampling Location	pH	TDS	Cl	Hardness as CaCO ₃	Ca as Ca	SO ₄	Turbidity (NTU)	Nitrate	F	Zn	Pb	Cu	Cr	Ni	Cd
	Desirable Limit for Drinking Water	6.5-8.5	500	250	300	75	200	5	45	1	5	0.05	0.05	0.05		0.01
1	Pachim Vihar	7.9	470	40	260	28.8	104.6	ND	1.23	ND	0.01	ND	ND	ND	ND	ND
2	MeeraBagh	8	720	115	280	33.6	228	ND	0.8	0.36	0.01	ND	ND	ND	ND	ND
3	Rohini	8	1200	220	300	33.6	201.9	2	1.44	ND	ND	ND	ND	ND	ND	ND
4	Shalimar Bagh	7.8	610	255	210	14.4	74.6	ND	0.7	0.06	ND	ND	ND	ND	ND	ND
5	Adash Nager	7.6	810	120	230	32	72.9	1	2	ND	ND	ND	ND	ND	ND	ND
6	Perhladpur	7.9	3100	70	210	25.6	140.9	3	1.87	1.22	ND	ND	ND	ND	ND	ND
7	Kondli	8.1	820	185	280	30.4	77.3	1	0.07	ND	0.06	ND	ND	ND	ND	ND
8	Mandawali	7.8	490	100	110	14.4	86.2	ND	1	0.06	ND	ND	ND	ND	ND	ND

S. No	Sampling Location	pH	TDS	Cl	Hardness as CaCO ₃	Ca as Ca	SO ₄	Turbidity (NTU)	Nitrate	F	Zn	Pb	Cu	Cr	Ni	Cd
9	Shanti Vihar	8.1	1020	225	260	22.4	105.5	1	2.9	0.13	ND	ND	ND	ND	ND	ND
10	AnandVihar	7.6	510	100	400	17.4	35	ND	1.64	ND	ND	ND	ND	ND	ND	ND
11	NandNagri	8.2	710	80	300	49.6	92.4	ND	1.3	0.18	ND	ND	ND	ND	ND	ND
12	Yamuna Vihar	7.7	1200	190	300	33.6	43.3	1	0.13	0.03	0.01	ND	ND	ND	ND	ND
13	Karawal Nagar	8	710	280	220	28.8	78.7	ND	2.1	0.12	0.01	ND	ND	ND	ND	ND
14	VasantKunj	7.9	460	40	110	32	150	ND	1.35	ND	0.01	ND	ND	ND	ND	ND
15	Meharauli	8.1	790	345	260	35.2	84.1	ND	1.1	1.12	0.01	ND	ND	ND	ND	ND
16	Dwarka	8	1020	95	410	36.8	100	1	0.7	0.1	0.04	ND	ND	ND	ND	ND
17	TilakNager	7.6	1100	40	280	27.2	85.5	1	2.37	ND	ND	ND	ND	ND	ND	ND
18	Wazipur	8	3100	290	1190	124.8	57.4	3	1.2	ND	1.04	ND	ND	ND	ND	ND
19	Lawrence Road	7.8	1010	195	410	49.6	67.1	1	1.9	1.04	0.02	ND	ND	ND	ND	ND
20	Badli	7.4	1220	110	280	36.8	95.8	1	0.04	0.87	0.01	ND	ND	ND	ND	ND
21	Rajpura Road	7.5	570	140	290	33.6	70.3	ND	0.84	ND	ND	ND	ND	ND	ND	ND
22	Moti Nagar	8	810	70	290	41.6	40.9	1	ND	ND	ND	ND	ND	ND	ND	ND
23	Rana Pratap Bagh	7.6	720	115	360	35.2	39.8	1	1.04	0.09	ND	ND	ND	ND	ND	ND
24	JanakPuri	7.8	1200	65	310	43.2	42.8	1	0.07	1.22	ND	ND	ND	ND	ND	ND

All the parameters are in mg/l except pH value.

ND – Not Detected

Source: ANALYSIS REPORT OF GROUND WATER FOR THE MONTH OF DECEMBER-2012

Report No.: DPCC/W/GW/12-13/252-285 of CPCB

Table 10.4: Status of water pollution in Yamuna River, Delhi

Water Quality Status of River Yamuna							
Report No.: DPCC/W/Y/11-12/091-099							
Date of Sampling : 05.03.2012							
S. No.	Locations	pH	COD (mg/l)	BOD (mg/l)	DO (mg/l)	Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)
Water Quality Criteria ('C' Class)		6.0-9.0	–	3(max)	4(min)	5000	–
1	River Yamuna at Palla	8.3	12	2.0	8.5	1500	500
2	Surghat (Downstream of Wazirabad Barrage)	7.8	28	4.4	5.1	9100	2800
3	River Yamuna at Khajori Paltoon Pool (Downstream Najafgarh Drain)	8.1	332	90	Nil	110000	75000
4	River Yamuna at Kudesia Ghat	8.2	136	28	Nil	46000	21000
5	River Yamuna at ITO Bridge	8.1	128	24	Nil	240000	110000

6	River Yamuna at Nizamudin Bridge	8.2	140	30	Nil	110000	46000
7	Agra Canal (Okhla)	8.0	160	35	Nil	46000	15000
8	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	8.2	272	62	Nil	1500000	750000
9	Agra Canal (Jaitpur)	7.9	100	30	Nil	91000	21000

Table 10.5: General Standards for Discharge of Environmental Pollutants

Parameter	Standards		
1	2	3	
	(a)	(b)	(c)
	Inland surface water	Public Sewer	Land for irrigation
Colour and Odour	All effort should be made to remove colour and unpleasant odour as far as practicable		
Suspended Solids mg/l, Max	100	600	200
Particulate size of suspended solids	Shall pass 850 micron IS sieve	-	-
pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
Temperature	Shall not exceed 5°C above the receiving water temperature	-	-
Oil and Grease mg/l, max.	10	20	10
Total residual chlorine mg/l, max.	1.0	-	-
Ammonical nitrogen (as N), mg/l, max.	50	50	-
Total Kjeldahl Nitrogen (as NH ₃) mg/l, max	100	-	-
Free ammonia (as NH ₃), mg/l, max	5	-	-
BOD ₃ at 27°C, mg/l, max.	30	350	100
COD, mg/l, max.	250	-	-
Arsenic (as As), mg/l, max.	0.2	0.2	0.2
Mercury (as Hg), mg/l, max	0.01	0.01	-
Lead (as Pb) mg/l, max.	0.1	1	-
Cadmium (as Cd) mg/l, max	2	1	-
Hexavalent Chromium (as Cr ⁺⁶) mg/l, max	0.1	2	-
Total Chromium (as Cr) mg/l, max	2	2	-
Copper (as Cu) mg/l, max	3	3	-
Zinc (as Zn) mg/l, max	5	15	-
Selenium (as Se) mg/l, max	0.05	0.05	-
Nickle (as Ni) mg/l, max	3	3	-

Parameter 1	Standards		
	2	3	
	(a) Inland surface water	(b) Public Sewer	(c) Land for irrigation
Cyanide (as CN) mg/l, max	0.2	0.2	0.2
Fluoride (as F) mg/l, max	2	15	-
Dissolved Phosphates (as P) mg/l, max	5	-	-
Sulphides (as S) mg/l, max	2	-	-
Phenolic compounds (as C ₆ H ₅ OH) mg/l, max	1	5	-
Radioactive materials:	10 ⁻⁷	10 ⁻⁷	10 ⁻⁸
Alpha emitter micro curie/ml	10 ⁻⁶	10 ⁻⁶	10 ⁻⁷
Beta emitter micro curie/ml			
Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
Manganese (as Mn)	2 mg/l	2 mg/l	-
Iron (as Fe)	3 mg/l	3 mg/l	-
Vanadium (as V)	0.2 mg/l	0.2 mg/l	-
Nitrate Nitrogen	10 mg/l	-	-

Best industry practices like the use of sediment traps, wheel washing facilities for vehicles leaving the site, adequate maintenance of drainage systems to prevent flooding and overflow, sewage collection and treatment, and comprehensive waste management (collection, handling, transportation and disposal) procedures should be adopted in mitigation measures.

Waste Management

Any waste generated from the construction/operation of the Project should be managed as per the following guidelines:

- Municipal Wastes (Management and Handling) Rules, 2000, which aims to enable municipalities to dispose municipal solid waste in a scientific manner.
- Hazardous Wastes (Management and Handling) Rules, 1989, which brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.

In absence of guideline for management of construction and demolition waste, mitigation measures suggested should be environmental friendly technologies based on 3R's- Reduce, Reuse and Recycle.

Ecology

The following rules acts and guidelines should be taken into consideration while conducting Environmental Examination of the Project:

- The Biological Diversity Act, 2002

- The Indian Fisheries Act, 1897: The Indian Fisheries Act, 1897 contains seven sections. Section 5 of the Act prohibits destruction of fish by poisoning waters.
- The Indian Forest Act, 1927: Section 26(i) of the Act makes it punishable if any person, who, in contravention of the rules made by the State Government, poisons water of a forest area.

If any tree is to be cut in Project implementation stage then, compensatory afforestation should be suggested and the survival of the sapling should be ensured.

10.4 ENVIRONMENTAL EXAMINATION OF THE PROJECT

The key issues to be investigated and assessed during the Environmental Examination should be identified and the range and extent of the study to be conducted should be determined. The Primary Project Stakeholders and the project impacts should be identified.

10.5 ENVIRONMENTAL BASELINE DATA STUDY

The primary and secondary baseline data should be collected and addressed to establish the existing environmental and socio economic conditions before the Project is implemented. This baseline should include but not limited to Land Use and Natural Resources; Ecological Resources; Air Quality and Noise; Water Quality and Quantity; Geology, Soils, Topography, Drainage; Solid and Liquid Waste Generation and Disposal; Visual/Aesthetics and Natural Hazards; Socioeconomic setup; Health and Safety.

10.6 IMPACT IDENTIFICATION

The impacts and effects of the proposed Project should be determined by using professional judgment from specialists, fieldwork, computer models, and other desktop analyses. The environmental impacts should be assessed distinctly for both construction and operation of the project.

Installation of the sewerage network and construction of the pumping stations - limited duration phase

The sewer laying works include a series of construction activities such as breaking up of road concrete pavement, sheet piling, excavation, sledge hammering, backfilling, reinstatement and transportation of waste and construction materials. All these activities may involve the use of a number of powered mechanical equipment (PME) comprising breaker, excavator, sheet piling, sledge hammer, dump truck, and concrete mixer. The duration and extent of construction works depends on the sewer diameter, depth and length.

The construction of the proposed pumping stations requires similar activities with additional work of constructing a small structure above ground to house the monitoring and electrical equipment. The construction works involve a number of noisy activities like excavation, formwork, backfilling, reinstatement etc.

The operation of the scheme - ongoing phase

Once in operation, the system will collect the sewage from the project area which was earlier disposed in unscientific manner leading to pollution. Thus, the scheme offers a significant environmental benefit to the area.

10.7 RATING IMPACTS

The impacts identified should be rated as minor or major and negative or positive to provide a basis for prioritization of these impacts to be dealt with.

10.8 ENVIRONMENTAL MANAGEMENT PLAN

A site specific Environmental Management Plan (EMP) should be developed to ensure that appropriate environmental management practices are followed during the projects construction and/or operation. The EMP should include the best practice in environmental management, compliance with environmental legislation, a plan to manage the environmental risk associated with the project, a monitoring plan and a social management plan.

10.9 PUBLIC CONSULTATION

During the Public Consultation (if required and wherever applicable), the results of the Environmental Examination should be presented to the stakeholders and they should be given the opportunity for review and comment.

CHAPTER - 11

TRAFFIC REVIEW

CHAPTER - 11: TRAFFIC REVIEW

11.1 OVERVIEW

During the last four decades a number of in-depth traffic and transportation planning studies have been undertaken for metropolitan Delhi and the National Capital Region. All these studies have stressed the need to strengthen the institutional set up and to plan, implement, co-ordinate, fund and monitor an integrated urban transport system. Transport planning and expenditure has historically placed disproportionate emphasis on improvements for private motorised vehicles. Economic growth and rising incomes have increased the demand for mobility which, in the context of these planning priorities, has encouraged a shift from non-motorised and public transport to private motor vehicles.

Transport situation in Delhi is rapidly deteriorating because of the increasing travel demand and inadequate transportation system. Despite extensive existing roadways and significant government investment in their expansion, Delhi has been unable to accommodate the growth in private vehicles on its roads.

Fundamentally, the factors causing deterioration in the transport system of metropolitan Delhi are, multi agency planning and implementation, inter agency interests and conflicts, lack of a strong will to improve the public transport system, lack of land use-transport integration, and, above all, a non-existent public transport culture.

11.2 TRAFFIC MITIGATION MEASURES

Traffic mitigation (TM) strategies offer benefits to the public, the Department, State and local agencies involved in construction projects. TM strategies help to improve the flow of traffic through the construction area and along detour routes, minimizing the disruption to motorists and businesses.

TM strategies can be effectively used to educate the public about the purpose of and plans for construction projects, helping to reduce citizen complaints and build goodwill for the Department. TM strategies help to support efficient and timely completion of construction projects, offering cost savings and minimizing the duration of disruption for motorists. Finally, TM strategies can reduce the number of incidents in construction corridors via speed incident detection and emergency response to reopen the route.

Provisions have been made in the tender documents for the sewerage works envisaged under the scope of these works for realizing traffic mitigation benefits for both department and the traveling public and to minimise the construction related disruptions.

11.3 TEMPORARY TRAFFIC MANAGEMENT MEASURES

Temporary traffic management is the process or method of managing road users including vehicles and pedestrians through, around or past an activity on a road reserve safely with a minimum level of inconvenience. Any work being undertaken in the road reserve must be controlled by an approved Traffic Management Plan.

A Traffic Management Plan (TMP) describes the design, implementation, maintenance and removal of an activity being carried out on the carriageway, footpath or road reserve, and how road users will be managed by temporary traffic management measures.

Various provisions made in the tender documents as regards to ensure the safety of the traveling public and to minimise the construction related disruptions are summarized below.

The contract shall be required to implement a comprehensive traffic management plan in agreement with the Engineer to minimize the impacts on the travelling public on any streets affected by construction of recommended works. The contractor will be required to arrange the work sites and order of working in or along carriageways to minimise the interference with the free flow of traffic and shall take all measures and precautions required by the traffic police and road authorities and the Engineer for the safety and convenience of traffic. All workmen working on roads shall be required to wear approved retro-reflective vests at all times.

TMP would be implemented during all construction works. Specific elements of the TMP shall include the use of flaggers and temporary lane realignments to maintain through traffic, signage to direct traffic movements, and possible reduction of speed limits in construction zones. Access to existing businesses within the Project vicinity would be maintained during construction by creating temporary driveways, and/or providing alternate access points.

The Contractor shall be required to carry out all safety measures which includes providing & erecting 2.0m high temporary barricading at site, writing and painting, arrangement for traffic diversion such as traffic signals during construction at site for day and night, glow lamps, reflective signs, making, flags, caution tape as directed by the engineer -in- charge. The excavated trenches shall remain fully barricaded and fitted with caution board/lamps and sign boards for diversion of traffic shall also be provided by the contractor. The pipes shall be so stacked/ placed along the alignment that the flow of traffic is not affected. The Contractor shall be required to obtain required permissions from Traffic Police.

The progress/programme and road opening schedule shall be arranged in details for discussion with the Engineer and the Traffic Police. Transport of the materials of construction will be subject to co-ordination of transport during peak hour traffic in the city.

The work sites shall be arranged in length to be consistent with progress in laying the sewers and sufficient distance between work sites must be maintained to ensure the free flow of road traffic. Where possible, pipeline construction work in roadways will be limited to a width that, at a minimum, maintains alternate one-way traffic flow past the construction zone.

The Contractor shall be required to provide and maintain at each work site proper and efficient automatic traffic lights operating day and night for the full duration of the Works. The Contractor shall be required use of stop and go boards for management of traffic at sites.

The Contractor shall be required to plan and employ necessary traffic diversions at work sites wherever required in agreement with the Engineer and the traffic police.

The Contractor shall be required to discuss and agree the progress/programme and road opening schedule with the Engineer and the Traffic Police.

In case, if opening of the manhole is necessary, the Contractor shall be required to submit a detailed road opening schedule to the Engineer for approval.

The Contractor shall be required to maintain the traffic flow at all times along the roads affected by the work.

The Contractor shall be required to maintain sufficient lighting road signs, barricades and traffic diversion signs along the sites of the works in accordance with the Traffic Police requirements and in agreement with the Engineer.

The Contractor shall also be required to comply with the conditions imposed by Traffic Police and Roads Opening Conditions and Requirements stipulated by DJB.

It is important to maintain adequate traffic capacity at a reasonable level in order to avoid serious congestion. The proposed temporary traffic management schemes shall require ensuring that the potential risk of accident arising from road works is minimized. It is imperative that road safety would be emphasized throughout the construction period.

The implementation of adequate warning signs and Multiple Sequence Warning Signs (MSWS) should be brought forward so that motorists can be alerted of the construction work and information regarding any traffic diversions enforced at the time.

11.4 POTENTIAL TRAFFIC IMPACTS

Provisions have been incorporated in the tenders for the recommended works for ensuring that appropriate traffic management measures will be undertaken during the construction period to ensure that any adverse impact on the travelling public is kept to a minimum:

- It is envisaged that the accesses might be affected by the recommended works. For all accesses and other minor accesses, it is anticipated that access should be maintained at all times where open trench construction crosses these access roads.
- Bus stops will be affected by construction activities; temporary bus stops will be required on both sides of the road positioned at suitable distance outside of the construction area at locations where suitable pedestrian waiting areas are available.
- Before commencement of excavation works, particular attention to the safety of pedestrians will be required.
- Minimal disruption to footpaths and safe pedestrian passage around the road works shall require to be ensured.
- Where temporary footpaths are necessary, they shall be provided before excavation commences and wherever possible pedestrians shall be separated from vehicular traffic by barriers or fencing.

It is envisaged that the impact due to the proposed road opening can be mitigated with the proposed temporary traffic management schemes, provided that the appropriate traffic management measures are carried out during implementation of works.

CHAPTER - 12

LAND REQUIREMENTS

CHAPTER - 12: LAND REQUIREMENTS

12.1 INTRODUCTION

This section reviews the current land status and the availability of the land for sewer pipe laying and sewerage infrastructures that are proposed under Sewerage Master Plan.

Appropriate modifications on the land requirement plan for works may be required during design and construction stage to alleviate land problems.

12.2 LAND REQUIREMENT FOR WORKS

The sewer lines have been proposed to be laid on the roads as far as possible, except in some exceptional cases where the alignment may have to pass through private/agricultural land for which necessary permission of the land owners/land resumption will be required.

As regards to the permission for lying of sewer lines on roads, necessary permission from road owning agencies e.g. Municipal Corporation of Delhi (MCD), Public Works Department PWD, Flood Control and Irrigation deptt. and DSIIDC etc. shall have to be taken prior to execution of work. The land requirement plans based on the preliminary alignment are completed and incorporated into the Layout Plan of the area.

12.3 LAND CLEARANCE AND ACQUISITION

As far as possible, govt. land has been proposed for construction/ setting up infrastructures. However in some areas private/agricultural land may inevitably required. Before the finalization/ detailed design of the schemes, govt. land owning agencies/land acquisition agencies are required to be approached for their consent on the proposal for allotment/acquisition of such land as identified for the purpose as specified above.

12.4 LAND ISSUES FOR NCT OF DELHI

Land issues for the proposed trunk sewers and the associated sewage pumping stations/sewage treatment plants have been studied. In principle, the gravity sewers and pumping mains shall be laid along major roads while the pumping stations/sewage treatment plants shall be located on vacant government lands as far as possible.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS (MoEF)

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

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JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
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15. Delhi Sewerage Master Plan - 2031

ANNEXURE - 1

SHAHDARA DRAINAGE ZONE (SHD)

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SHAHDARA DRAINAGE ZONE (SHD)

1. INTRODUCTION

The Shahdara Drainage zone is bounded by River Yamuna in West and state of Uttar Pradesh on the other three sides with Loni in North, Sahibabad in East and Noida in South. The zone is predominantly residential in nature with large pockets of areas covered by economically weaker sections and lower income groups. There are small pockets of industrial development in Jhilmil, Friends Colony, Patparganj and Shahdara areas. Location of Shahdara Drainage Zone is shown in **Figure 1**.

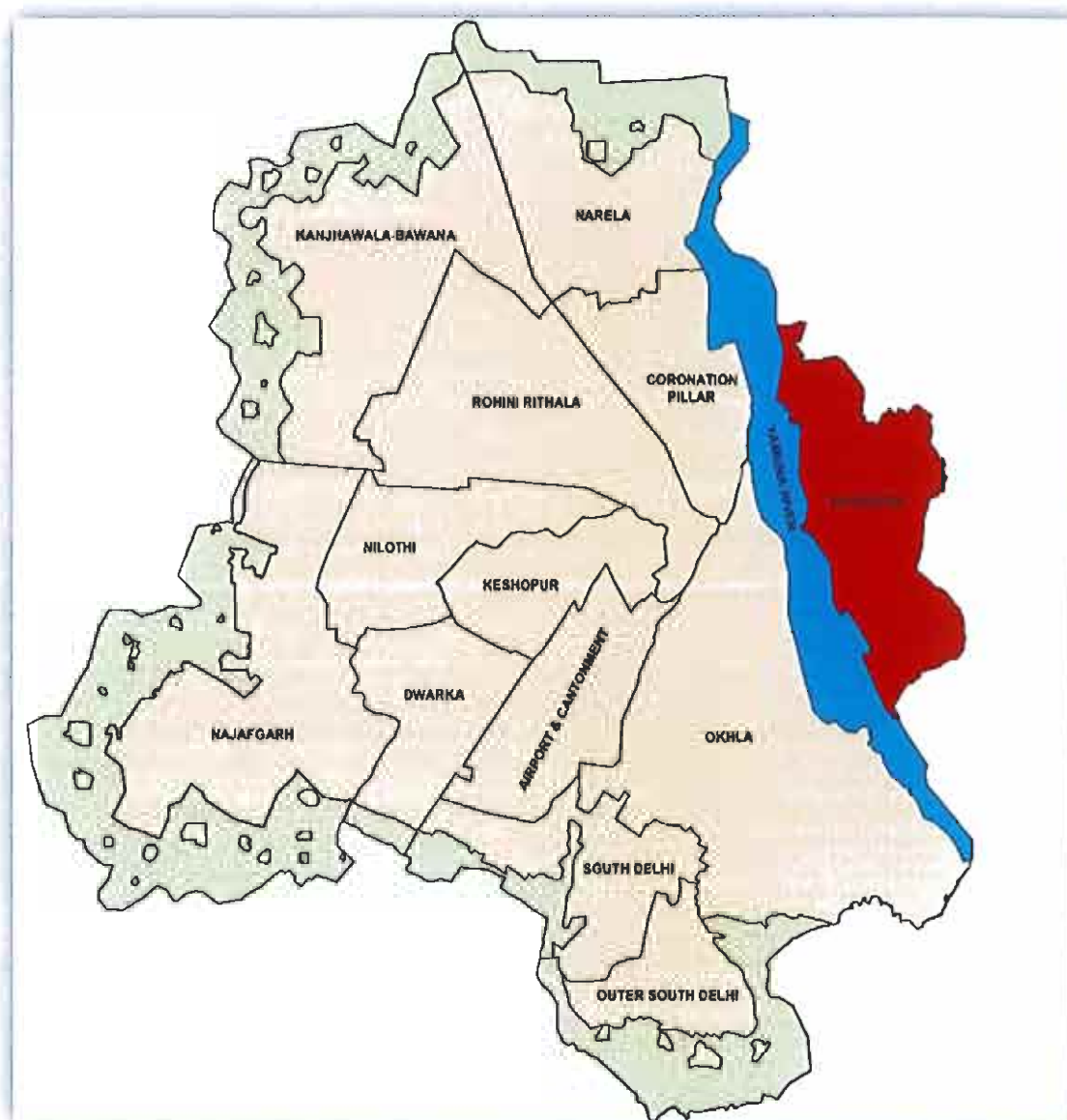


Figure 1: Shahdara Drainage Zone

Shahdara Drainage Zone consists of major areas like Shahdara, Yamuna Vihar, Kondli, Sonia Vihar etc. This drainage zone falls under the DDA planning zone E, whereas Sonia Vihar and Rajiv Nagar fall under River Front Zone O as shown in the **Figure 2**.

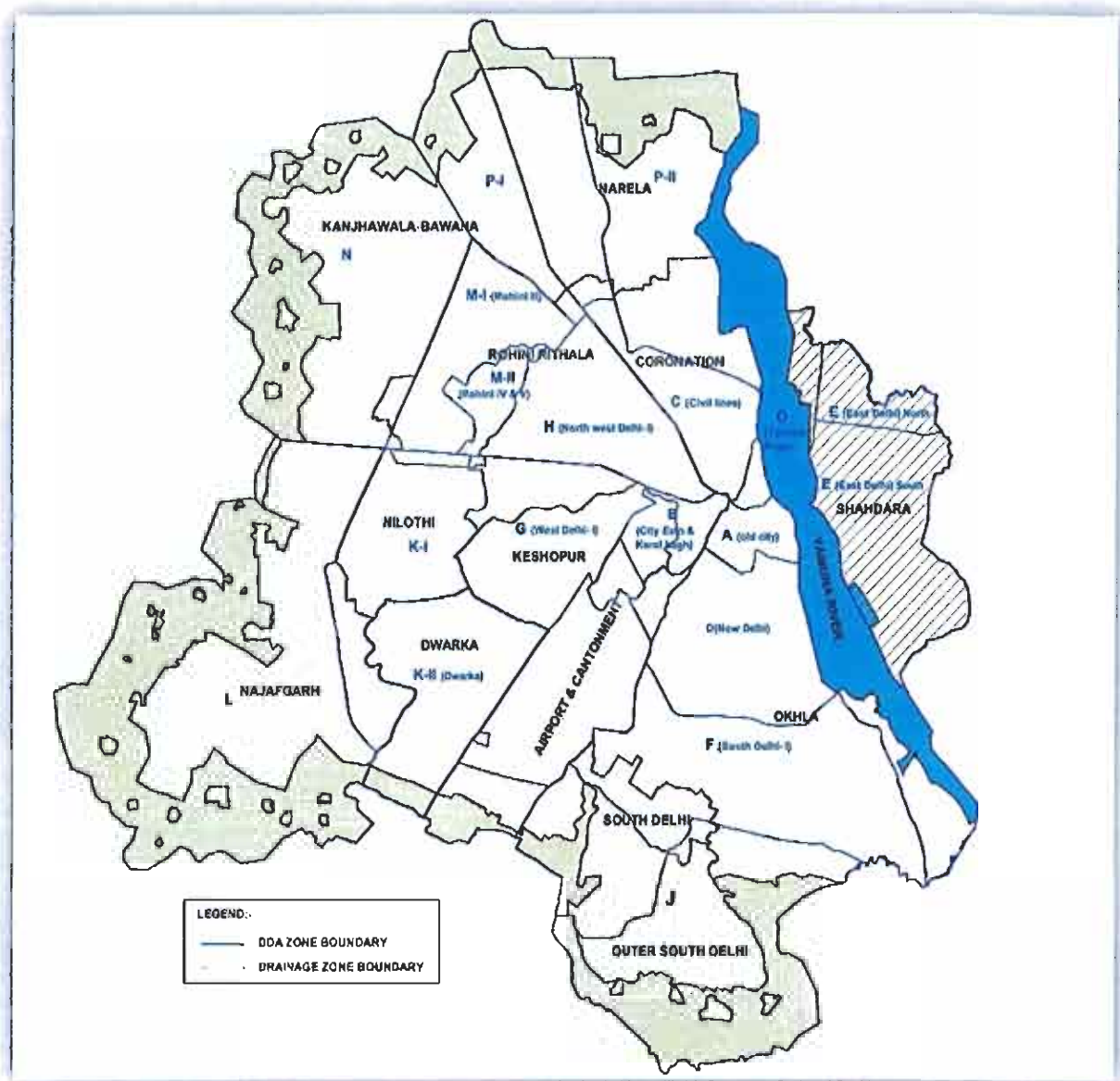


Figure 2: DDA Zones and Shahdara Drainage Zone

Soil Description of Shahdara Drainage Zone

Areas like Bhajan Pura, Yamuna Vihar, Mustafabad, Karawal nagar, Ghonda, Geeta Colony, Laxmi Nagar, Preet vihar, Mayor Vihar etc. with younger alluvium deposits & some of the areas like Vasundra Enclave, Mayur Vihar Phase III, Ghazipur etc. are covered with older alluvium deposits.

Shahdara Zone is most critical from seismic microzonation point of view. This zone is high Hazardous zone due to Liquefaction potential. This Liquefaction factor is due to Newer alluvium proximal to Yamuna river. Special Care to be taken during construction in the areas like Mustafabad, Karawal Nagar, Geeta Colony, Laxmi Nagar, Kailash Nagar, Silampur, Anandi Vihar, Mayur Vihar, Yamuna Vihar, Dilshad Garden, Preet Vihar, Nand Nagri, Bhajanpura, Mansarovar Park area, Kondli, Vasundra Enclave, Mayur Vihar Phase-III etc.

This Zone is having varying Water Depth ranging from 5 – 20m. Left peripheral portion of this zone having Mustafabad, Karawal Nagar, Geeta Colony, Laxmi Nagar, Kailash Nagar, Silampur etc. is having water depth of 2-5m. The central portion of this drainage zone which includes Anandi Vihar, Mayur Vihar, Yamuna Vihar, Dilshad Garden, Preet Vihar, Nand Nagri, Bhajanpura, Mansarovar Park area etc. is having

water depth 5-10m. One corner of this zone having Kondli, Vasundra Enclave, Mayur Vihar Phase-III etc. is having water depth of 10-20m. This zone is fully covered with Khadar soil.

2. MASTER PLANNING FOR SHAHDARA DRAINAGE ZONE

The boundaries of zones have been decided based on topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The Drainage Zone is partially sewerage. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone, Sewerage Status and Land Use is shown in the **Figure 3**.

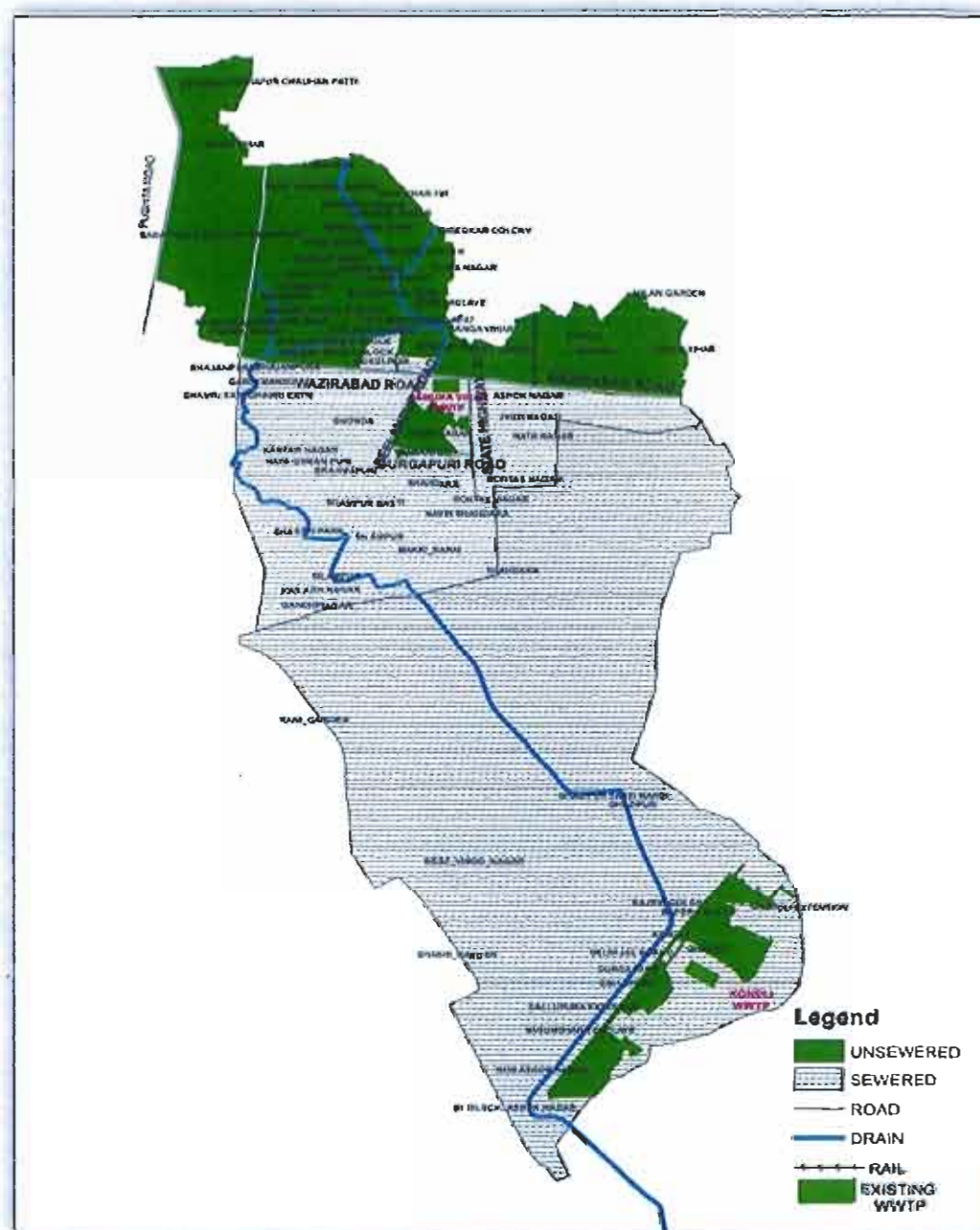


Figure 3: Sewerage Status of Shahdara Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data has been gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

The feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in a phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Shahdara Drainage Zone has been divided into three (3) sub-drainage zones as below:

- Yamuna Vihar (SHD-YV)
- Kondli (SHD-KN)
- Sonia Vihar (SHD-SV)

The three sub drainage zones and contour maps of Shahdara Drainage Zones are shown in **Figure 4, 5, 6 & 7.**

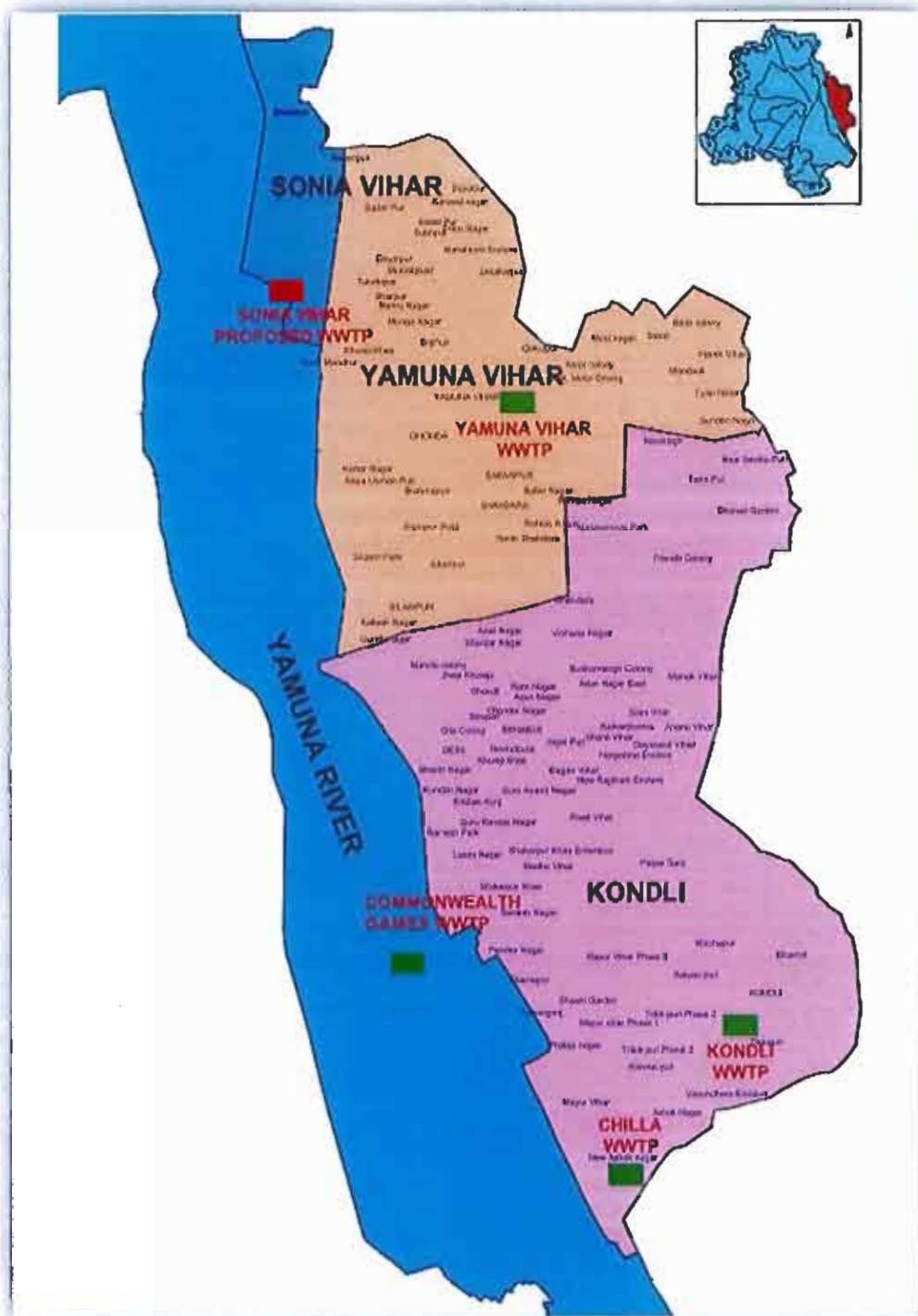


Figure 4: Sub Drainage Zone Map of Shahdara Drainage Zone (SHD)

Contours maps for unsewered areas of sub Drainage Zones are as shown in **Figure 5** to **Figure 7** below:

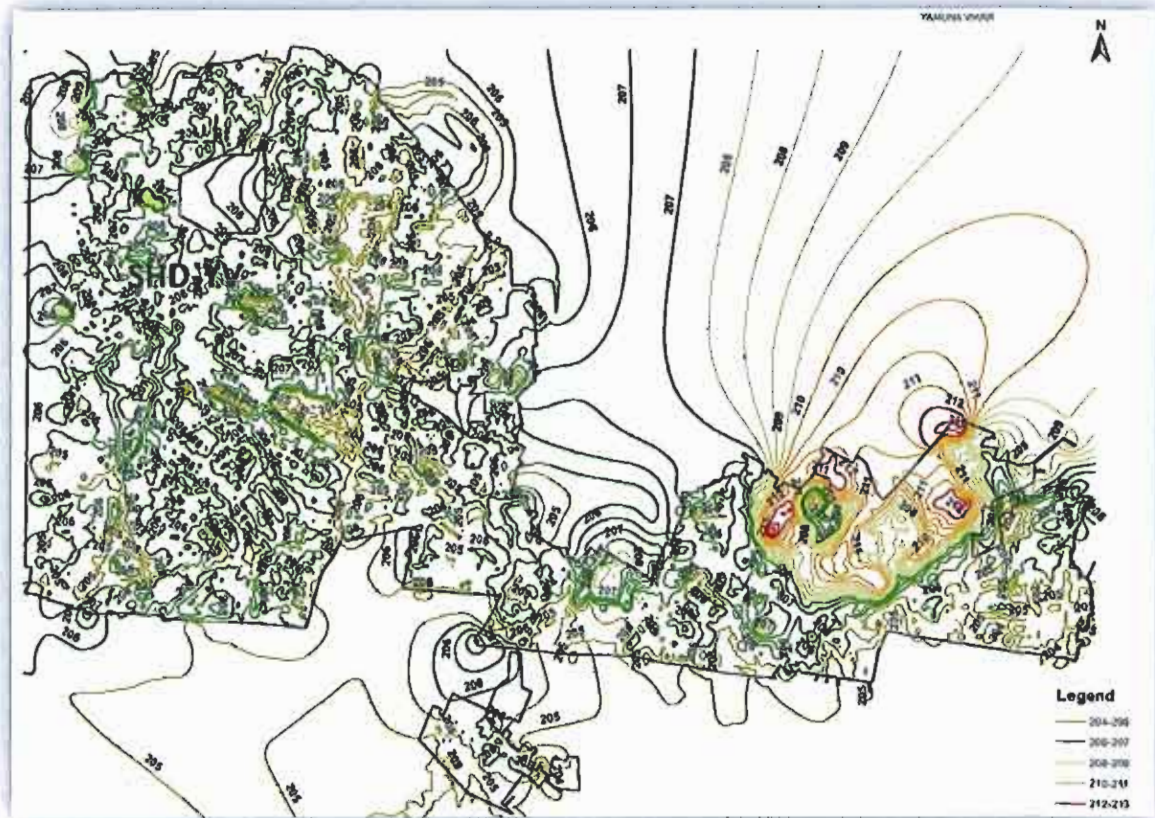


Figure 5: Contour Map of Sub-Drainage Zone (SHD-YV)

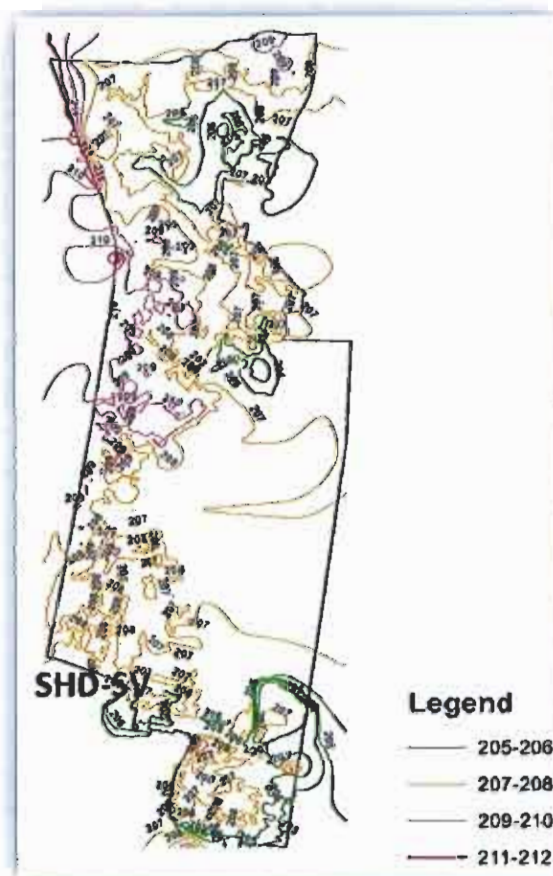


Figure 6: Contour Map of Sonia Vihar Sub-Drainage Zone (SHD-SV)

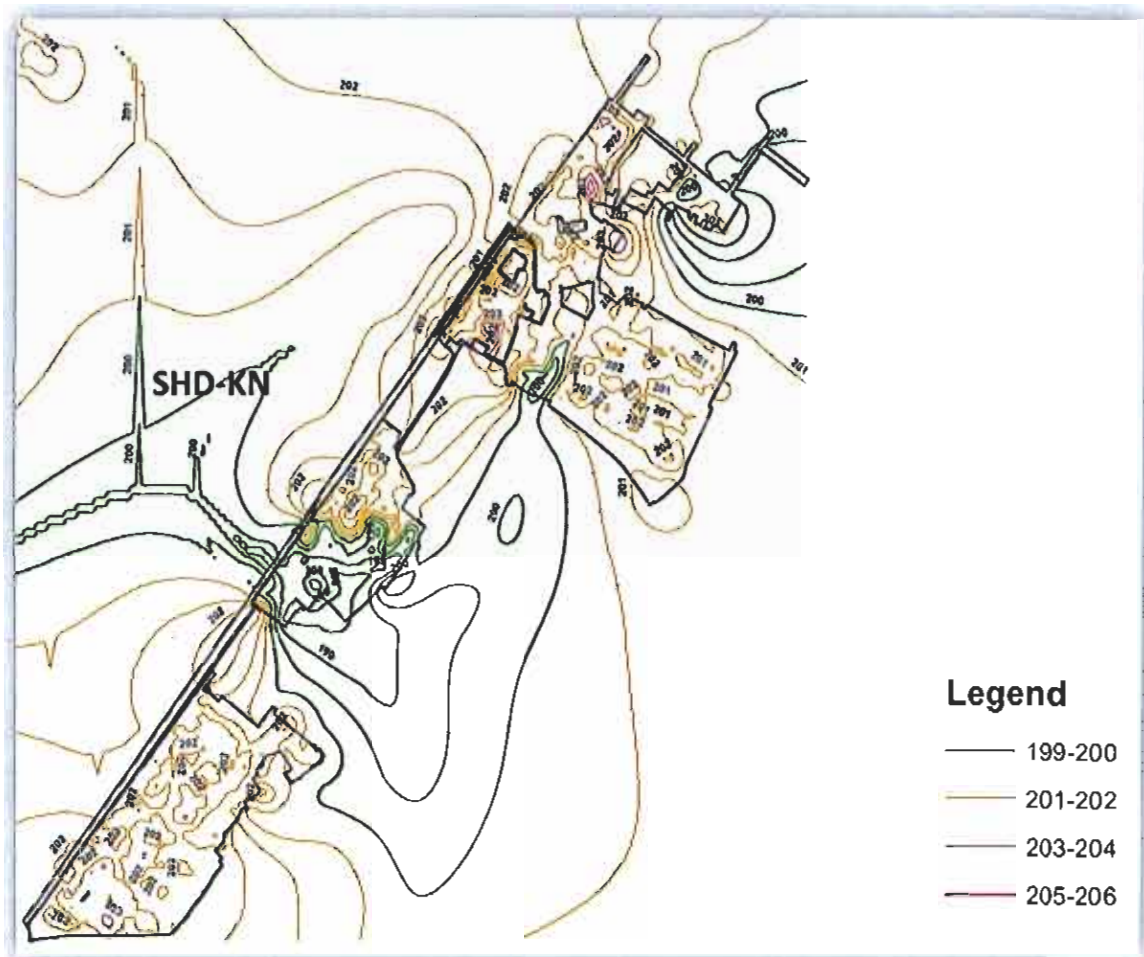


Figure 7: Contour Map of Kondli Sub-Drainage Zone (SHD-KN)

Based on population projections Sub-Drainage Zone wise estimated sewage generation is presented in the table below:

Table 1: Estimated Sewage Generation of SHD Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
SHD-YV	158.26	181.28	204.30	34.90	39.90	45.00
SHD-KN	316.52	362.56	408.60	69.70	79.90	90.00
SHD-SV	24.62	28.20	31.78	5.40	6.20	7.00
Total	499.40	572.04	644.68	110.00	126.00	142.00

3.1 Sub Drainage Zone: Yamuna Vihar (SHD-YV)

This Sub Drainage Zone spread across Yamuna Vihar, Karawal Nagar, Mustafabad, Gokulpur, Saboli, Mandoli, Harsh Vihar, Milan Garden, Ghonda, Jyoti Nagar, Silampur etc. The area is partially sewered and there is an existing WWTP known as Yamuna Vihar WWTP. Land use map is as shown in the Figure 8.

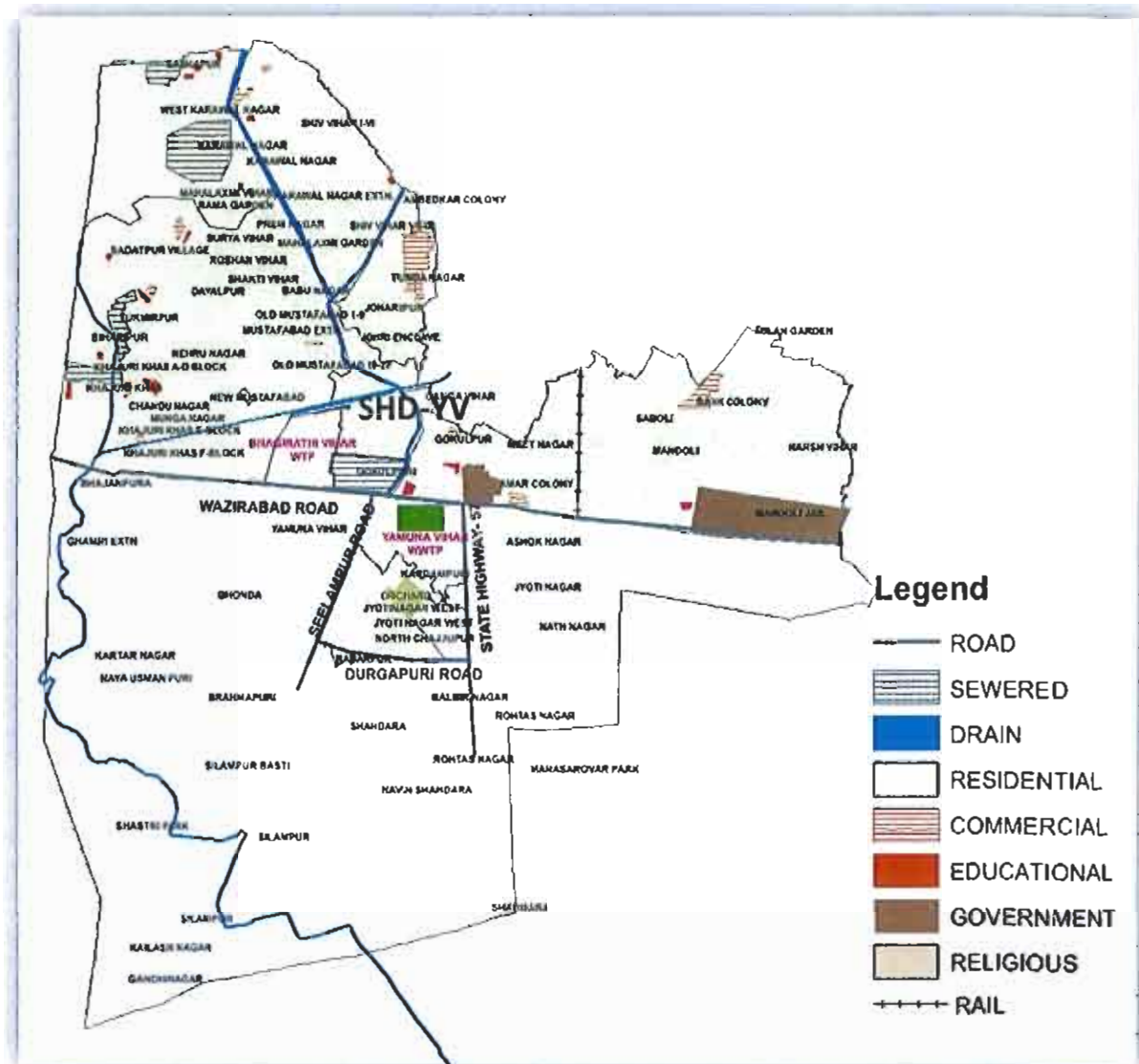


Figure 8: Land Use Map of Shahdara Sub Drainage Zone (SHD-YV)

Existing Sewerage Infrastructure

The existing wastewater network system of Yamuna Vihar is divided into two portions namely North Shahdara and South Shahdara. North Shahdara observes highest density amongst other sub-drainage / drainage zone.

Southern part of the Sub Drainage Zone is mostly sewered with few pockets of unsewered areas.

The sub drainage zone has existing WWTPs with combined capacity of 20 MGD. Another WWTP of 25 MGD capacity is under construction and is likely to be commissioned June / July, 2014.

The details of existing WWPS and their integration arrangement have been shown in the line diagram as **Figure 9**.

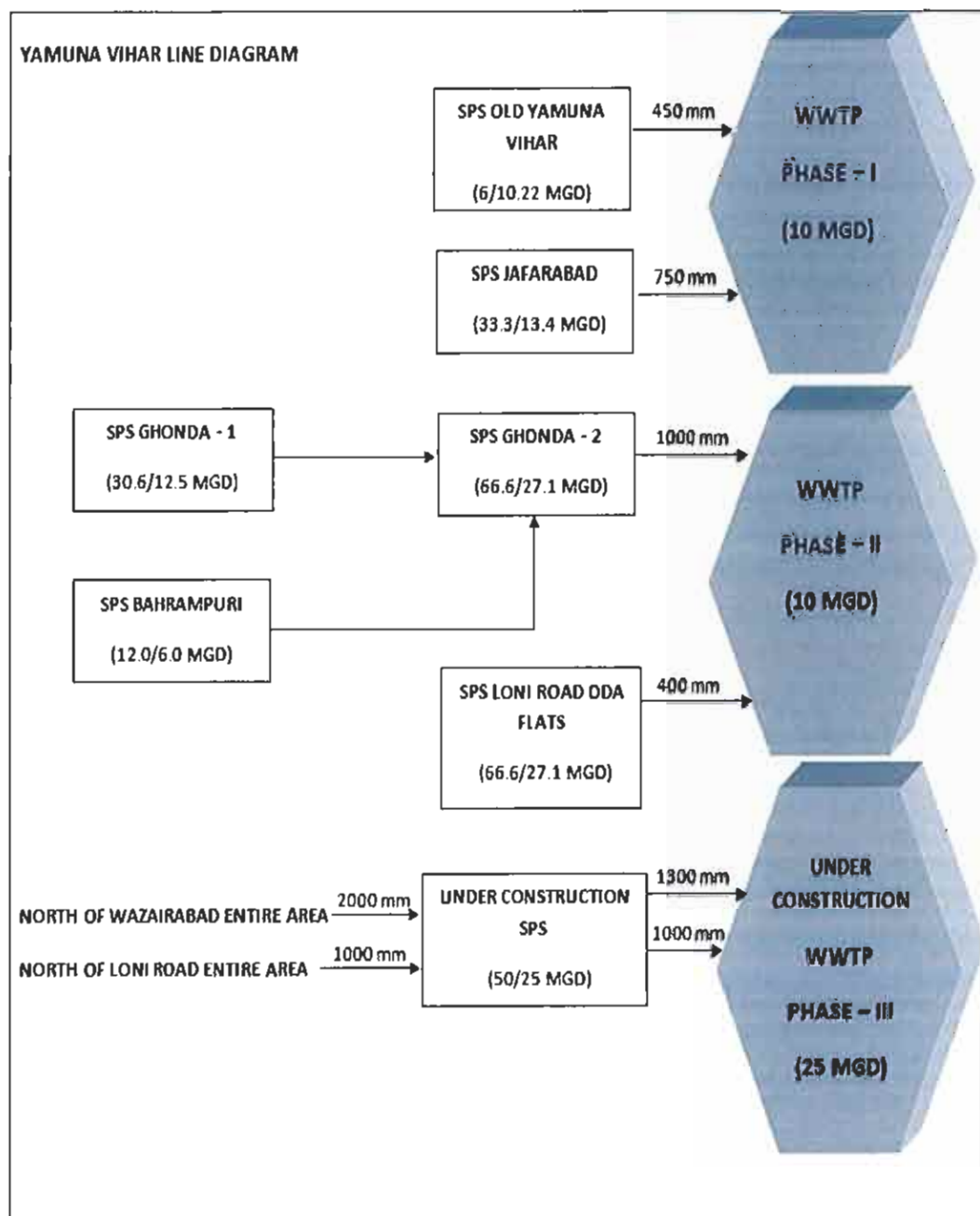


Figure 9: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Wazirabad Trunk Sewer has been laid recently under YAP II, which shall act as trunk sewer to cater the sewage generated from most of the areas to Yamuna Vihar WWTP.

DJB is in progress of implementing Interceptor Sewer Project in this sub drainage zone to intercept all sub drains outfalling to Shahdara drain by Interceptor Sewer. Further, it is proposed to utilize Interceptor Sewer as trunk sewer for unsewered areas with integration to proposed network.

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Wazirabad Road Sewer and Interceptor Sewer are being utilized as trunk sewer for the Sub Drainage Zone. The hydraulic analysis shows that the capacity of Wazirabad Sewer and Interceptor Sewer will be sufficient to cater 2031 sewage load from this sub zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in figure as below:

- Sewage from West Karawal Nagar, Sabhapur, Karawal Nagar, Mahalaxmi Vihar, Rama Garden, Karawal Nagar Extension, Shiv Vihar, Johri Enclave, Ganga Vihar, Gokulpuri and nearby area is routed to proposed Interceptor Sewer.
- Sewage from Surya Vihar, Sadatpur Village, Roshan Vihar, Dayalpur, Nehru Nagar, Tukmirpur, Biharipur, Khajuri Khas, Chandu Nagar, Munga Nagar, Nehru Nagar, New Mustafabad, Tunda Nagar, Johripur, Johri Enclave, Karawal Nagar Extension, Rama Garden 1, Prem Nagar, Mahalaxmi Garden, Bhagat Vihar, Roshan Vihar, Babu Nagar, Dilshad Garden, Shakti Vihar, Mustafabad, Bhagirathi Vihar, Brijpuri, Chandbag Tunda Nagar, Johri Enclave and nearby area is routed to with existing Wazirabad Road Sewer.
- Sewage from unsewered parts of Kardampuri, Jyoti Nagar and nearby area is routed to Existing Trunk Sewer towards existing Shahdara WWPS.
- Sewage from Buland Masjid is routed to individual WWPS at Buland Masjid and then via rising main to Existing Brahmpuri WWPS.

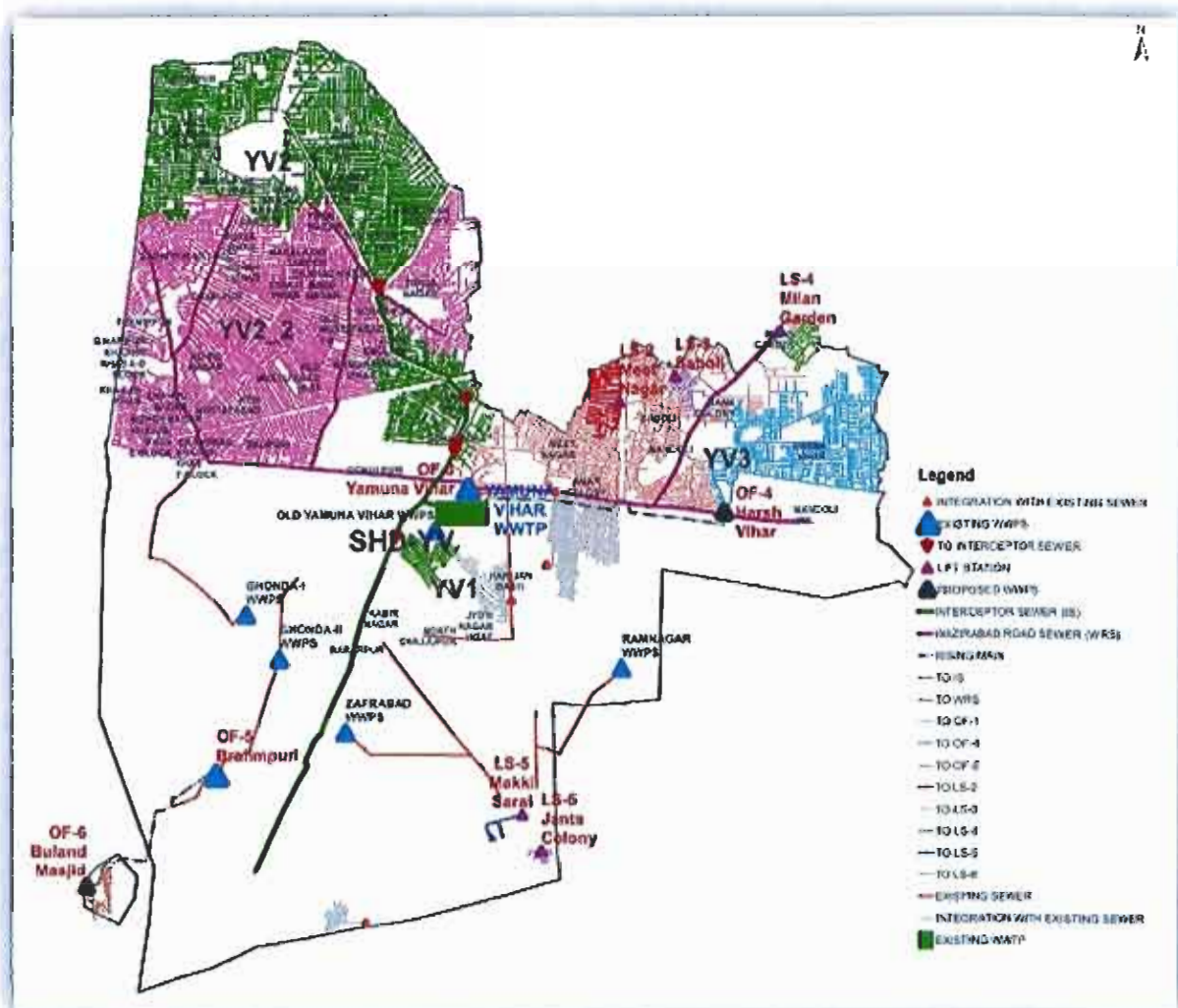


Figure 10: Scheme Map of Yamuna Vihar Sub Drainage Zone (SHD-YV)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Yamuna Sub Drainage zone is shown in the **Figure 10**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	556332
300	HDPE/DWC	8715
350	HDPE/DWC	6574
400	HDPE/DWC	5124
500	HDPE/DWC	2428
563.6	HDPE	1845
635.2	HDPE	1618
700	RCC NP3/NP4	206
800	RCC NP3/NP4	272
1000	RCC NP3/NP4	978
1100	RCC NP3/NP4	540
1200	RCC NP3/NP4	368
Total		585000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewer and represented in figure below. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as built drawings.

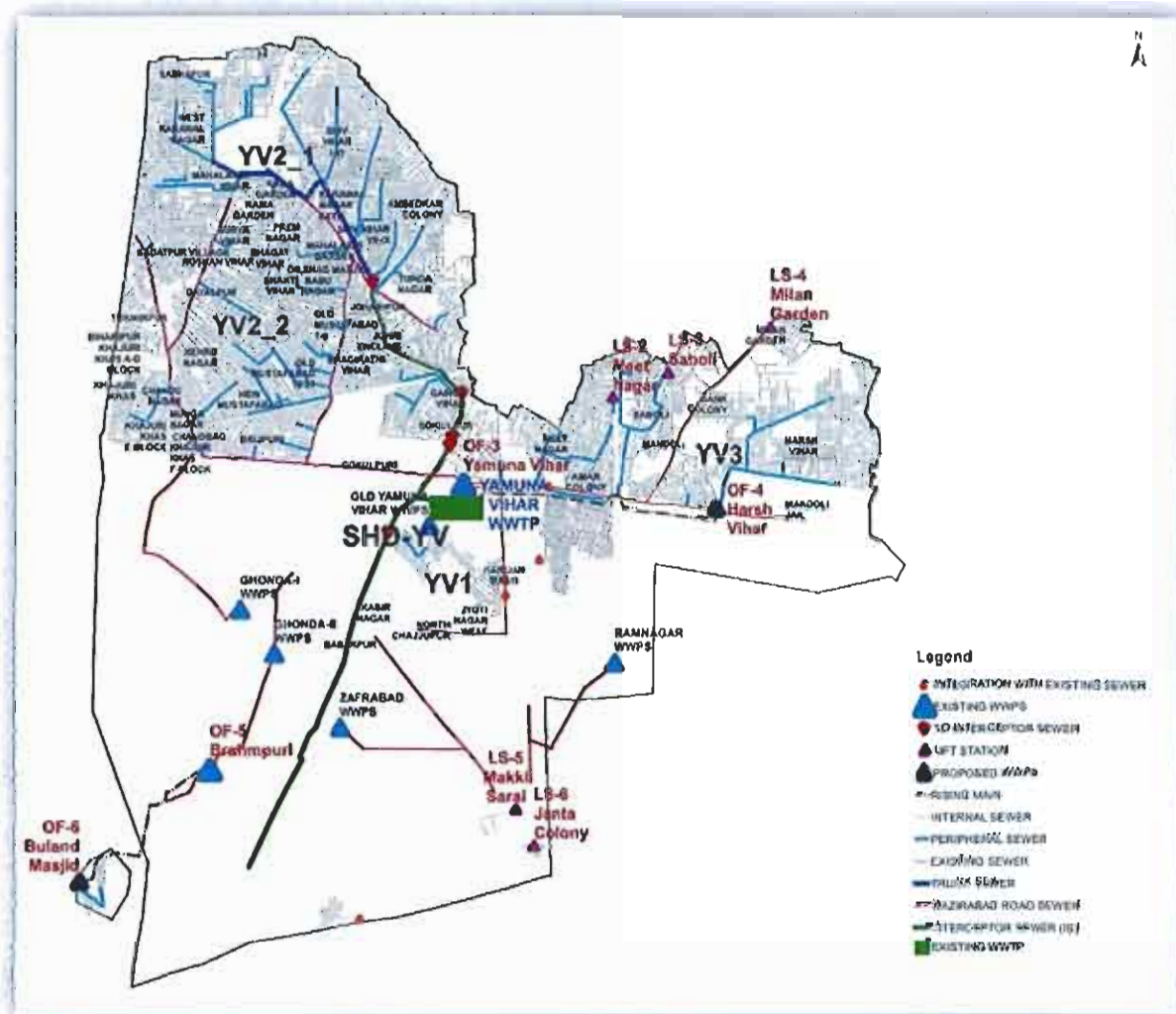


Figure 11: Proposed Sewerage Infrastructure of Yamuna Vihar Sub Drainage Zone (SHD-YV)
Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Milan Garden	LS	0.30	100	1	30	Nearest Manhole
2	Meet Nagar	LS	1.30	250	1	265	Nearest Manhole
3	Saboli	LS	0.50	150	1	70	Nearest Manhole
4	Harsh Vihar	WWPS	4.00	500	1	2400	Yamuna Vihar WWTP
5	Buland Masjid	LS	1.50	300	1	2000	Existing WWPS

Waste Water Treatment Requirements

The existing Waste Water Treatment capacity of 45 MGD at Yamuna Vihar was found to be sufficient to cater anticipated sewage load for design year 2031 from the sub drainage zone. No additional treatment capacity has been proposed for this Sub Drainage Zone.

3.2 Sub Drainage Zone: Kondli (SHD-KN)

The Sub Drainage Zone is spread across Geeta Colony, Preet Vihar, Mandawali, Ghazipur, Shashi Garden, Kondli, New Ashok Nagar, Dallupura etc. The area is mostly sewered and there are WWTPs at 3 locations i.e. Kondli (90 MGD), Chilla (9 MGD; to be commissioned by June / July 2014) and Common Wealth Games Village (1 MGD). Land use map for unsewered areas is as shown in the **Figure 12**.

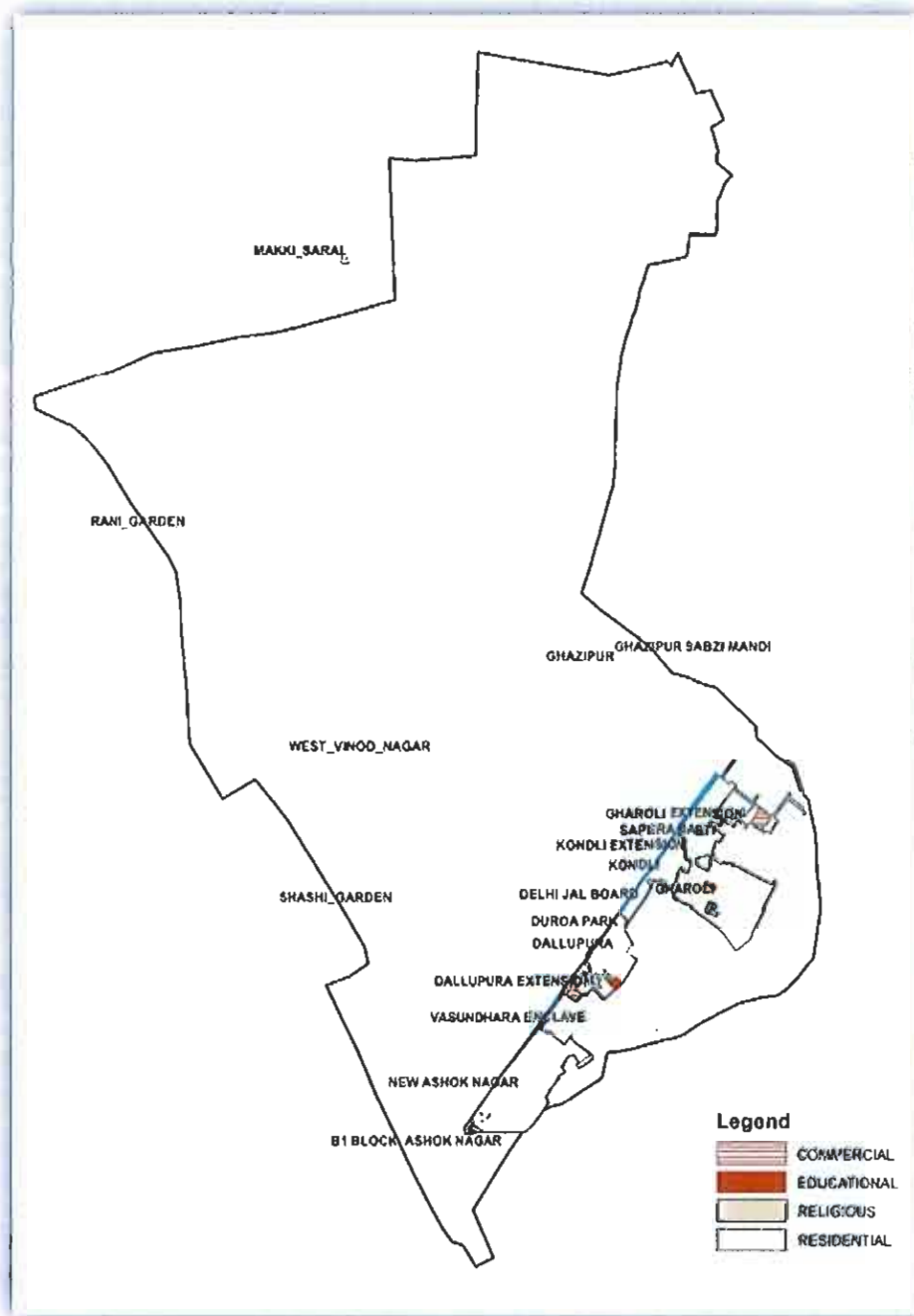


Figure 12: Land Use Map of Kondli Sub Drainage Zone (SHD-KN)

Existing Sewerage Infrastructure

Sewerage Network already exists in most of the areas in Sub Drainage Zone. Trunk Mains in this zone have already been laid along the main roads. The wastewater generated from this Sub Drainage Zone leads to major WWPSs namely Preet Vihar WWPS, Jagrati WWPS, Kalyanpuri WWPS, Dallupura WWPS, Gharauli WWPS. There is an existing WWTP of 90 MGD known as Kondli WWTP. Out of which 45 MGD is recently commissioned.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 13**:

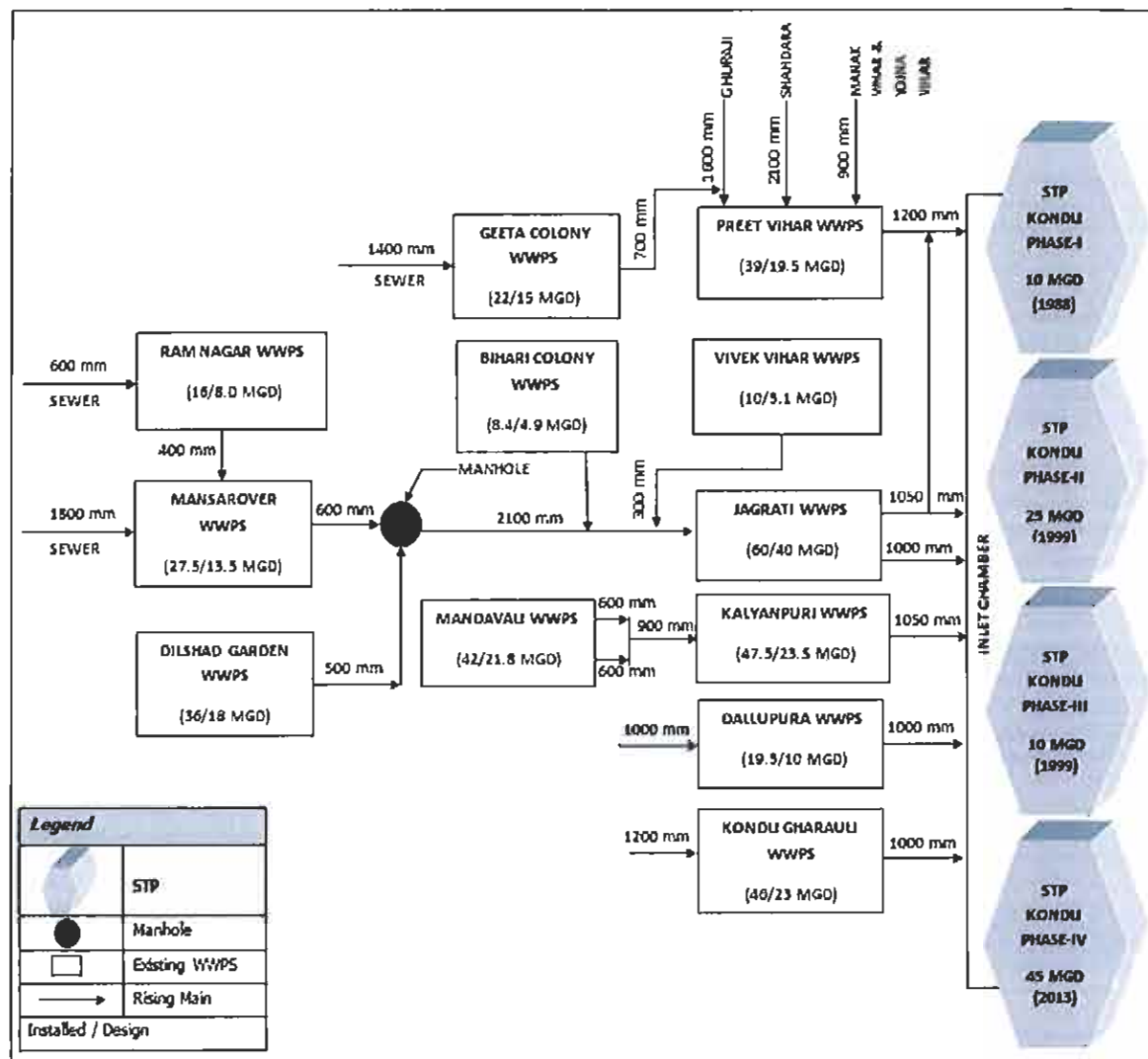


Figure 13: Flow Chart of Existing Major Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 1** :

- Sewage from unsewered parts of West Vinod Nagar, Mandawali, Fazalpur and nearby area is routed to Existing Trunk Sewer towards Existing Mandawali WWPS.

- Sewage from Ashok Nagar, Dallupura and nearby area is routed to Existing Trunk Sewer towards Existing Dallupura WWPS.
- Sewage from Gharoli and nearby area is routed to Existing Trunk Sewer towards Existing Gharoli WWPS.

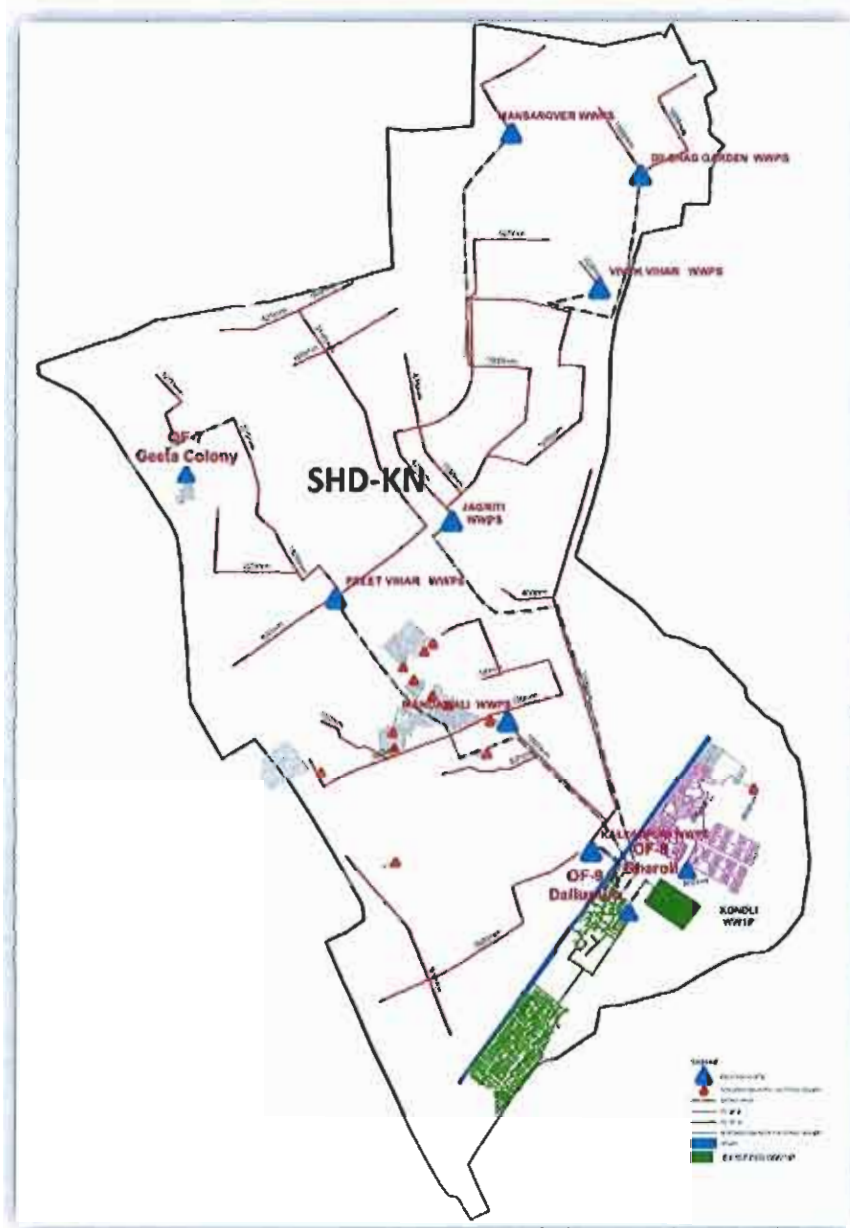


Figure 14: Scheme Map of Kondli Sub Drainage Zone (SHD-KN)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Kondli Sub Drainage Zone is shown in the figure above.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimise the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Table 4: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	152542
300	HDPE/DWC	1909
350	HDPE/DWC	1685
400	HDPE/DWC	1101
500	HDPE/DWC	995
563.6	HDPE	229
635.2	HDPE	539
Total		159000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in figure below. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

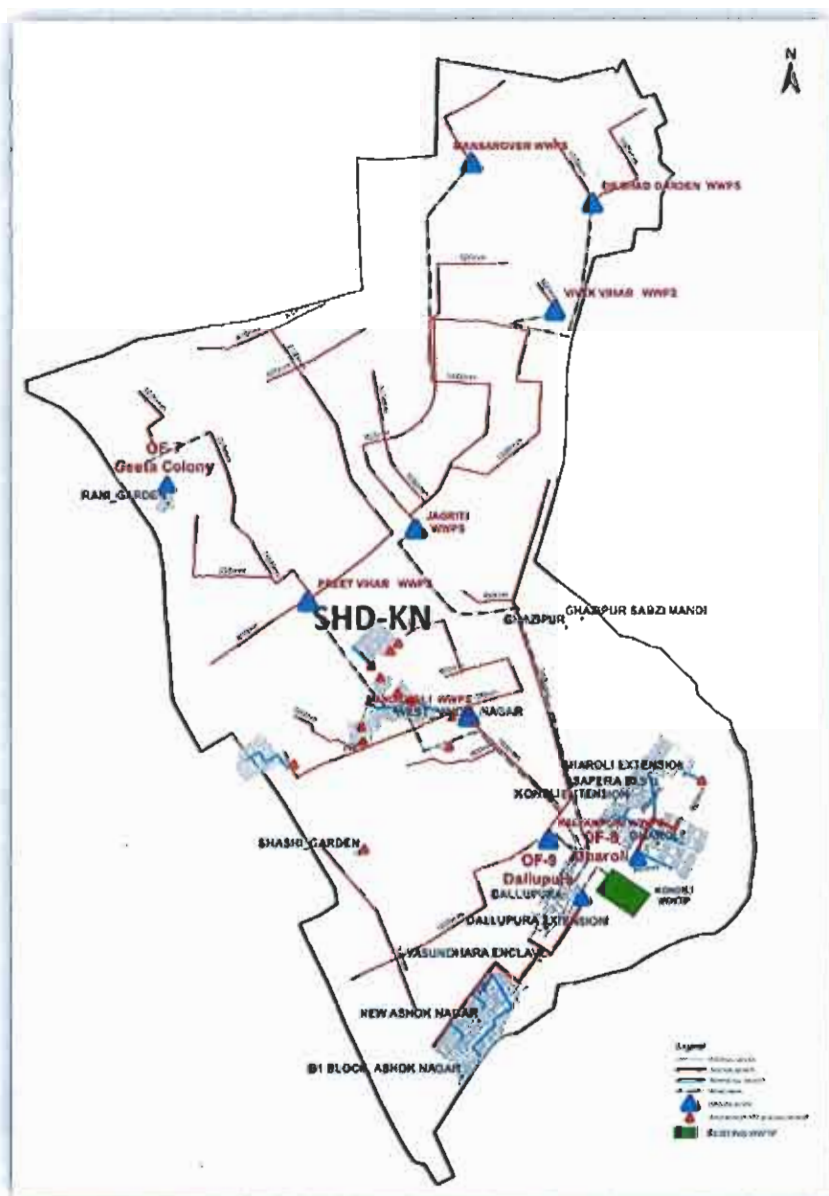


Figure 15: Proposed Sewerage Infrastructure of Kondli Sub Drainage Zone (SHD-KN)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Makki Sarai	LS	0.10	100	1	250	Nearest Manhole
2	Janta Colony	LS	0.50	150	1	120	Circular Road Trunk Sewer

Waste Water Treatment Requirements

No additional treatment capacity requirements proposed for the Sub Drainage Zone.

3.3 Sub Drainage Zone: Sonia Vihar (SHD-SV)

This sub drainage zone falls under DDA Zone "O" and lies between two parallel Pushta Roads. Land use map is as shown in the **Figure 16**.

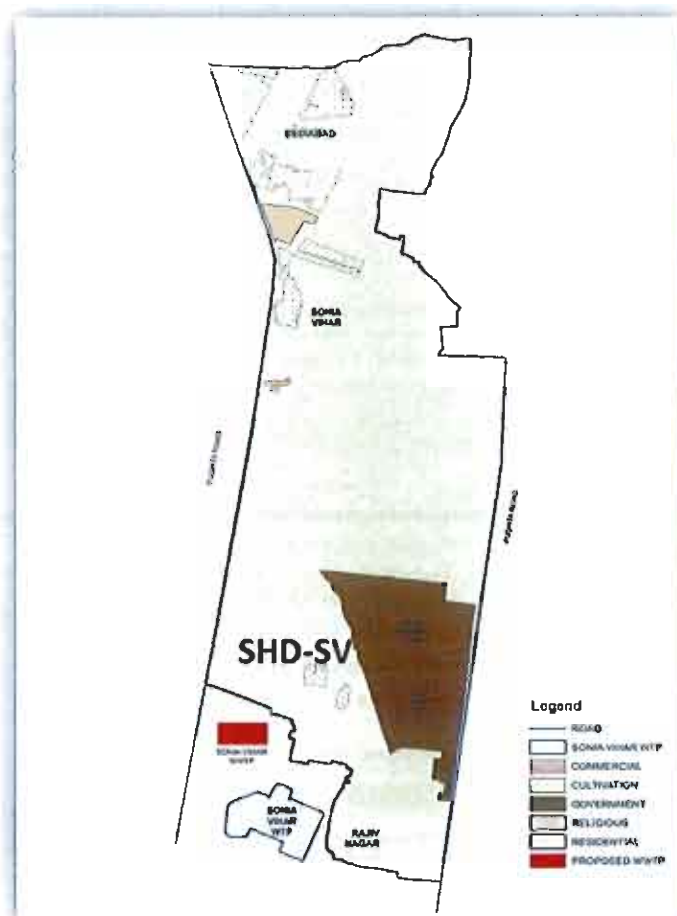


Figure 16: Land Use Map of Sonia Vihar Sub Drainage Zone (SHD-SV)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 17** as below:

- The area is unsewered and no sewage treatment facility exists.
- One WWTP is proposed of capacity 7 MGD the Sub Drainage Zone.
- Sewage from Southern part of Sonia Vihar and Rajiv Nagar is routed to Proposed WWPS at Rajiv Nagar (OF: 2) and then via rising main to Proposed Sonia vihar WWTP.
- Sewage from Northern part of Sonia Vihar and Bediabad is routed to Proposed WWPS at Sonia Vihar (OF: 1) and then via rising main to Proposed Rajiv Nagar WWPS. One intermediate Lift Station is proposed at Bediabad (LS-1).

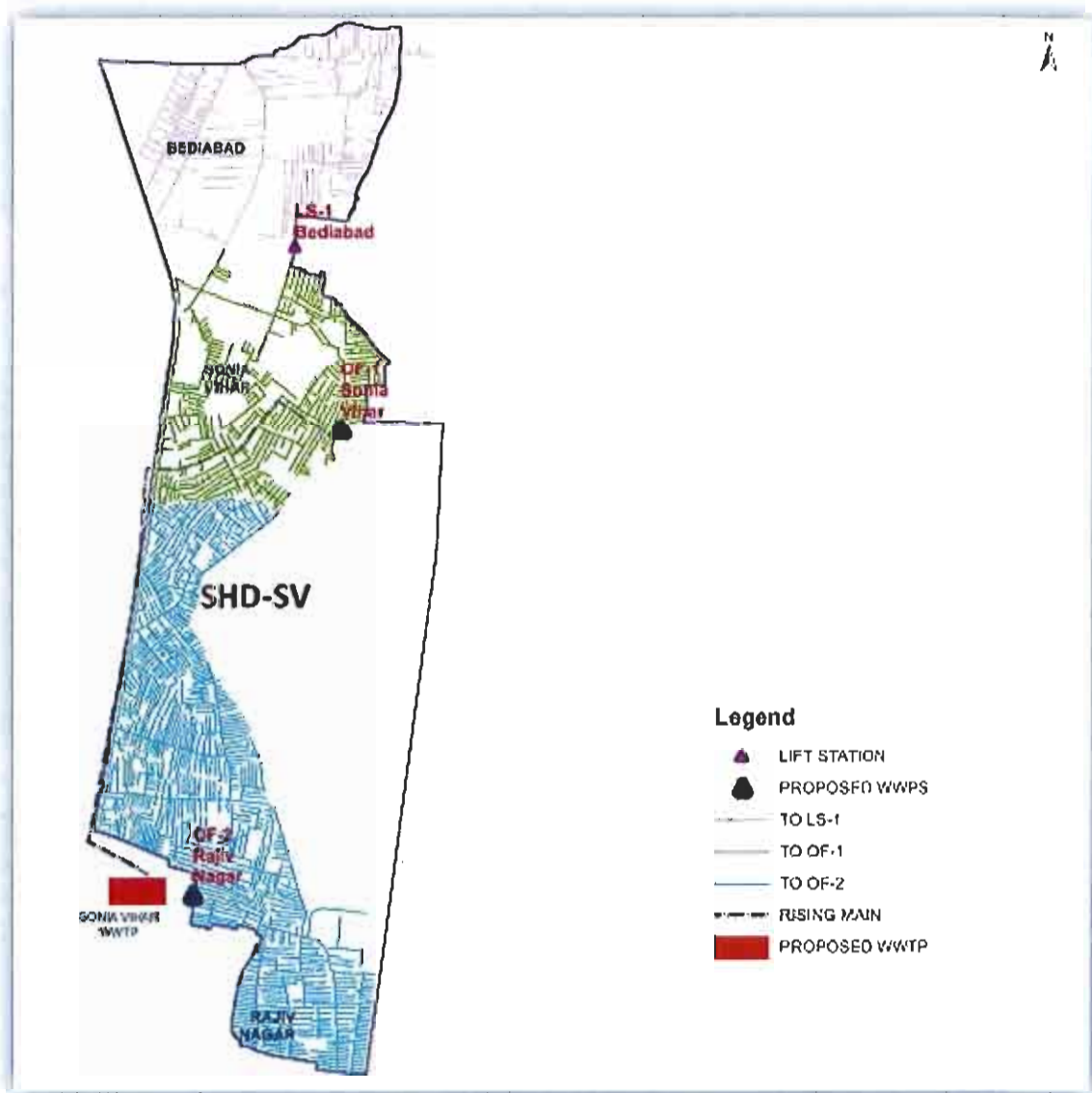


Figure 17: Scheme Map of Sonia Vihar Sub Drainage Zone (SHD-SV)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Sonia Vihar Drainage Zone is shown in the figure above.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewerage network details are shown in **Table 6**.

Table 6: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	139376
300	HDPE/DWC	940
400	HDPE/DWC	2695
500	HDPE/DWC	2045
563.6	HDPE	1730
635.2	HDPE	778
700	RCC NP3/NP4	813
800	RCC NP3/NP4	190
900	RCC NP3/NP4	433
Total		149000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in figure below. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

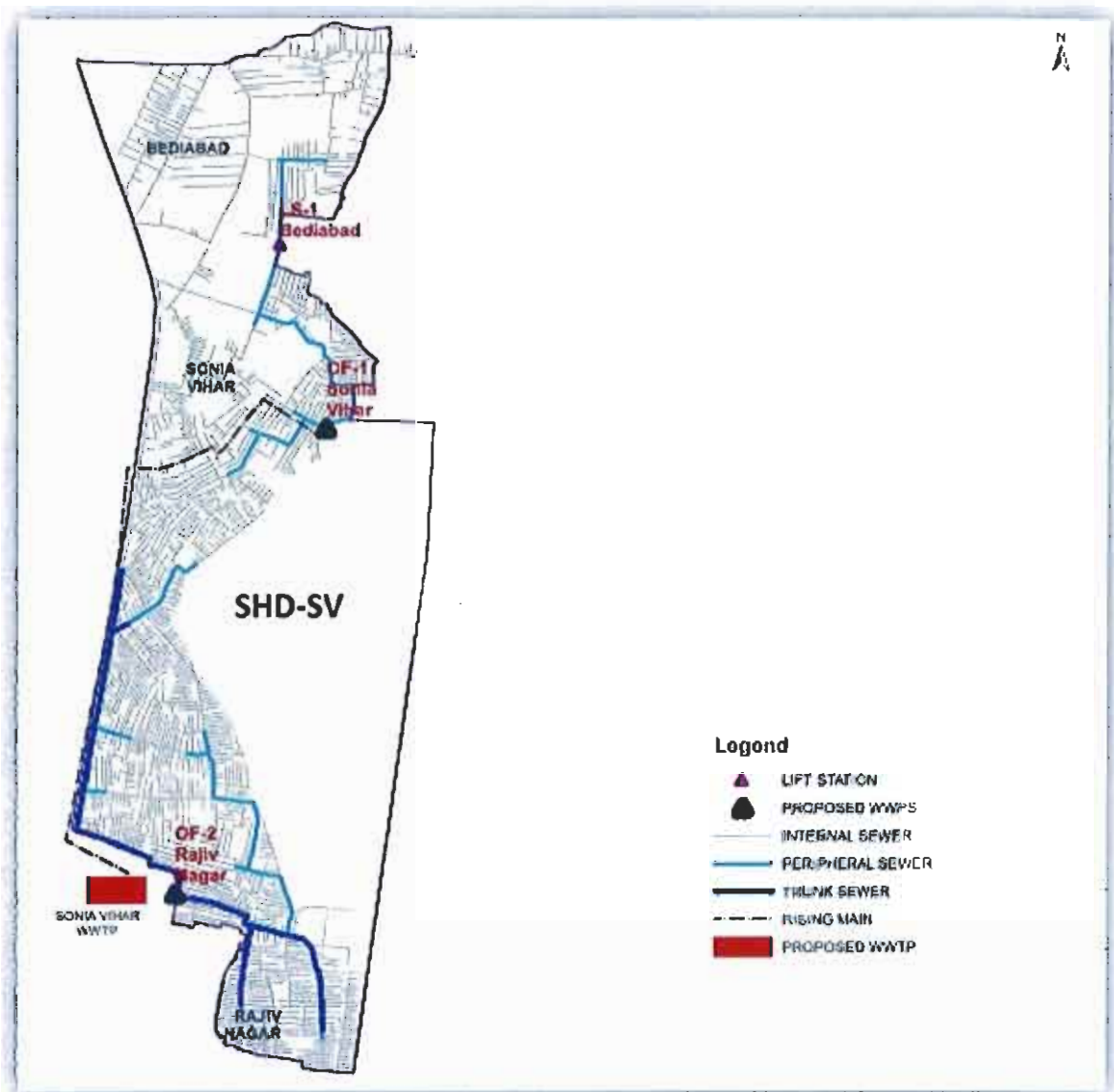


Figure 18: Proposed Sewerage Infrastructure of Sonia Vihar Sub Drainage Zone (SHD-SV)

Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; however, necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 7**.

Table 7: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Sonia Vihar	WWPS	4.30	500	1	3300	proposed WWTP
2	Rajiv Nagar	WWPS	12.00	700	1	50	proposed WWTP
3	Bediabad	LS	1.50	250	1	15	Nearest Manhole

Waste Water Treatment Requirements

One WWTP of 7 MGD Capacity is proposed for this Sub Drainage Zone.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 8**.

Table 8: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Yamuna Vihar	(SHD-YV)	585	1	4	-
Kondli	(SHD-KN)	159	-	2	-
Sonia Vihar	(SHD-SV)	149	2	1	1
Total		893	3	7	1

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 9**.

Table 9: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP		Pumping Station			
	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Yamuna Vihar	-	-	Milan Garden	LS	0.3	11.5
			Meet Nagar	LS	1.3	17.6
			Saboli	LS	0.5	14.4
			Harsh Vihar	WWPS	4.0	2132.0
			Buland Masjid	LS	1.5	44.3
Kondli	-	-	Makki Sarai	LS	0.1	30.2
			Janta Colony	LS	0.5	34.1
Sonia Vihar	7	4.0 - 5.0	Sonia Vihar	WWPS	4.3	2079.5
			Rajiv Nagar	WWPS	12.0	2847.0
			Bediabad	LS	1.5	44.3

Line Diagram for Proposed WWPS and WWTP for Yamuna Vihar Sub-Drainage Zone is shown in **Figure 19**.

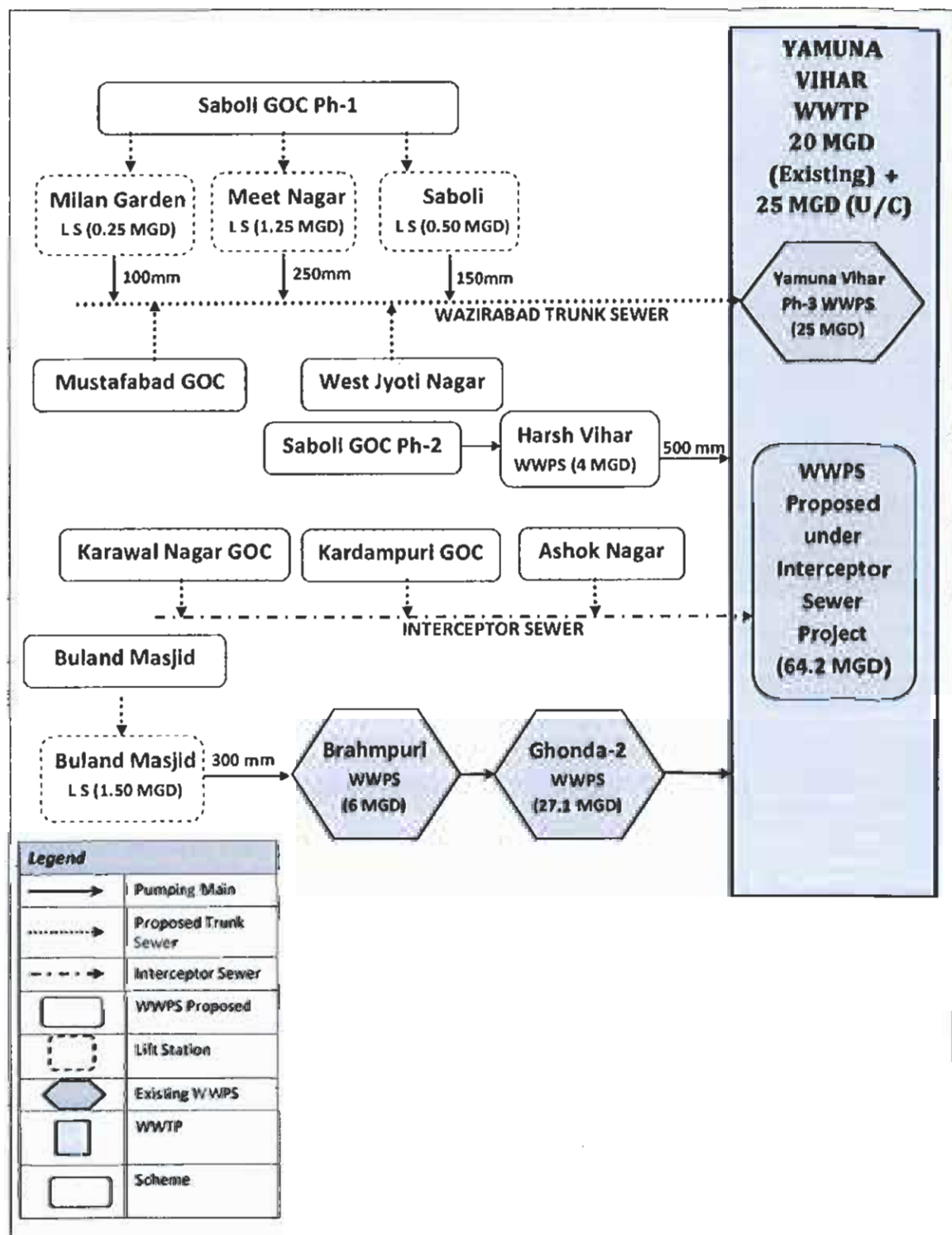


Figure 19: Line Diagram for Proposed WWPS and WWTP – Yamuna Vihar

Line Diagram for Proposed WWPS and WWTP for Sonia Vihar Sub-Drainage Zone is shown in **Figure 20**.

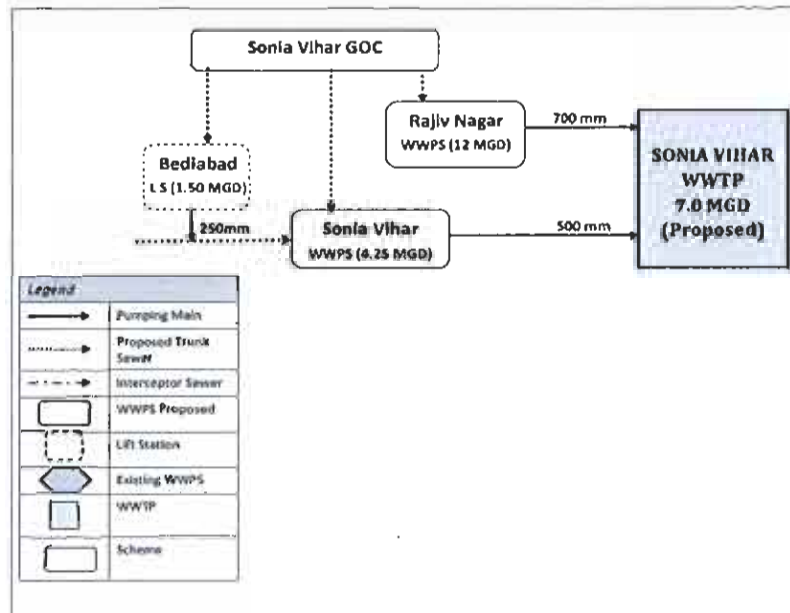


Figure 20: Line Diagram for Proposed WWPS and WWTP – Sonia Vihar

Line Diagram for Proposed WWPS and WWTP for Kondli Sub-Drainage Zone is shown in **figure 21**:

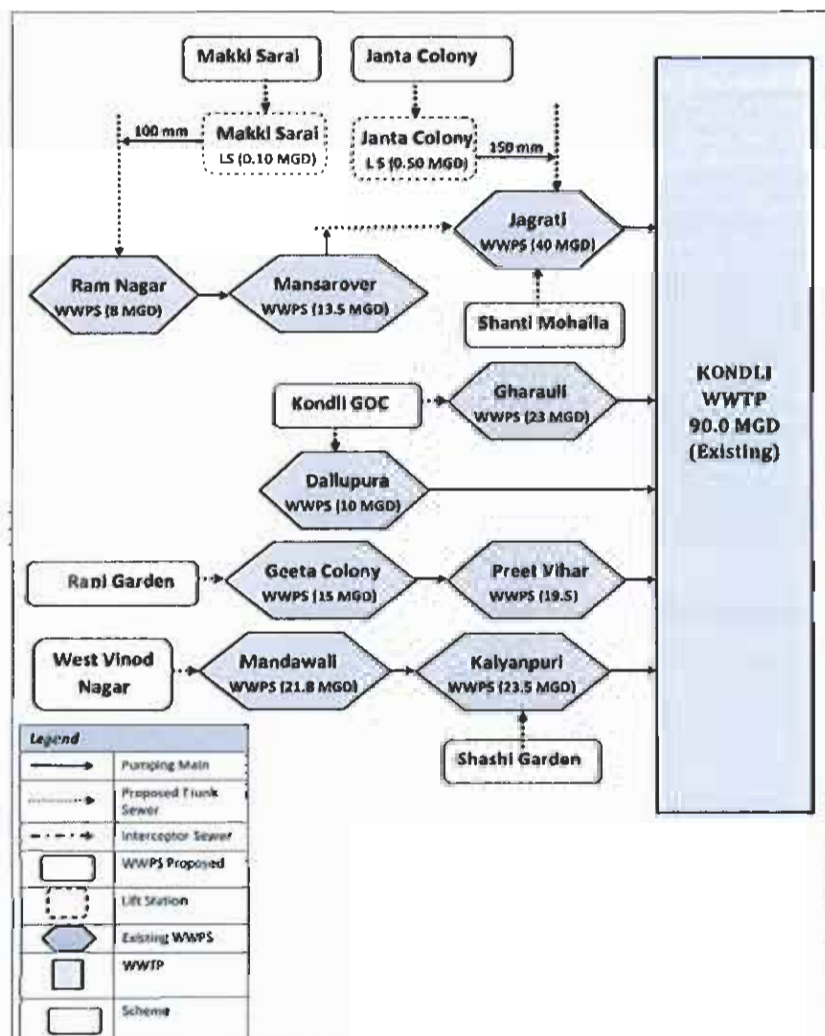


Figure 21: Line Diagram for Proposed WWPS and WWTP – Kondli

Disposal of Treated Effluent

Treated effluent from Yamuna Vihar is being discharged to Shahdara Drain which ultimately discharges to Yamuna River while Kondli WWTP discharges directly to Yamuna River via channel. Treated effluent from Sonia Vihar WWTP is proposed to be discharged to nearby drain.

Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be MCD, DMRC and DDA. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Shahdara Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 22**.

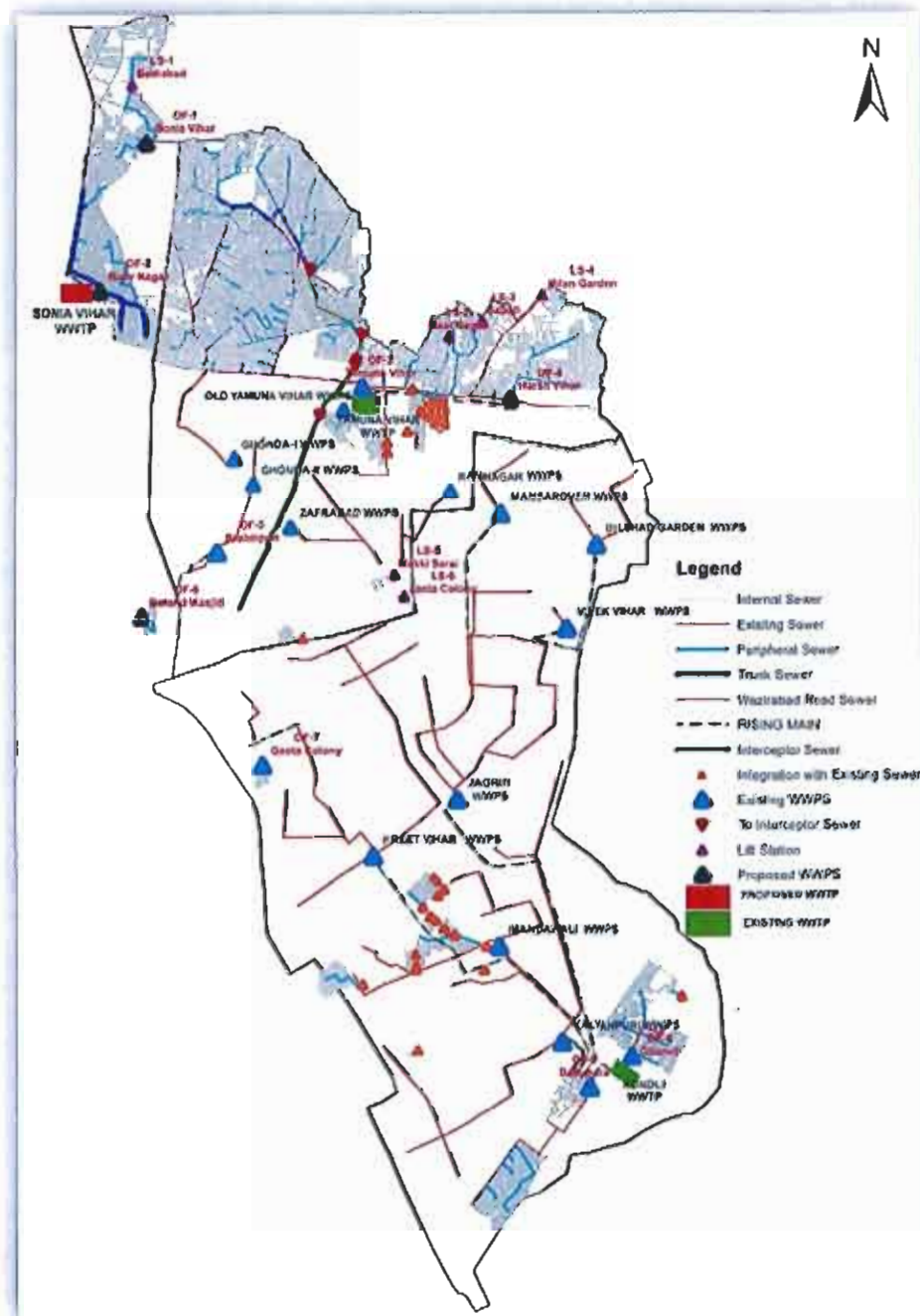


Figure 22: Proposed Sewerage Scheme for Shahdara Drainage Zone

Various Group of Colonies (GOCs) wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 23**.

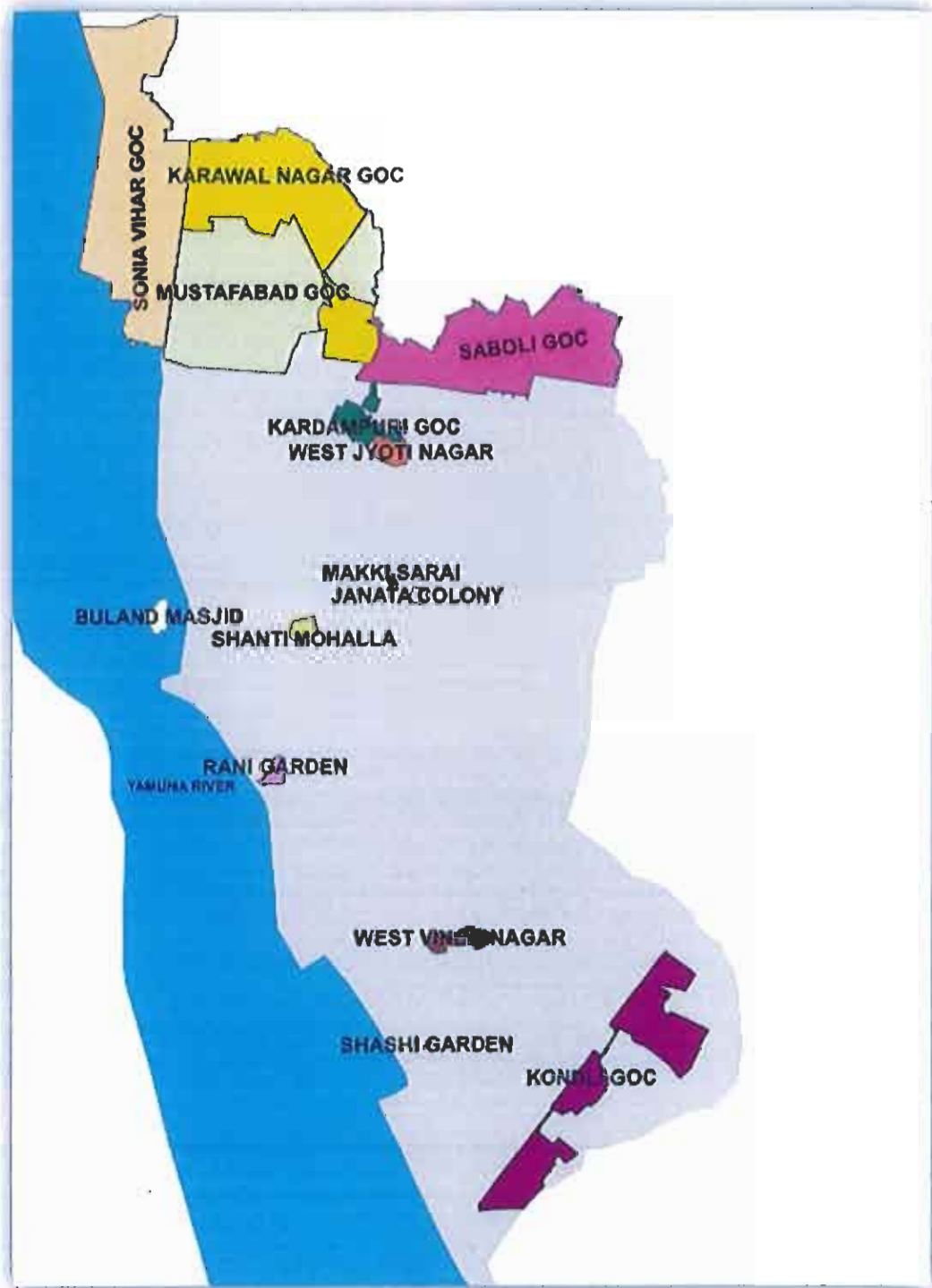


Figure 23: GOC-wise Sewerage Schemes – Shahdara Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 10: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Yamuna Vihar	YV1	SHD-YV1-KP	Kardampuri GOC				
2	Yamuna Vihar	YV1	SHD-YV1-BM	Buland Masjid				
3	Yamuna Vihar	YV1	SHD-YV1-WJN	West Jyoti Nagar				
4	Yamuna Vihar	YV2	SHD-YV2-Z1	YV2Z1 Part of Karawal Nagar				
5	Yamuna Vihar	YV2	SHD-YV2-Z2	YV2Z2 Part of Mustafabad				
6	Yamuna Vihar	YV3	SHD-YV3	SHD YV3 Part of Saboli				
7	Yamuna Vihar	YV3	SHD-YV3-P2	SHD-YV3 Phase-II				
8	Sonia Vihar	SV	SHD-SV	Sonia Vihar GOC				
9	Kondli	KN1	SHD-KN1-SG	Shashi Garden				
10	Kondli	KN1	SHD-KN1-RG	Rani Garden				
11	Kondli	KN1	SHD-KN1-WVN	West Vinod Nagar				
12	Kondli	KN1	SHD-KN1-SM	Shanti Muhalla				
13	Kondli	KN1	SHD-KN1-MS	Makki Sarai				
14	Kondli	KN1	SHD-KN1-JC	Janta Colony				
15	Kondli	KN2	SHD-KN2	Kondli GOC				
16	Yamuna Vihar	YV1	SHD-YV1-AN	Ashok Nagar				

Table 11: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Colonies Name
1.	Karawal Nagar	Ankur Enclave (Karawal Nagar Extn. North) Delhi-94 Mukund Vihar, Karawal Nagar, Delhi-94 Parkash Vihar, Karawal Nagar, Delhi-94 Pashchimi Karawal Nagar, Block A & B West Karawal Nagar, Delhi-94 West Karawal Nagar Shahdara Delhi-94 Shaheed Bhagat Singh Colony West Karawal Nagar Delhi-94 Chauhan Patti Vistar, West Karawal Nagar Delhi 94 Harijan Basti, Block A B & C, Karawal Nagar Karwal Nagar Roshan Vihar, East Sadat Pur, Karawal Nagar Shiv Vihar Ph-9, East Ext, Delhi-94 Shiv Vihar Ph-7, Karawal Nagar, Delhi Shiv Vihar, Phase-10, Delhi O&P-Block, Shiv Vihar Karawal Nagar Delhi-94 Shiv Vihar Ph-8, Karawal Nagar, Delhi-94 Janaki Panchal Vihar, Poorvi Karawal Nagar, Delhi-94 Shanti Nagar, Shiv Vihar, Delhi-94 Ashok Vihar E-Block Shiv Vihar Phase-I Karawal Nagar Delhi-94 Patel Vihar Shiv Vihar Phase-II, Karawal Nagar, Delhi-94 Shiv Vihar Ph-III Karawal Nagar Delhi-94 Shiv Vihar Ph-V, East Karawal Nagar, Delhi Shiv Vihar Ph-6, Gokulpuri, Karawal Nagar, Delhi Shiv Vihar, U-Block, Karawal Nagar, New Delhi Kamal Vihar Extn. Karawal nagar Delhi-94 Kamal Vihar Karawal nagar, Delhi Ganga Vihar Delhi-94 Ganga Vihar(H-Block), Delhi-94 Sadat Pur Harijan Basti, Sadat Pur, Delhi-94
2.	Sonia Vihar	Soniya Vihar, Sahadra, Delhi-94 Village Sabha pur Extned Abadi Delhi 94 Chauhan Patti Pur Extn. Sabhapur Mazra Delhi 94 Sabha Pur Chauhan Patti Sabha Pur (New) Shri Ram Colony, Rajeev Nagar, Delhi-94
3.	Mustafabad	Rama Garden Karawal Nagar Delhi-94 Rama Garden, B-Block, Karawal Nagar, Delhi-94 Mahalaxmi Enclave Karawal Nagar New Delhi-94 Bhagat Vihar, Karawal Nagar, Delhi-94 Prem Nagar, Karawal Nagar, Delhi-94 Prem Vihar, Purvi Karawal Nagar, New Delhi

Sl. No.	Name of GOC	Colonies Name
		Bhagirathi Vihar, Phase-2, 33 Feeta Idgah Road. Indra Vihar Ph-II Johri Pur Delhi-94 Indra Vihar Ph-I Bhagirathi Vihar G-Block near Johripur, Delhi-94 Bhagirath Vihar Ph-I & II, Nand Nagari Ram Vihar, Loni Road, Joharipur Maa Ramabai Ambedkar Mohalla, Paschchimi Johri Pur, Delhi-94 Kanhaiya Mohalla (Village Johripur) Delhi-94 Khajani Nagar, Johari Pur Delhi 94 Dr. Ambedkar Colony (A& B-Block) Johri Pur Extn., Delhi-94 Kardam Farm R S T Enclave, Johripur Extn., Delhi-94 Dr. Ambedkar Vihar, Harijan Basti, Zohripur Extn., Delhi-94 Jagdamba Colony, Johripur, Delhi-94 Tunda Nagar Harijan Basti JohariPur Delhi 94 Surya Vihar, Village East Sadatpur, Karawal Nagar, Delhi-94 Mahalaxmi Vihar, East Karawal Nagar, Delhi Karawal Nagar Extn., Delhi-94 Karawal Nagar Purvi Extn., Pushkar Vihar, Ph-4 Shiv Vihar, Delhi-94 Shakti Vihar, East Dayal Pur, Delhi-94 Moonga Nagar, Karawal Nagar Road, Delhi Brijpuri, Wazirabad road, Delhi-94 Sadatpur Extn. Block C-5 & C-6 Karawal Nagar Delhi-94 Sadatpur Extn., Pusta Area, K, L, M, N, Block, Delhi-94 Pashchimi Sadatpur Vistar, Delhi-94 Dagarpur Mohalla (B-4) Jauhripur Delhi-94 Dagarpur Mohalla (B-4) Jauhripur Delhi-94 Johri Pur Extn. Delhi-93 Johri Pur Extn. Delhi-94 Chaman Park Near Johripur, Delhi Babu Nagar Karawal Nagar Extn. Delhi-94 Govind Vihar Karawal Nagar Delhi-94 Chandu Nagar Karawal nagar Road, Delhi Nehru Vihar GokulPuri Delhi-93 Rajiv Gandhi Nagar Mustafabad New Delhi Khajuri Colony E- Block Delhi-94 Khajuri Colony, E-Extn., Left Out Part E-Block, Khajuri Khas, Delhi-94 Khajuri Colony F- Block, Mangal Pandey Road, New delhi Harijan Basti D- Block East Gokal Pur Delhi-94 Shakti Garden Harijan Basti Block E-II, East Gokal Puri Delhi-94 East Gokalpuri E- Block, Hari Nagar Harijan Basti Delhi-94 Harijan Basti A- Block Purvi Gokalpur, Delhi-94 Chanderpuri, Chand Bagh, Main Wazirabad Road, Delhi-94 Dilshad Masjid (Mustafabad) Karawal Nagar, Mustafabad Extn. Karawal Nagar Brijpuri Road Delhi-94 Bihari pur Extn., Near C R P Campus, Khajuri Khas, Delhi-94 Bihari pur Village Fadaration (RWA) Karawal Nagar Delhi 94

Sl. No.	Name of GOC	Colonies Name
		Biharipur Old Bihari pur New Khajuri Khas Village Delhi 94 Dayal Pur Old Mustafabad (10-27) Dayal Pur Extn. C-Block, Main Road, Tukmerpur, Delhi-94 Village Dayalpur Extn, Delhi-94 Nehru Vihar Ambika Vihar, A-Block, East Karawal Nagar Ambika Vihar B & C Block, Purvi Karawal Nagar, Delhi-94 Old Mustafabad Gali No.1 to 9 Gokalpuri Shahadra New Mustafabad Ziauddinpur, Near Brijpuri Pulia
4.	Saboli	Harizan Basti D-Block, Karawal Nagar Bank Colony, Mandoli, Delhi-93 East Mandoli Extn.Harijan Basti D- Block Delhi-93 Mandoli Extn.Harijan Basti Delhi-93 Rajiv Nagar Mandoli New Delhi-93 Rajiv Nagar Mandoli New Delhi-94 Budh Vihar Harijan basti Mandawali Delhi-93 Mandoli Kachi Amar Colony B- Block, Purvi Gokulpuri Delhi-94 Amar Colony C- Block, East Gokal Pur Delhi-94 Harsh Vihar Delhi-93 Harsh Vihar Extn. Delhi-93 Harsh Vihar, D-Block, Delhi-93 Harsh Vihar, D-Block, Delhi-93 Sushila Garden Mandoli Delhi-93 Meet Nagar C- Block Delhi-94 Meet Nagar A & B Block, Delhi-94 Saboli Vill.Saboli Extn. Near Khera Mandir Delhi-93 Pratap Nagar Saboli Vill.Delhi Village Gokul Pur Delhi 94 Gokulpuri Extn., Ziauddinpur, Delhi-94
5.	Kardampuri	Kardam Puri Extn.Shahdara Delhi-94 North Chhajupur, Delhi West jyoti Nagar Enclave Main Loni Road Delhi-94 Garhi Mandu
6.	Kondli	New Ashok Nagar, E-Extn, Harijan Basti, Delhi-110096 New Ashok Nagar, Delhi-110096 New Ashok Nagar, C-Block, Delhi-110096 New Ashok Nagar, B-I, Block, Delhi-110096 New Ashok Nagar, C'Extn. Block, Delhi-96 New Ashok Nagar, D-Block, Shahdara, Delhi

Sl. No.	Name of GOC	Colonies Name
		New Ashok Nagar, E-Block, Delhi-96 New Ashok Nagar, Chilla Block-A, Delhi-110096 New Ashok Nagar. Block-B-I, Delhi-96 New Ashok Nagar, Chilla Saroda Bangar, Delhi-96 New Ashok Nagar, C'Block, Delhi-110096 New Ashok Nagar Block-E & D(E & D) New Delhi-110096 New Ashok Nagar C-2, Block Delhi-110096 New Ashok Nagar, Block C-I, Delhi-11096 Kondli Colony, New Ashok Nagar, Delhi-110096 Gharoli Extn., Village Gharoli Extn, A-Block, Harijan Basti, Delhi Harijan Basti C-Block, Gharoli Extn.Delhi-110096 Sapera Basti, Village Gharoli, Delhi-11096 Gharoli Extn., B-Block, Rajbir Colony Delhi-96 Durga Park, Durga Mohalla, Dallupura, East, Delhi Village Dallupura Vasundhra Enclave Delhi 96 Dallu Pura Dallu Pura Extended Abadi, New Ashok Nagar Chilla Saroda, Delhi Village Kondli, Delhi-96 Ashok Nagar, Harijan Basti Uttariya School Block, Mandawali , Fajalpur Extn. Kalyan Marg, Delhi-110092
7.	West Jyoti Nagar	West Jyoti Nagar
8.	Makki Sarai	Makki Sarai
9.	Janta Colony	Janta Colony
10.	Buland Masjid	Shastri Park Extn., (Buland Masjid), Delhi-53
11.	Shanti Mohalla	Shanti Mohalla
12.	Rani Garden	Rani Garden (Ambedkar Park) Shastri Nagar, Delhi-110031
13.	West Vinod Nagar	Ganesh Nagar Pandav Nagar complex, Delhi-110092 West Vinod Nagar, E-Block, Delhi-110092 West Vinod Nagar, F-Block Vinod Nagar(North A Block) Mandawali West Vinod Nagar, D-Block, Delhi-110092 East Vinod Nagar,G'Block Delhi-91 School Block, Unche Pur, Mandawali Fazalpur, Delhi Mandawali, C-Block, Fajalpur, Unche Par Mandawali, C-Block, Fajalpur,Unche Par, Delhi-110092 Chander Vihar, Mandawali Fajalpur Extn. Delhi-110092
14.	Shashi Garden	Shashi Garden, E-Block,Shahdara,Delhi-91
15.	Ashok Nagar	Ashok Nagar D Block Main Wazirabad Road,Delhi-93 Ashok Nagar, D-Block, Shahdara, Delhi-93

ANNEXURE - 2
CORONATION PILLAR DRAINAGE ZONE
(COR)

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CORONATION PILLAR DRAINAGE ZONE (COR)

1. INTRODUCTION

Coronation Pillar Drainage Zone is bounded by Northern Railway Main Line in the South and West, Narela Drainage Zone in North and Yamuna River in East. Coronation Pillar Zone is predominantly residential in nature with large pockets of institutional area, mainly educational, to the south east of Najafgarh Drain like Delhi University, St. Stephen's College, Miranda House, Sri Ram College of Commerce, Delhi School of Economics, Hansraj College, Hindu College, Indraprastha College, etc. To the north of Model Town near the treatment plant site are swampy undeveloped areas. The industrial areas are mainly GT Karnal Road Industrial area, Dilkhush Industrial area, Rajasthan Udyog Nagar and Jahangirpuri Industrial area. Location of Coronation Pillar Drainage Zone is shown in the *Figure 1*.

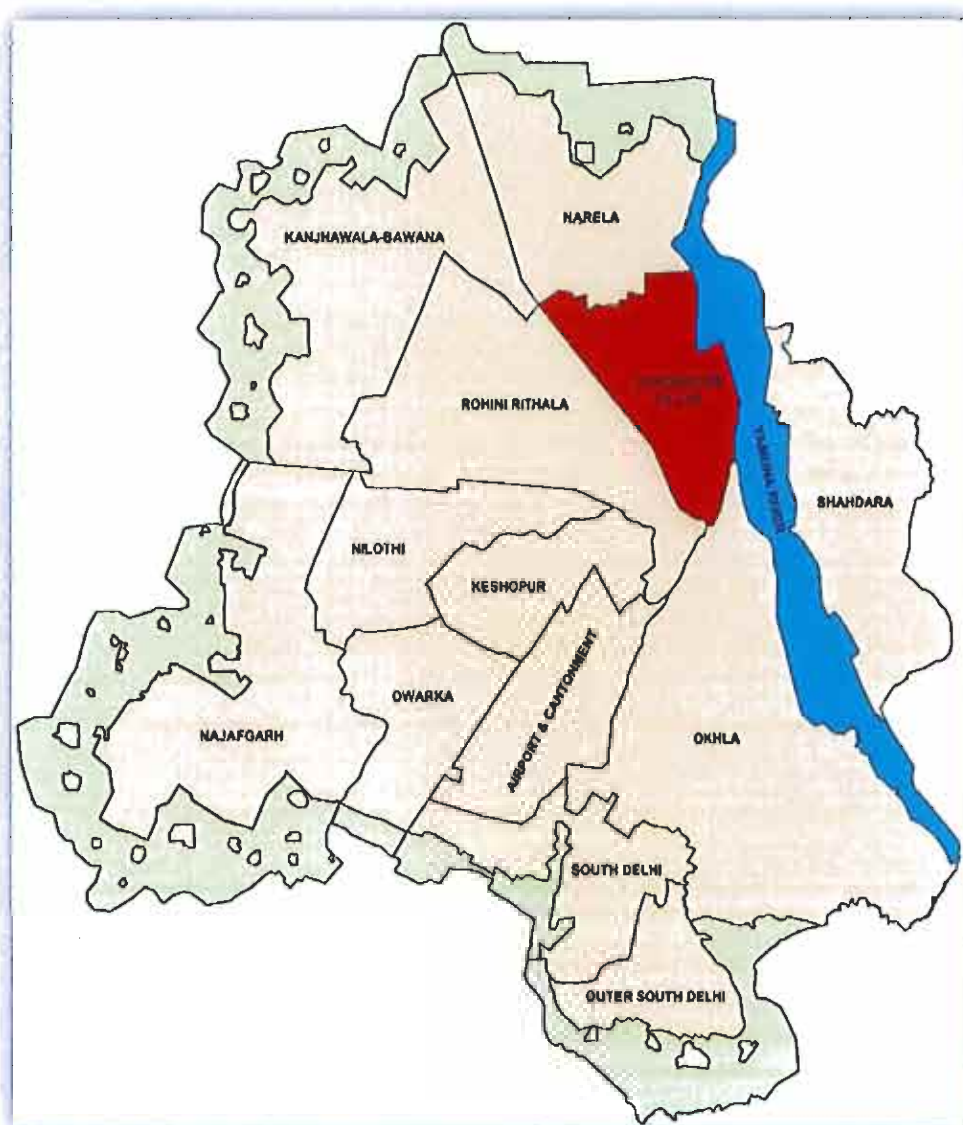


Figure 1: Coronation Pillar Drainage Zone

Coronation Pillar Drainage Zone comprises major areas like Samaypur, Sarup Nagar, Bhalswa Dairy, Sant Nagar, Wazirabad, Adarsh Nagar, Jahangirpuri, Mukharji Nagar, Timarpur, Model Town etc. This drainage zone falls under DDA Zone C and P-II as shown in the *Figure 2*.

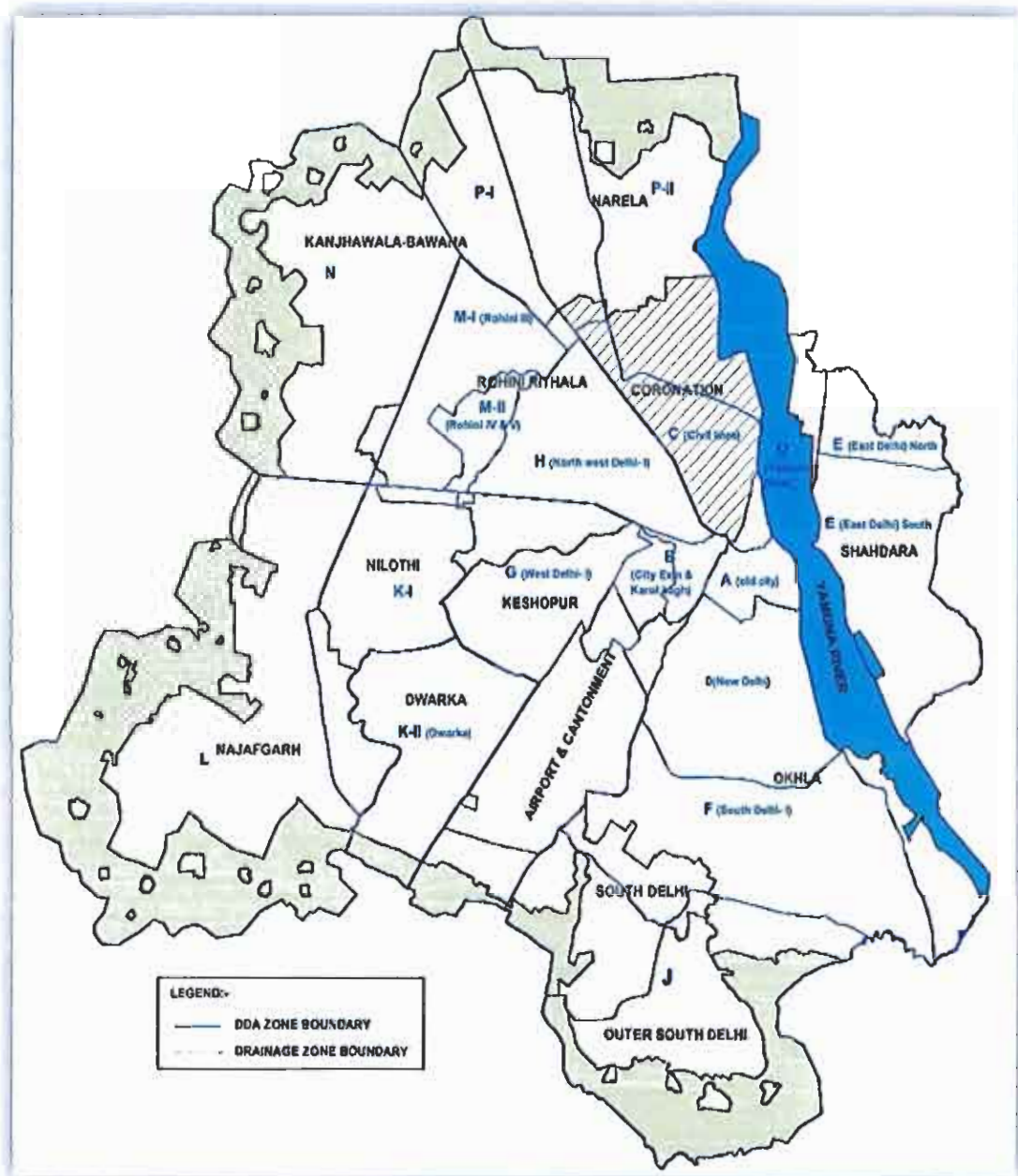


Figure 2: DDA Zones and Coronation Pillar Drainage Zone

Soil Description of Coronation Pillar

North of this zone i.e. Sant nagar, Burari side is covered with younger alluvium deposits & rest of the portion like Delhi university, Kamla Nagar, Roop Nagar, Shakti Nagar etc. with older alluvium deposits. Coronation Pillar Zone Jahangiri Puri, Model Town, Adrash Nagar, Dr. Mukherji Nagar, Timarpur, Delhi University, Roop Nagar, AzadPur, Shakti Nagar, Kamla Nagar etc. is most critical from seismic microzonation point of view. This zone comes under high Hazard category due to Liquefaction potential. This Liquefaction factor is due to Newer alluvium proximal to Yamuna river, Special Care to be taken during construction in this zone.

This zone can be further divided into two areas depending upon the water depth availability. Jahangiri Puri, Model Town, Adrash Nagar, Dr. Mukherji Nagar, Timarpur etc. having water at shallow depth i.e. 2-5m. Delhi University, Roop Nagar, AzadPur, Shakti Nagar, Kamla Nagar etc. is having Water at 5- 10m range only.

In this zone 80% of the portion is covered with Khadar soil in the areas like JahangirPuri, Adarsh Nagar, Model Town, Dr. Mukherji Nagar, Sant Nagar etc. & 20 % of the portion with Bangar soil in the areas like Delhi University, Roop Nagar, Kamla Nagar, Shakti Nagar etc.

2. MASTER PLANNING FOR CORONATION PILLAR DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSS, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

Almost half of the area in Coronation Pillar Drainage Zone is sewered except for the north part, mostly above Supplementary Drain in the proximity of Coronation Pillar Wastewater Treatment Plant which is still developing, namely north of Jahangirpuri Road, part of SGT Nagar area and near Gandhi Vihar. Topographical Survey & GIS integration has been carried out for unsewered portion of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

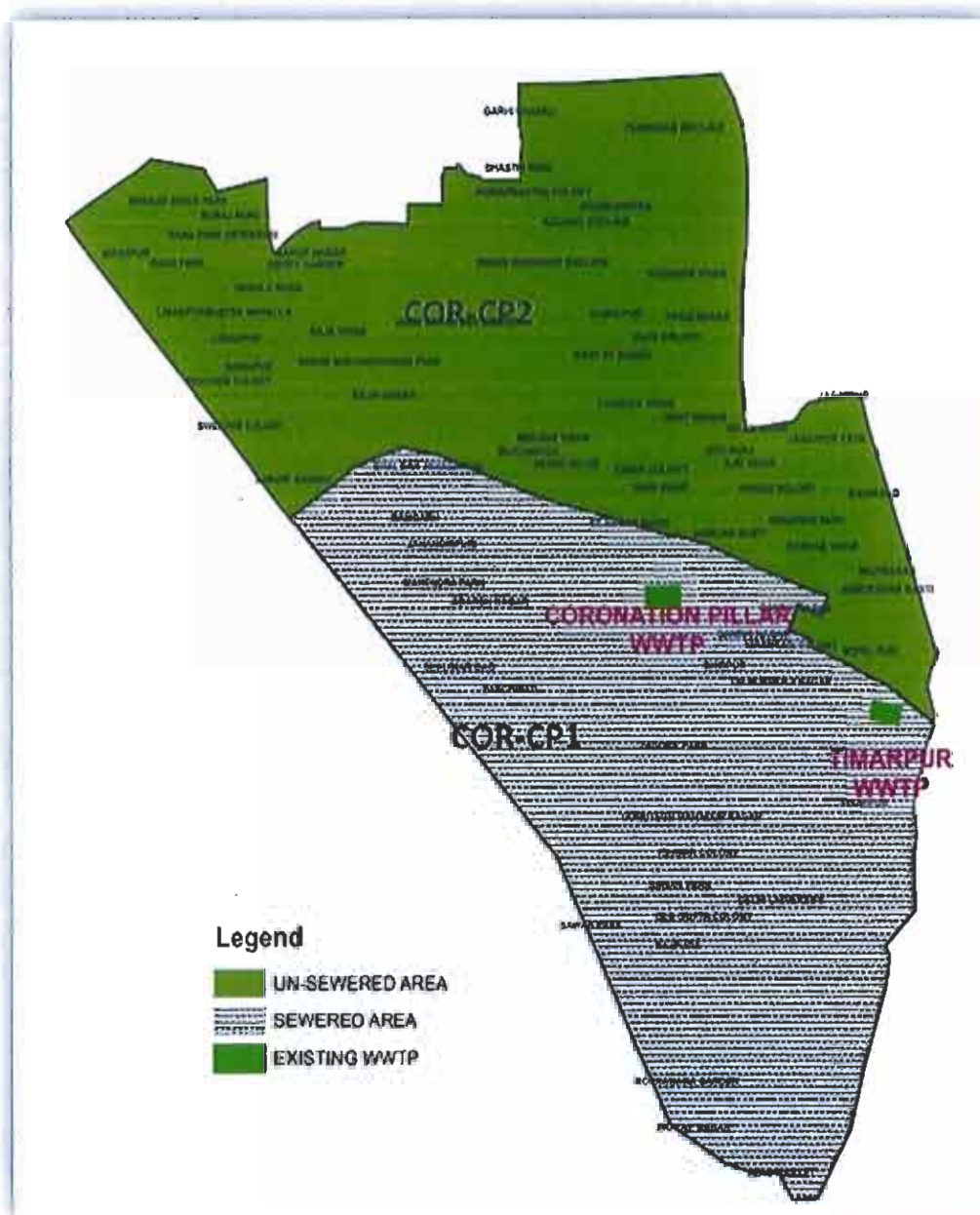


Figure 3: Sewerage Status of Coronation Pillar Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Coronation Pillar Drainage Zone has been divided into two (2) Sub Drainage Zones as below:

- Coronation Pillar 1 (COR-CP1)
- Coronation Pillar 2 (COR-CP2)

Sub Drainage Zone Map and Contour Map are shown in the *figures 4 & 5* respectively.

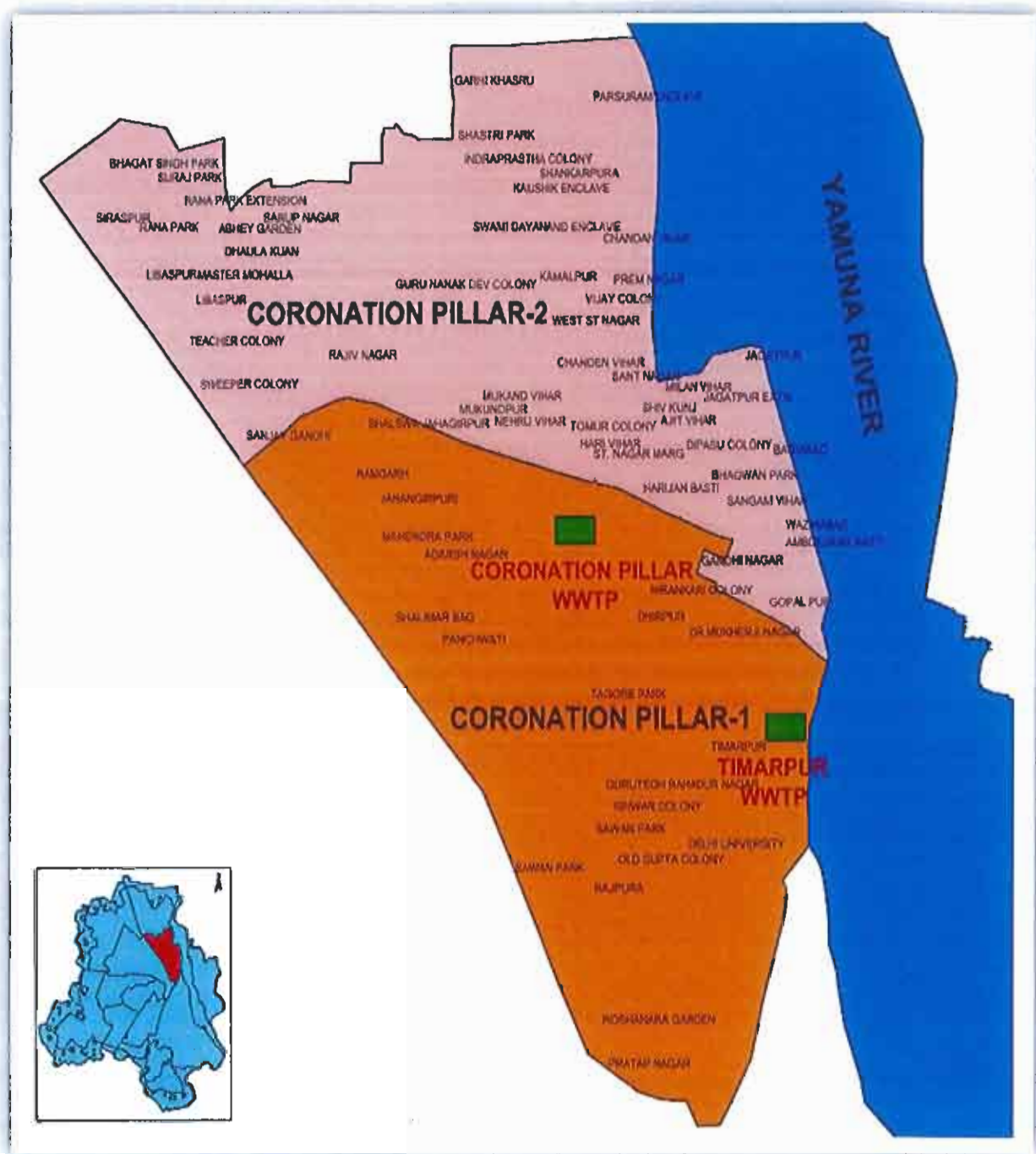


Figure 4: Sub Drainage Zone Map of Coronation Pillar Drainage Zone (COR)

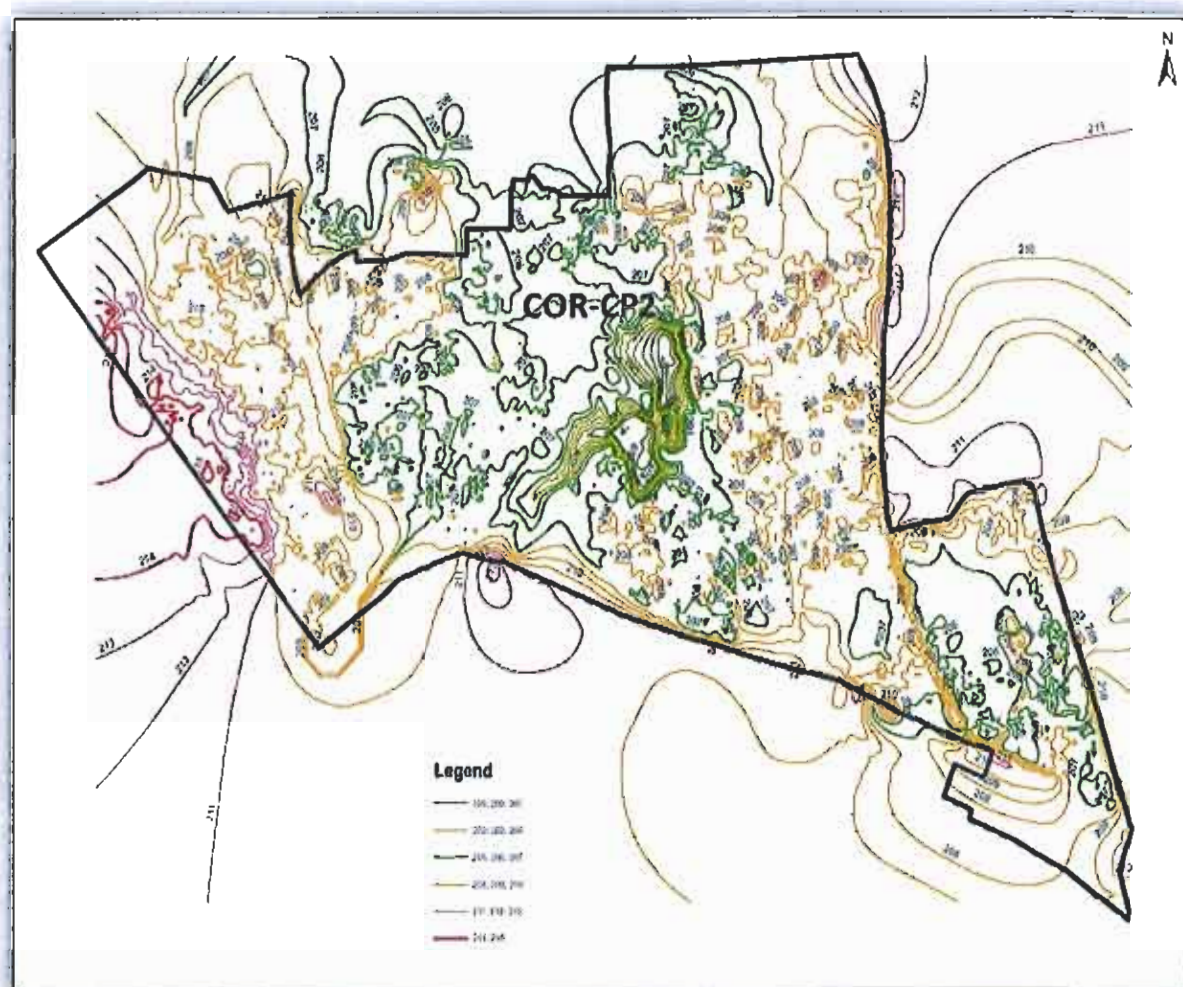


Figure 5: Contour Map of Unsewered Area of Coronation Pillar Drainage Zone (COR)

Based on population projections Sub Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Coronation Pillar Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
COR-CP1	125.32	153.69	182.05	27.60	33.90	40.10
COR-CP2	124.38	152.54	180.69	27.40	33.60	39.80
Total	249.70	306.22	362.75	55.00	67.50	79.90

3.1 Sub Drainage Zone: Coronation Pillar 1 (COR-CP 1)

This Sub Drainage Zone spread across Adarsh Nagar, Mukharji Nagar, Timarpur, Model Town etc. The area is sewered and there are 2 WWTPs known as Coronation Pillar and Timarpur. Land use map is as shown in the **Figure 6**.

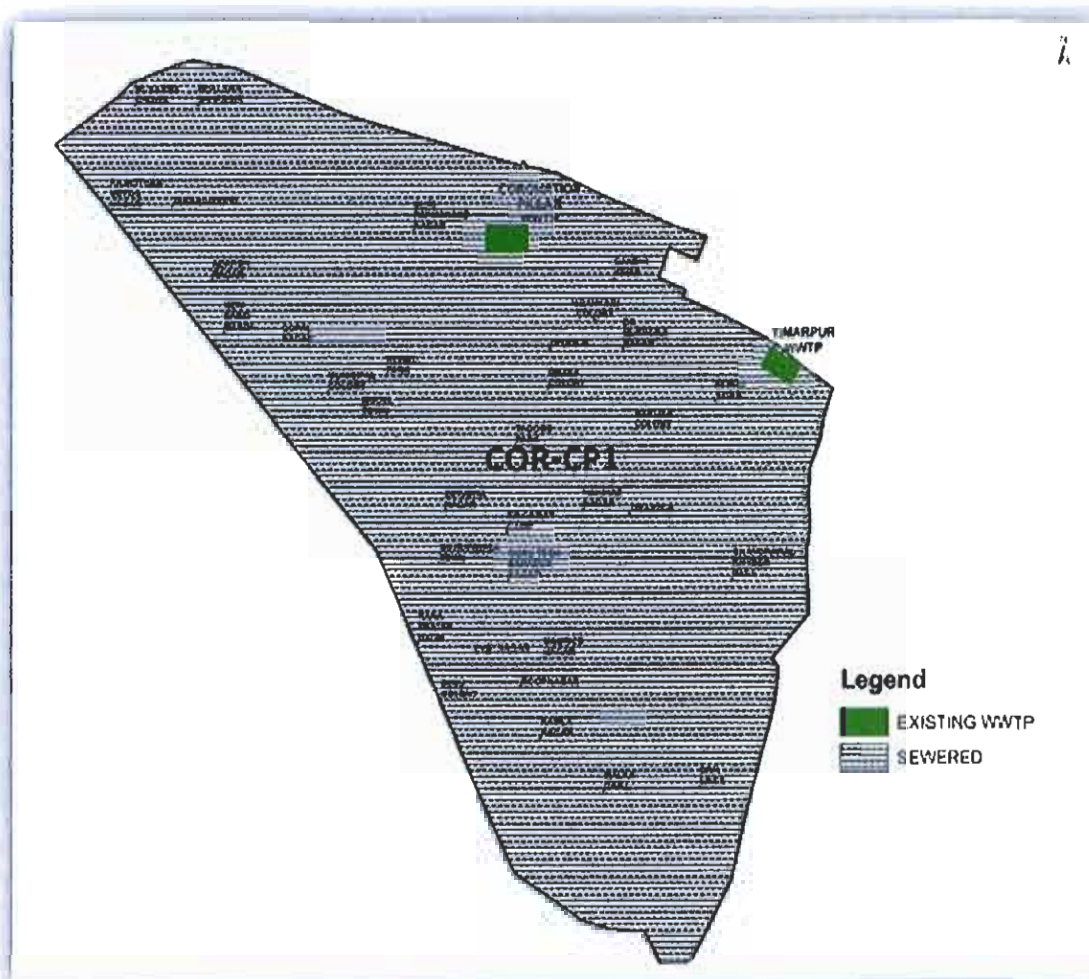


Figure 6: Land Use Map of Coronation Pillar Sub Drainage Zone (COR-CP1)

Existing Sewerage Infrastructure

The sub drainage zone is completely sewered. There is an existing WWTP of 40 MGD Capacity built in phases known as Coronation Pillar WWTP. Out of which, 10 MGD is defunct. Additional treatment capacity (40 MGD) at Coronation Pillar WWTP is already planned. There is one more WWTP (oxidation ponds) at Timarpur of 6 MGD capacity that only caters to access sewage overflow from the system.

The major part of the wastewater generated from the area is led to the University wastewater pumping station, through the North Trunk Sewer and University Trunk Sewer from where it is pumped to Coronation Pillar Treatment Plant. Some part of the wastewater is directly pumped to the treatment plant through a number of small pumping stations.

Rana Pratap (RP) Bagh, Kalyan Vihar, Tagore Park, Bhai Parmanand (BP) Colony and Mukherjee Nagar WWPS that conveys wastewater by pumping and gravity ultimately to University WWPS. (Roopnagar PS and Timarpur PS conveying wastewater to Najafgarh drain has already been abandoned).

Panchwati PS which conveys wastewater to Azadpur. Bharauli (New Sabzi Mandi) PS which conveys wastewater to Rajasthan Udyog Nagar (GTK Road) WWPS. SGT Nagar Extension PS conveying wastewater to SGT Nagar PS.

Line Diagram for Existing WWPS and WWTP is shown in **the figure 7**:

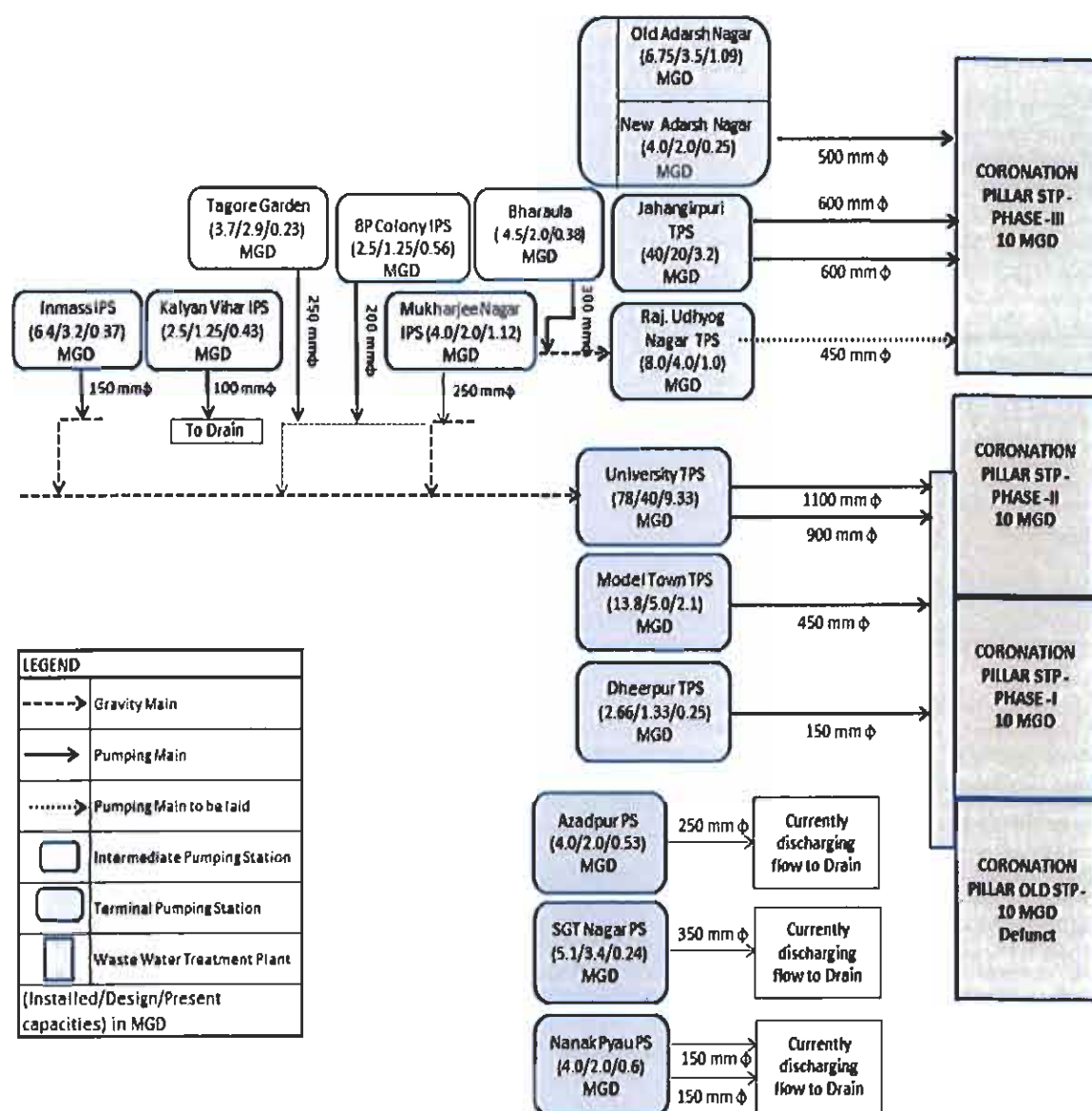


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

3.2 Sub Drainage Zone: Coronation Pillar 2 (COR-CP2)

This Sub Drainage Zone spread across Samaypur, Sant Nagar, Sarup Nagar, Khushak, Amrit Vihar, Laxmi Vihar, Burari, Baba Colony, Tomar Colony, Hardev Nagar, Wazirabad, Mukundpur, Rajiv Nagar, Bhalswa, Temple Colony, Libas pur, Gandhi Vihar, Gopalpur etc. The area is unsewered and no sewage treatment facility exists. Land use map is as shown in the **figure 8**.

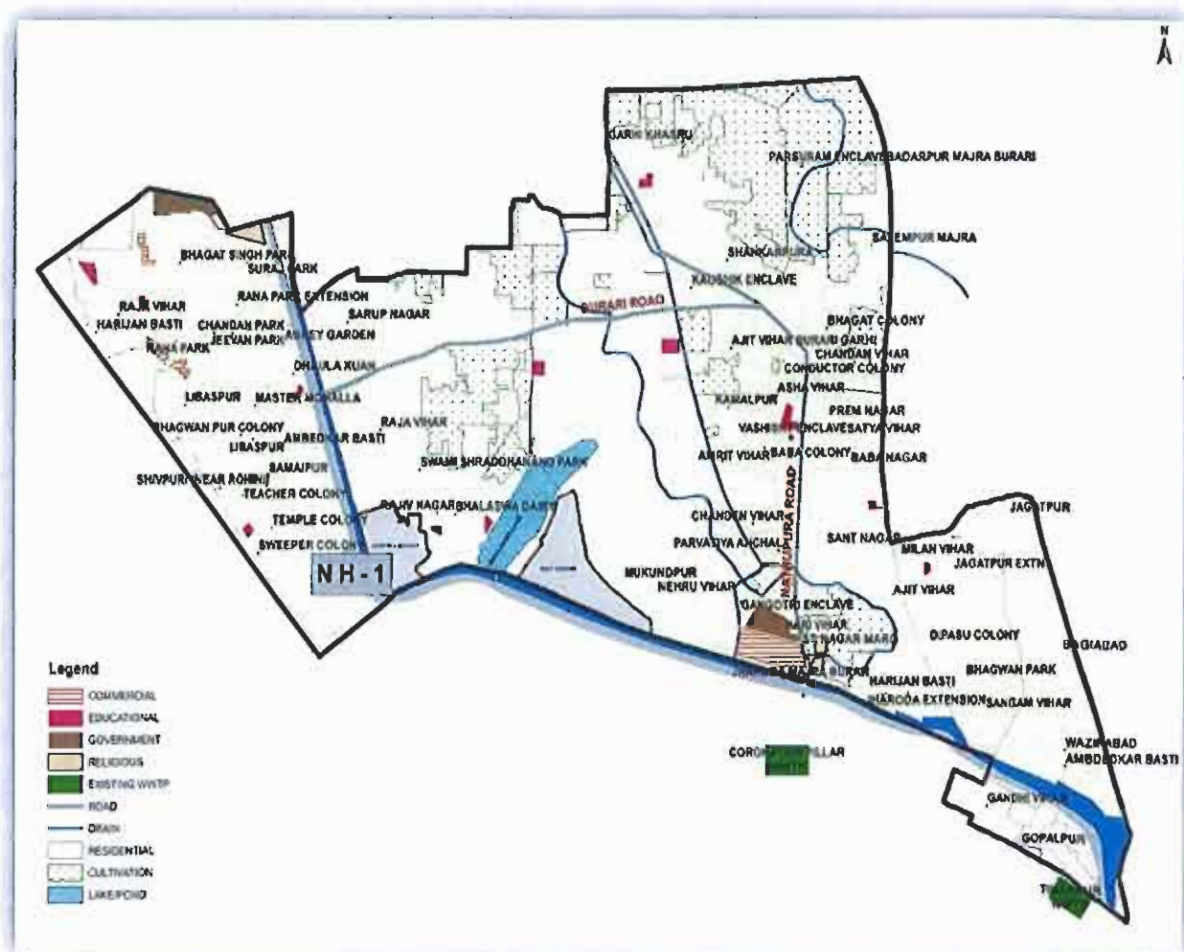


Figure 8: Land Use Map of Coronation Pillar Sub Drainage Zone (COR-CP2)

Existing Sewerage Infrastructure

Trunk sewer exists in part of Teacher Colony, Sweeper Colony, SGT Nagar and nearby area and is discharging sewage to existing SGT Nagar WWPS.

DJB is in process of implementing Interceptor Sewer Project in this sub drainage zone to intercept all sub drains outfalling into Najafgarh supplementary drain by Interceptor Sewer. A WWPS of capacity 111 MGD is also proposed under Interceptor project that will cater the sewage carried by interceptor sewer ultimately discharging to planned WWTP of 40 MGD. It is proposed to utilize Interceptor Sewer as trunk sewer for unsewered areas with integration to proposed network.

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets. Proposed Interceptor Sewer is being utilized as trunk sewer for the Sub Drainage Zone. The hydraulic analysis shows that the capacity of proposed Interceptor Sewer will be sufficient to cater 2031 sewage loads from this sub zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in figure as below:

- The area is unsewered Interceptor Sewer is proposed along supplementary drain to intercept sub drains and route sewer to Interceptor WWPS (111 MGD) and ultimately to Coronation Pillar WWTP.
- Sewage from Libaspur, Siraspur, Samaypur, Sanjay Gandhi Transport Nagar Bhalswa Dairy, Mukundpur, Amrit Vihar, Sant Nagar, Wazirabad and nearby area is routed to Interceptor Sewer.
- Sewage from Salempur Majra, Burari and nearby area is routed to Proposed Burari WWPS and then via rising main to proposed gravity sewer towards Interceptor Sewer.
- Sewage from Amrit Vihar, Garhi Khasru and nearby area is routed to Proposed Amrit Vihar WWPS and then via rising main to proposed gravity sewer towards Interceptor Sewer WWPS.
- Sewage from Sarup Nagar, Sarup Vihar and nearby area is routed to Proposed Guru Nanak Dev Colony WWPS and then via rising main to proposed Interceptor Sewer.

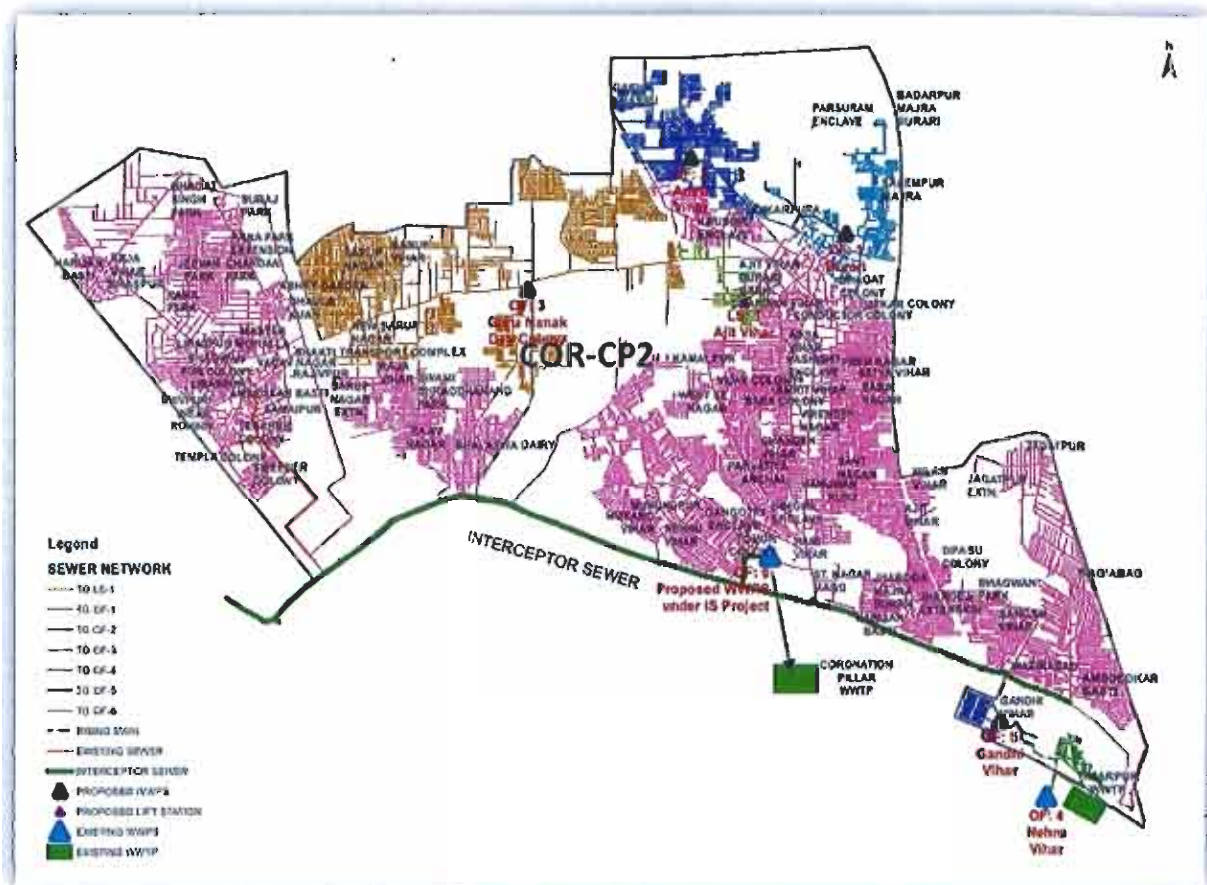


Figure 9: Scheme Map of Coronation Pillar Sub Drainage Zone (COR-CP2)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Coronation Pillar Sub Drainage Zone (COR CP2) is shown in the *Figure 9*.

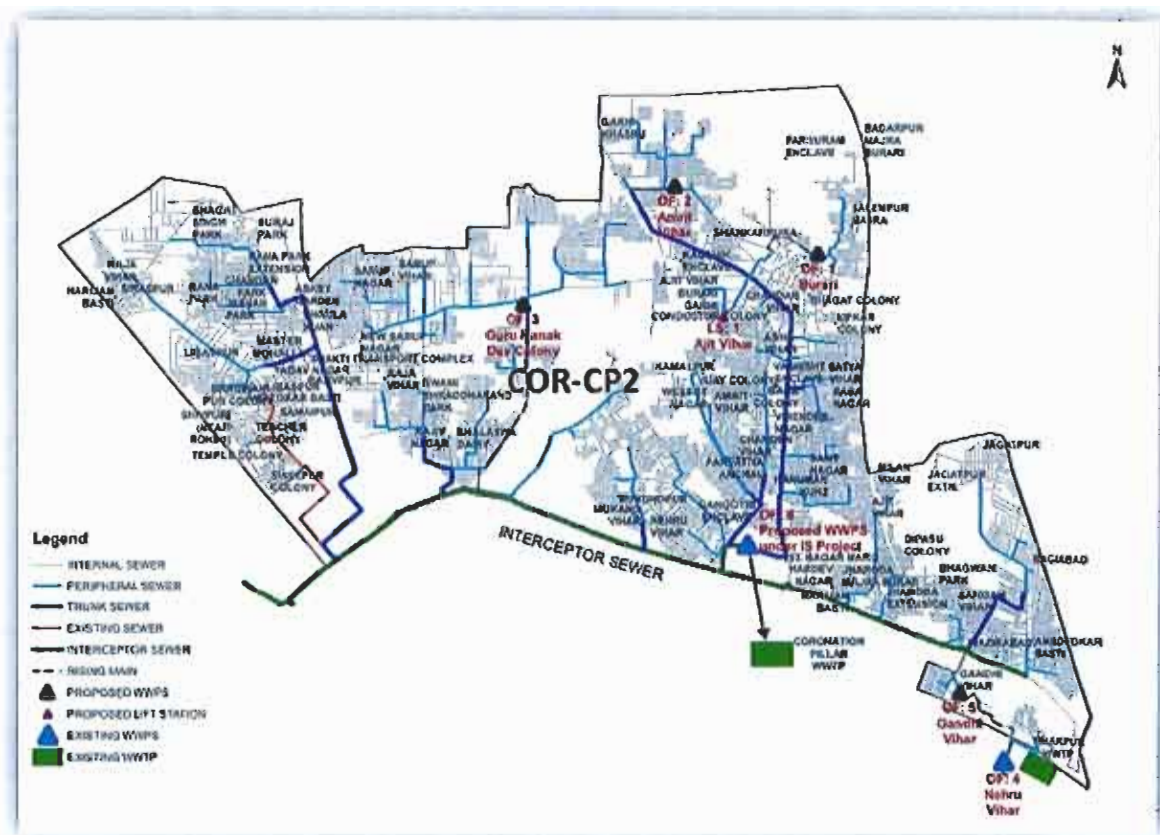
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in *Table 2*.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	752356
300	HDPE/DWC	8558
350	HDPE/DWC	3568
400	HDPE/DWC	17120
500	HDPE/DWC	13438
563.6	HDPE/DWC	3312
635.2	HDPE/DWC	3860
700	RCC NP3/NP4	2214
800	RCC NP3/NP4	2038
900	RCC NP3/NP4	1898
1000	RCC NP3/NP4	2954
1100	RCC NP3/NP4	1295
1200	RCC NP3/NP4	252
1400	RCC NP3/NP4	2137
Total		815000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 10**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

**Figure 10: Proposed Sewerage Infrastructure of Coronation Pillar Sub Drainage Zone (COR-CP2)**

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Gurunank Dev Colony	WWPS	14.00	800	1	2300	Interceptor Sewer
2	Amrit Vihar	WWPS	5.00	500	1	600	Proposed Trunk Sewer
3	Burari	WWPS	3.00	400	1	800	Proposed Trunk Sewer
4	Ajit Vihar	LS	1.50	250	1	150	Nearest Manhole
5	Gandhi Vihar	WWPS	2.00	400	1	1600	Existing WWPS

Waste Water Treatment Requirements

The planned Waste Water Treatment Plant of 40 MGD capacity at Coronation Pillar was found to be sufficient to cater anticipated sewage load for design year 2031 from the sub drainage zone. No additional treatment capacity has been proposed for this Sub Drainage Zone.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 4** below:

Table 4: Summary of Proposed Sewerage Infrastructure

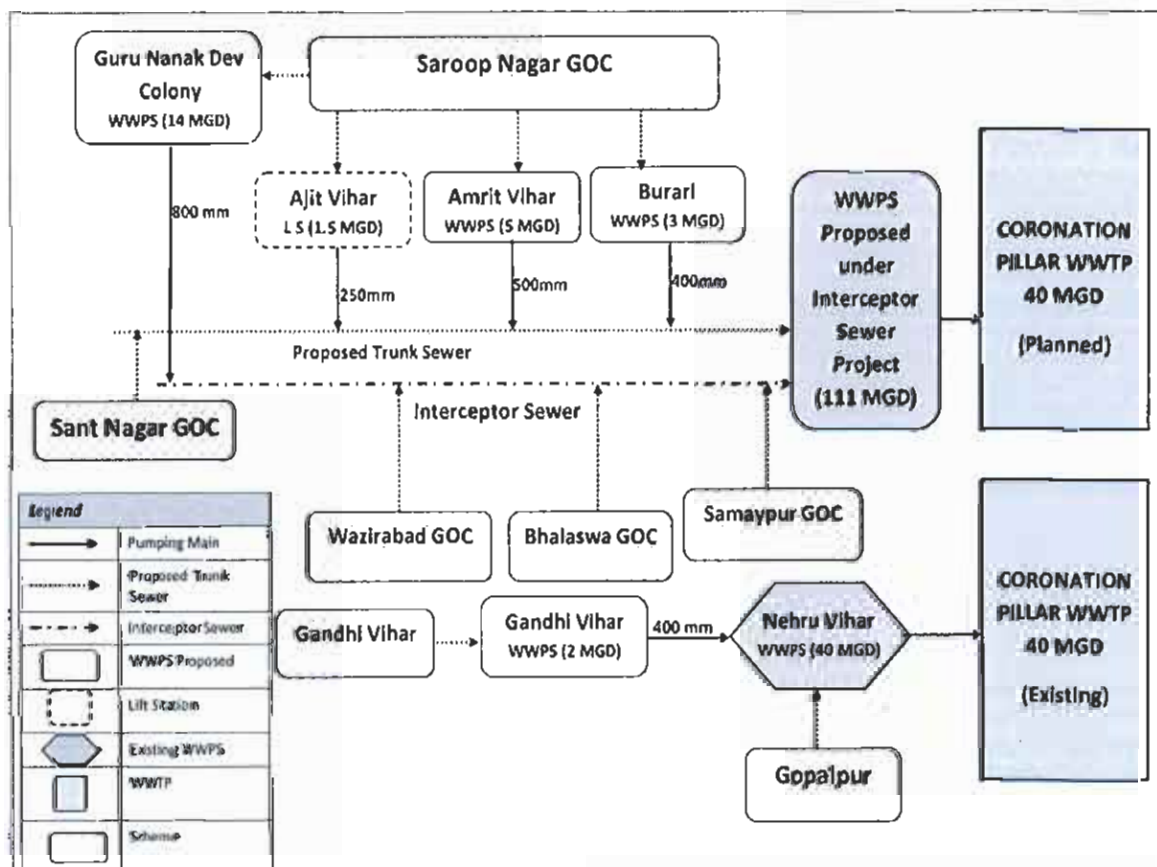
SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Coronation Pillar 1	(COR-CP1)	-	-	-	-
Coronation Pillar 2	(COR-CP2)	815	4	1	-
Total		815	4	1	-

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **table 5**.

Table 5: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Coronation Pillar	Coronation Pillar2	–	–	Gurunank Dev Colony	WWPS	14	2820
				Amrit Vihar	WWPS	5	2081.7
				Burari	WWPS	3	2050
				Ajit Vihar	LS	1.5	51.2
				Gandhi Vihar	WWPS	2	1060.4

Line Diagram for Proposed WWPS and WWTP for Coronation Pillar is shown in the **figure 11**:

**Figure 11: Line Diagram for Proposed WWPS and WWTP**

Disposal of Treated Effluent

Treated effluent from Coronation Pillar WWTP is being discharged to nearby drain which ultimately discharges to Yamuna River via Najafgarh Drain.

Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be DTC, DDA and PWD. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Coronation Pillar Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in the **Figure 12**.

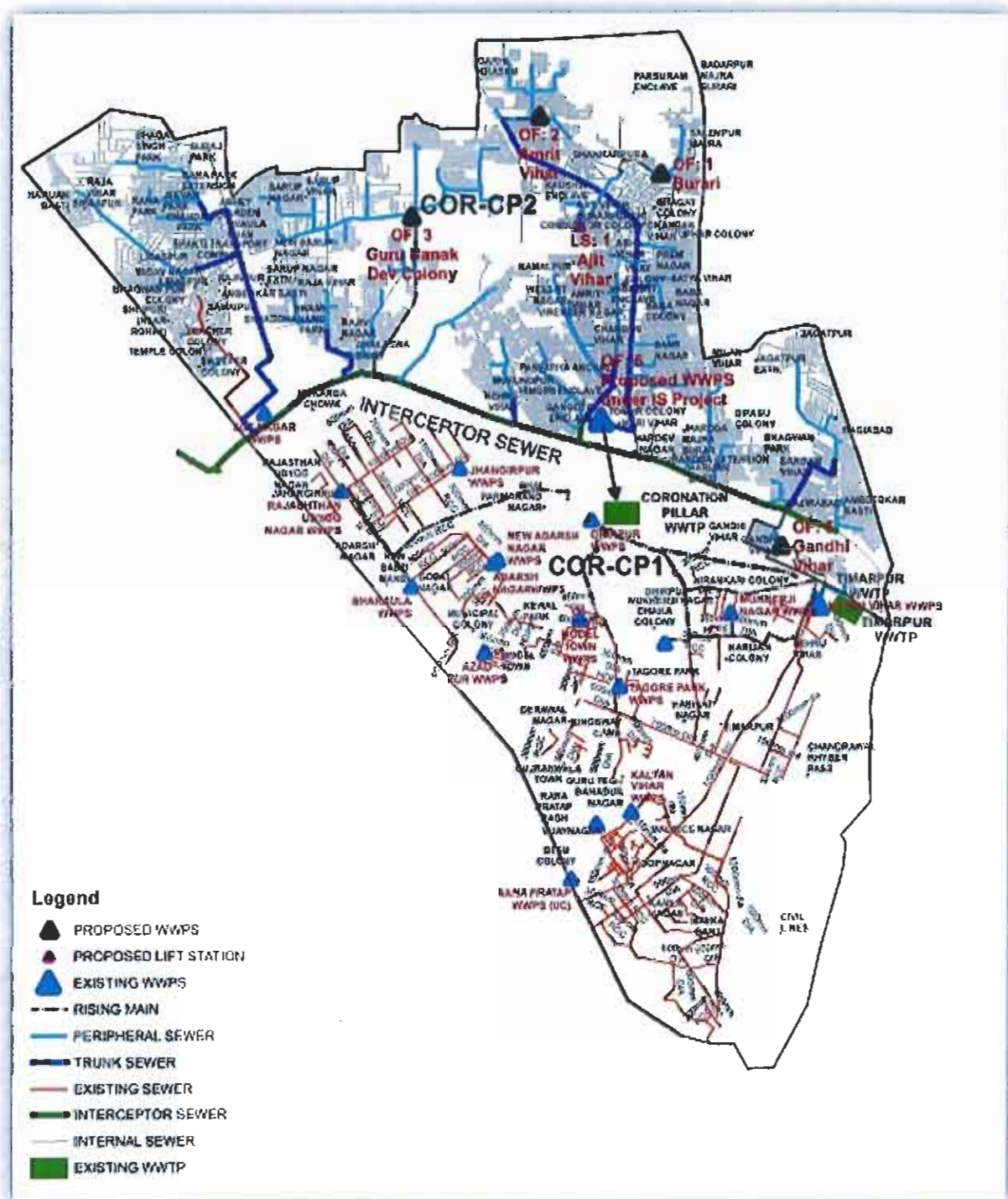


Figure 12: Proposed Sewerage Scheme for Coronation Pillar Drainage Zone

Various Group of Colonies (GOCs)-wise sewerage schemes have been prepared for the drainage zone and represented in **Figure 13**:

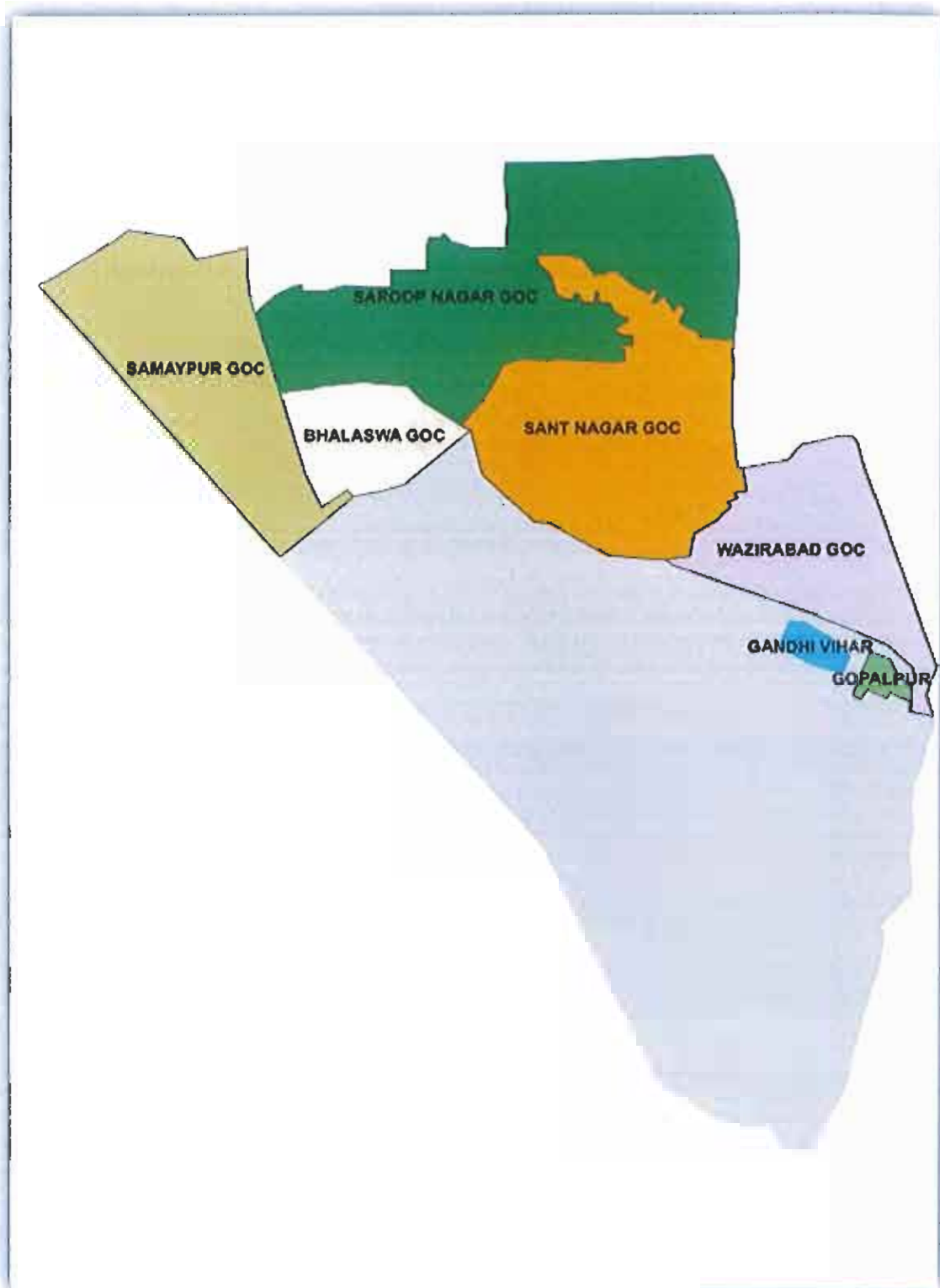


Figure 13: GOC-wise Sewerage Schemes – Coronation Pillar Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 6: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Coronation Pillar	CP2	Cor-CP2-SP	Samaypur GOC				
2	Coronation Pillar	CP2	Cor-CP2-WB	Wazirabad GOC				
3	Coronation Pillar	CP2	Cor-CP2-BL	Bhalaswa GOC				
4	Coronation Pillar	CP2	Cor-CP2-SRP	Sarooop Nagar GOC				
5	Coronation Pillar	CP2	COR-CP2-SNT	Sant Nagar GOC				
6	Coronation Pillar	CP2	Cor-CP2-GV	Gandhi Vihar				
7	Coronation Pillar	CP2	Cor-CP2-GP	Gopalpur				

Table 7: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Colonies Name
1.	Saroop Nagar	Swaroop Nagar, South Part-II, G.T. Karnal Rd & Burari Rd., New Delhi Saroop Vihar (Kadipur) Block A B C D, Near Nathu Pura, Delhi-36 Ishwar Nagar Extn. Sarup Nagar, Delhi-42 W, X, Y, Z - Block Extn. Swaroop Nagar, Delhi 42 J & K Block, Swaroop Nagar, Delhi-42 Swaroop Nagar, Part-II, East G.T. Road to Buaradi Road, Delhi-42 Saroop Nagar, J&K Block, Samaipur, Badli, Delhi Saroop Nagar Extn. (South), Delhi Saroop Nagar Extn. W X Y Z Block Pt-II East Village Libaspur Delhi-42 Bhalswa Village, Lal Dora Extn. Delhi 33 Rajiv Nagar, Bhalsawa Dairy, Delhi-42 Rajiv Nagar Extn. Near Bhalsawa Dairy, Delhi-42 Bhalswa Guru Nanak Dev Colony Bhalswa Dairy Delhi-42 Swami Sardhanand Park, Bhalswa Dairy, Delhi-42 Gurunanak Nagar Bhalswa Dairy, Delhi Vashisht Enclave, Baba Colony, Burari, Delhi-84 Sant Nagar Block A1 Extn. Burari Road Delhi-84 Satya Vihar (Kamal Pur) Burari Delhi-84 Satya Vihar at Burari Delhi - 110084 Upkar Colony Virender Nagar Nehru Gali, Bhagat Colony, Burari, Sant Nagar, Delhi-84 Gangotri Enclave Prem Nagar Sant Nagar Block 'A' Burari Road, Delhi Sant Nagar, B-Block Burari, Delhi-84 Shiv Kunj, Area No.5 B-Block, Sant Nagar Burari Himgiri enclave, Burari Road, Delhi-84 Parvatiya Anchal, C-Block, Sant Nagar, Burari, Delhi-84 Uttranchal Enclave, Burari, Delhi Tomar Colony (Kamal Pur) Burari, Delhi-84 Asha Vihar Conductor Colony Kamal Vihar Kamal Pur Burari Delhi-84 West kamal Vihar Near Kamal Pur Burari Delhi-84 West Sant Nagar Colony, A 2 Block, Burari, Delhi-84 Amrit Vihar, Burari Harit Vihar Kamalpur Burari Delhi-84 Vijay Colony, Salempur Mazara, Burari Extn., Delhi Salempur Majra

Sl. No.	Name of GOC	Colonies Name
		Parsuram Enclave Salupur Majra Burari Delhi-84 Pradhan Enclave, C & D Block, Mazra Burari, New Delhi-84 Burari (3 no. SPS) Chanden Vihar, West Sant Nagar, Burari, Delhi-84 Baba Colony, A-Block, Burari, Delhi-94 Baba Colony B-Block, Burari, Delhi-84 Inderprasth Colony Pt-I Extn. Burari, Delhi- Indraprastha Colony Part-I, Burari, Delhi-84 Kaushik Enclave (B) Block, Part-II, Burari, Nathupura Road, Delhi-84 Kaushik Enclave, Burari Extn. Delhi-84 Kaushik Enclave, A-Block, Burari Road, Delhi Mukundpur Extn., Part-1, Delhi-42 Mukand Pur Vistar Delhi-42 Group of Colonies, Mukand Pur Extn., Delhi Mukand Pur Hingiri Enclave, Mukand Pur (Extn.-II), Burari
2.	Samaypur	Jeet Ram Colony, Budh Pur Distt., North West, Delhi Labour colony
3.	Bhalaswa	Bhalaswa Village, Lal Dora Extn. Delhi 33 Rajiv Nagar, Bhalsawa Dairy, Delhi-42 Rajiv Nagar Extn. Near Bhalsawa Dairy, Delhi-42 Bhalswa Guru Nanak Dev Colony Bhalswa Dairy Delhi-42 Swami Sardhanand Park, Bhalswa Dairy, Delhi-42 Gurunanak Nagar Bhalswa Dairy, Delhi
4.	Sant Nagar	Swaroop Nagar, South Part-II, G.T. Karnal Rd & Burari Rd., N. Delhi Saroop Vihar (Kadipur) Block A B C D, Near Nathu Pura, Delhi-36 Ishwar Nagar Extn. Sarup Nagar, Delhi-42 W,X,Y,Z - Block Extn. Swaroop Nagar, Delhi 42 J & K Block, Swaroop Nagar, Delhi-42 Swaroop Nagar, Part-II, East G.T. Road to Buaradi Road, Delhi-42 Saroop Nagar, J&K Block, Samaipur, Badli, Delhi Saroop Nagar Extn. (South), Delhi Saroop Nagar Extn. W X Y Z Block Pt-II East Village Libaspur Delhi-42
5.	Wazirabad	Hardev Nagar, Jharoda Majra, Burari Hardev Nagar, Jharoda Majra, Extn. Jharoda Extn, Pt-1, Majra Burari Jharoda Extn.-II, Part Cross Road, Burari, Delhi-84 Jharodh Majra Burari Bhagwan Park, Jharoda Majra, Burari, Delhi-84 Jharoda Part-3, Surender Colony, Burari, Delhi-84

Sl. No.	Name of GOC	Colonies Name
		Harijan Basti Jharoda, Mazra, Delhi-84 Ajit Vihar Burari Garhi, Delhi-84 Jagat Pur More, Burari, Delhi-84 Milan Vihar Near Jagat Pur Bandh Sant Nagar (Burari) Delhi-84 Deepansu Colony Sant Nagar Burari, Delhi Jagat Puri Jhangola Jagatpur, Vill. Jagatpur (Extended Purani Abadi) Delhi-84 Wakirabad Wazirabad
6.	Gandhi Vihar	Gandhi Vihar
7.	Gopalpur	Gopalpur

ANNEXURE - 3

NARELA DRAINAGE ZONE (NRL)

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NARELA DRAINAGE ZONE (NRL)

1. INTRODUCTION

The Narela Drainage zone is bounded by northern green buffer, boundary of NCT Delhi in the North, Coronation Pillar drainage zone in South, Railway line in West and Yamuna River on the East side. The area has large green coverage, farmland with scattered unauthorized development mostly concentrated towards Southern and Western boundary of the Zone. Location of Narela Drainage Zone is shown in the *Figure 1*.

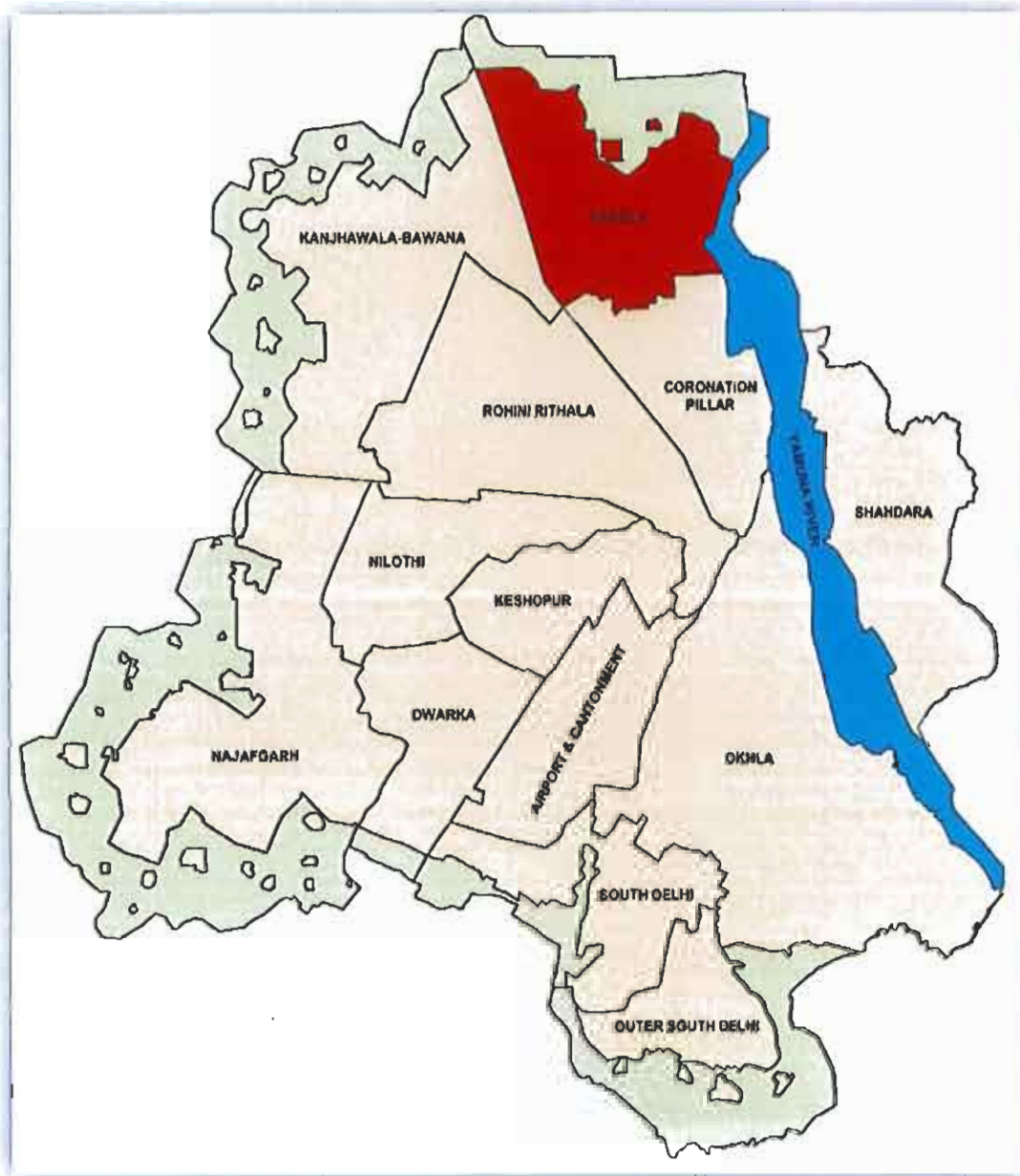


Figure 1: Narela Drainage Zone

Narela Drainage Zone consists of major areas like Narela Village, Singhu, Hamidpur, Khampur, Bakholi, Zindpur, Palla, Bakhtawarpur, Hiranki, Kadipur, Nanglipuna etc. This drainage zone falls under the DDA planning zone P-I and P-II as shown in the *Figure 2*.

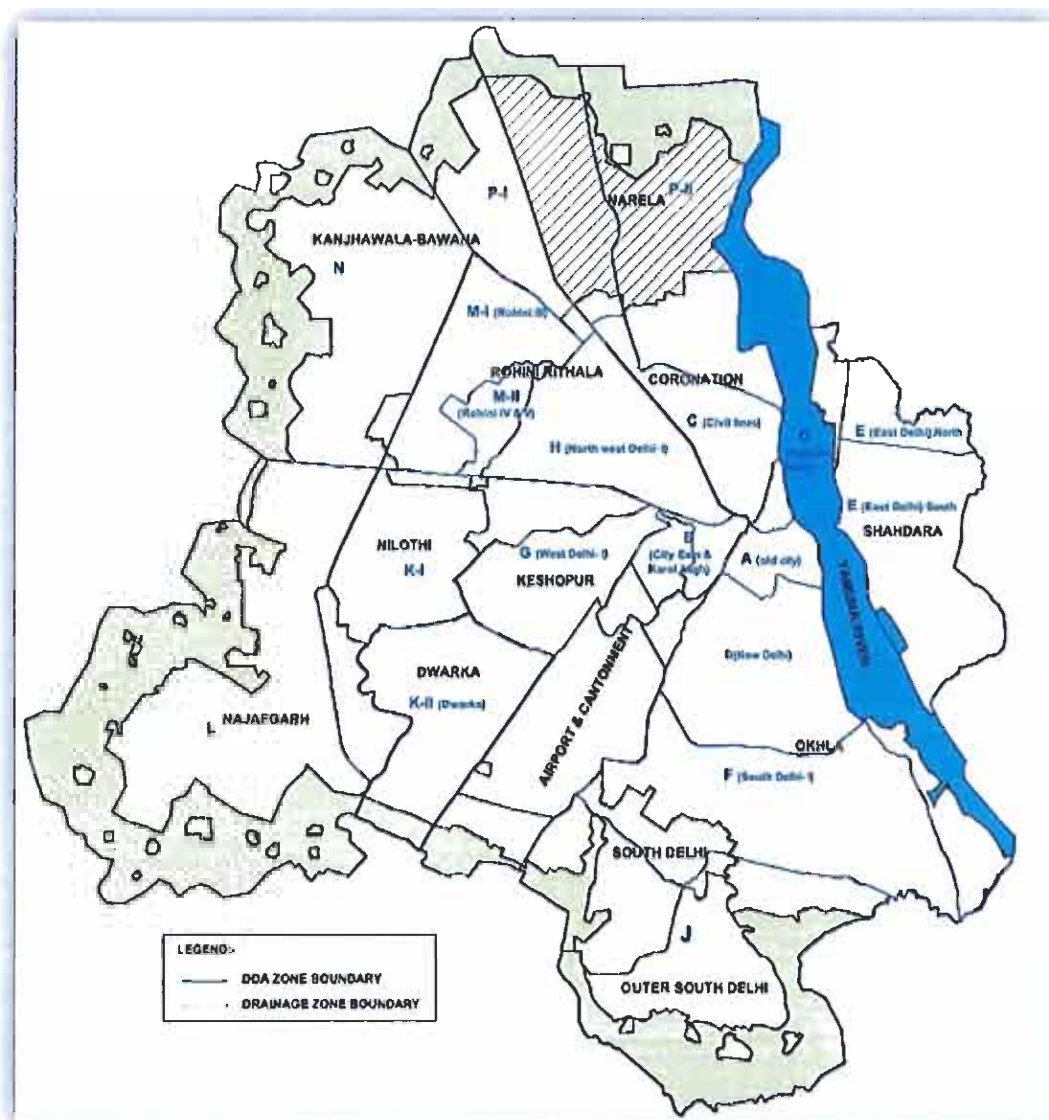


Figure 2: DDA Zones and Narela Drainage Zone

Soil Description of Narela

Tajpur kalan, BakhtawarPur side is covered with younger alluvium deposits whereas rest of the portion like Narela, Alipur, KheraKalan etc. with older alluvium deposits.

Narela Zone (Bhagat Singh park, Nagli Puna, Kadi Pur, Khera kalan, IbrahimPur, BakhtawarPur, ShahPur Garhi, SungarPur, Jhangola, Tikri Khurd, Tajpur kalan, Singhola etc.) is also most critical from seismic microzonation point of view. This zone is high Hazard due to Liquefaction potential. This Liquefaction factor is due to Newer alluvium proximal to Yamuna river, Special Care to be taken during construction in this zone.

This zone is having varying water depth ranging from 2- 5m in lower areas like Bhagat Singh park, Nagli Puna, Kadi Pur, Khera kalan, IbrahimPur etc. and central portion is having water depth ranging from 5-10m in BakhtawarPur, ShahPur Garhi, Sungarpur, Jhangola etc. whereas in upper range i.e. Tikri Khurd, Tajpur kalan, Singhola etc. water depth varies from 10- 20m.

Whole of the area is covered with Khadar Soil. (Bhagat Singh park, Nagli Puna, Kadi Pur, Khera kalan, IbrahimPur, BakhtawarPur, Shahpur Garhi, Sungarpur, Jhangola, Tikri Khurd, Tajpur kalan, Singhola etc.)

- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Narela Drainage Zone has been divided into three (3) Sub Drainage Zones as below:

- Narela (NRL-NR)
- Zindpur (NRL-ZP)
- Palla (NRL-PL)

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Based on population projections Sub Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Narela Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
NRL-NR	39.81	65.31	90.80	8.80	14.40	20.00
NRL-PL	11.94	19.59	27.24	2.60	4.30	6.00
NRL-ZP	66.29	108.73	151.18	14.60	24.00	33.30
Total	118.04	193.63	269.22	26.00	42.70	59.30

3.1 Sub Drainage Zone: Narela (NR)

This Sub Drainage Zone spread across Singhu, Hamidpur, Khampur, Bhakoli, Narela, Singhola and Shahpur Garhi etc. This zone is heterogeneous in nature and having rural unplanned and few planned areas. The area has a large green coverage in the form of orchards, forest and farmlands. Land use map is as shown in the **Figure 6**.

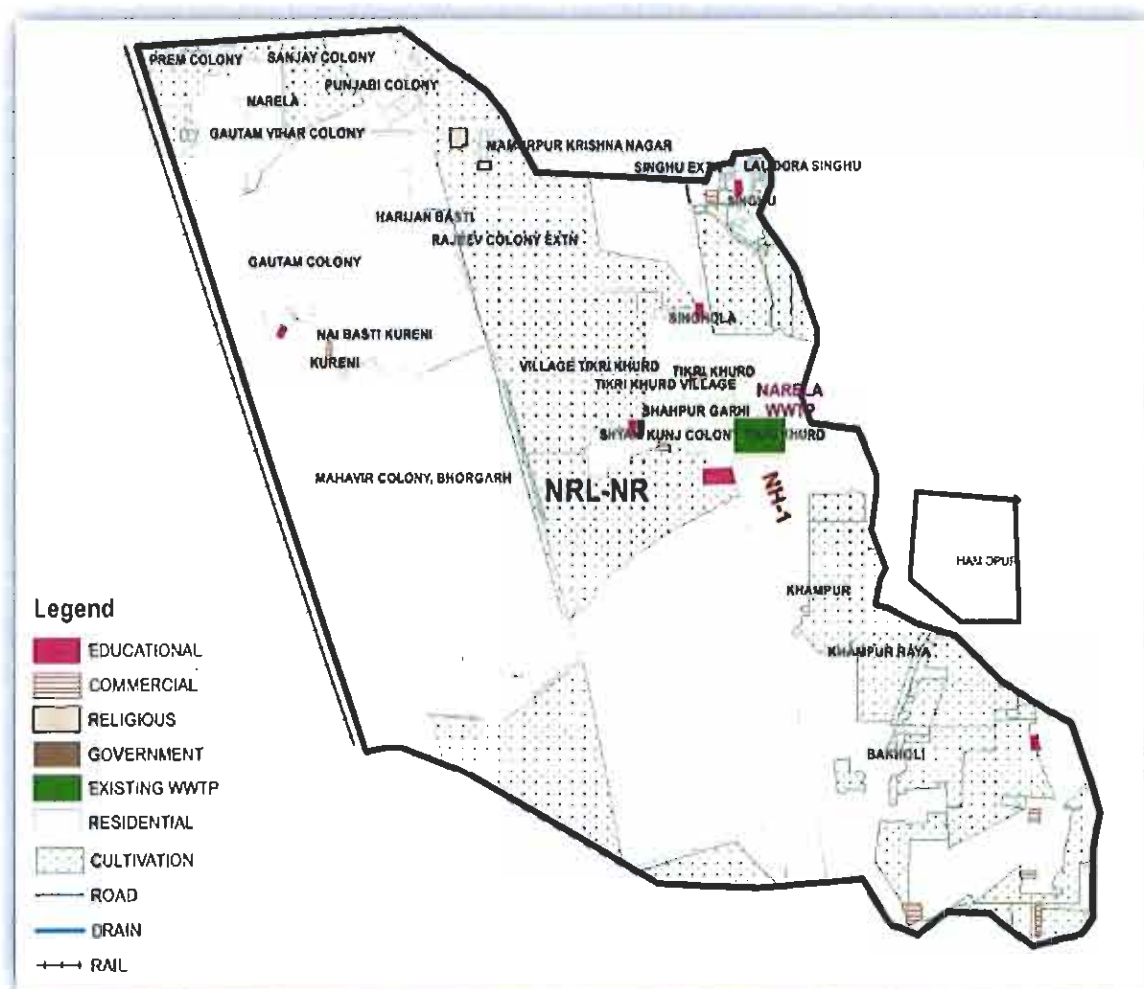


Figure 6: Land Use Map of Narela Sub Drainage Zone (NRL-NR)

Existing Sewerage Infrastructure

Sewerage Network already exists in part of the Sub Zone including parts of Narela, Kureni, Harijan Basti, Gautam Colony, Singhola etc. as shown in the land use map above. There is an existing WWTP known as **Narela WWTP (10 MGD)** capacity.

Sewage from Narela, Kureni, Harijan Basti, Gautam Colony, Singhola and nearby area outfalls into Narela WWPS (26 MGD Peak Flow) and pumped via existing rising main (750 mm) to Narela WWTP.

Line Diagram for Existing WWPS and WWTP is shown in the **Figure 7**:

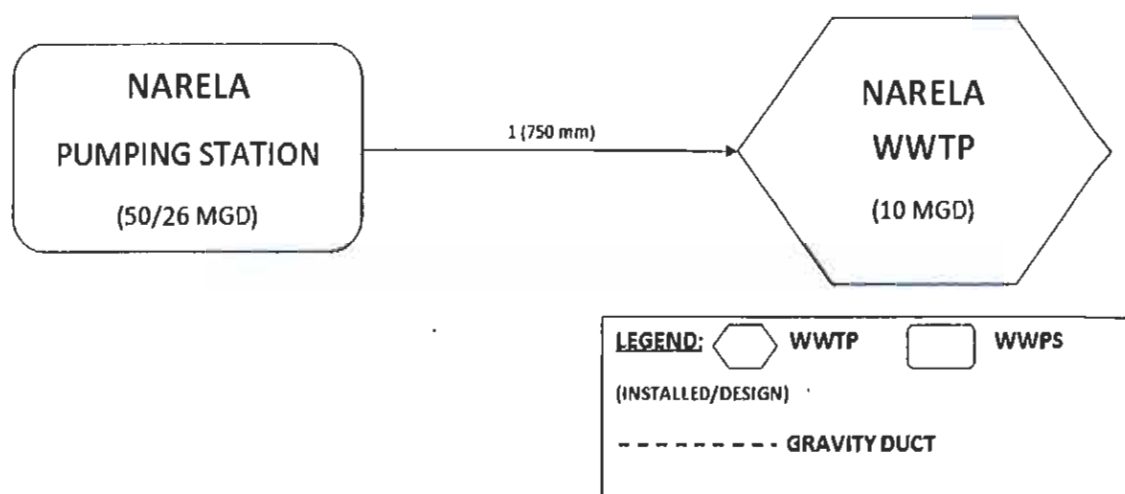


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 8**:

- Area is partially sewerred including part of Narela, Kureni, Harijan basti, Gautam colony, Singhola and nearby area.
- There is an existing WWTP known as **Narela WWTP (10 MGD)** capacity.
- Sewage from unsewered parts of Narela, Gautam Colony, Kureni, Harijan Basti, Shahpurgarhi and nearby area is routed to Existing Trunk Sewer towards Narela WWPS. One intermediate Lift Station is proposed.
- Sewage from Hamidpur, Bhakoli, Khampur and Singhu Village is routed to individual proposed WWPS's and then via rising main to existing Narela WWTP.

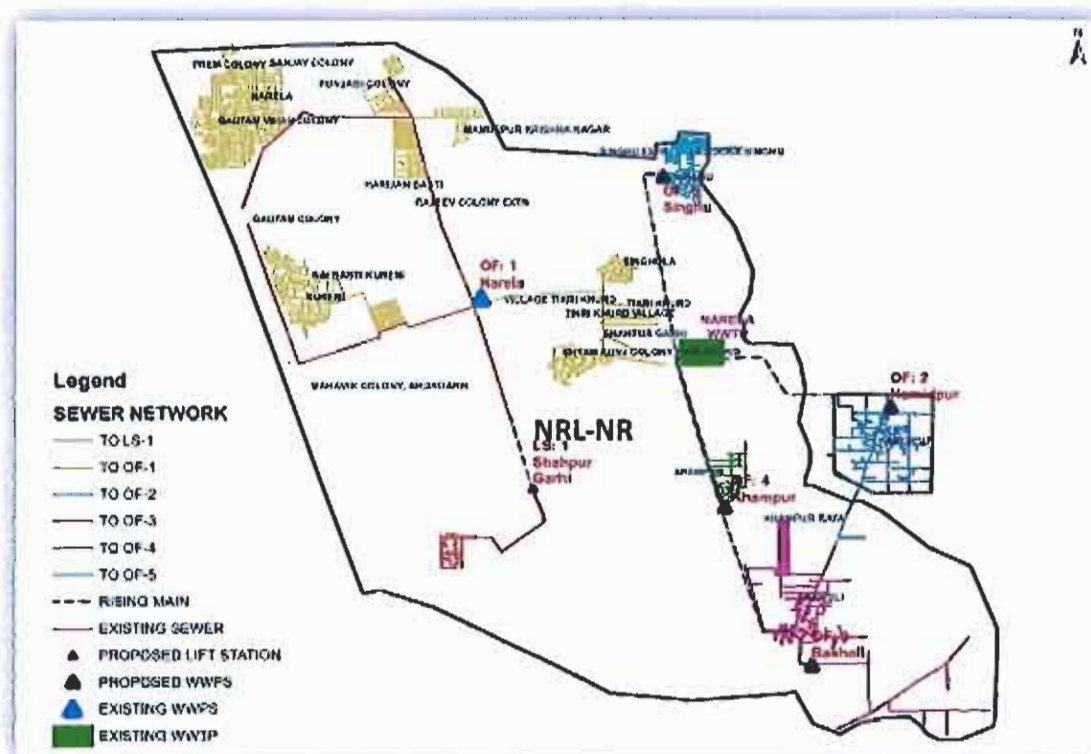


Figure 8: Scheme Map of Narela Sub Drainage Zone (NRL-NR)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Narela Sub Drainage Zone is shown in the **Figure 8**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	184509
300	HDPE/DWC	2841
350	HDPE/DWC	1014
400	HDPE/DWC	3647
500	HDPE/DWC	1660
563.6	HDPE/DWC	1305
635.2	HDPE/DWC	24
Total		195000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 9**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.



Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 3**.

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Singhu	WWPS	1.00	250	1	2500	Existing WWTP
2	Hamidpur	WWPS	1.50	300	1	2200	Existing WWTP
3	Khampur	WWPS	1.00	250	1	2100	Existing WWTP
4	Bhakoli	WWPS	2.00	400	1	4200	Existing WWTP
5	Shahpur Garhi	LS	0.50	200	1	850	Nearest Manhole

Waste Water Treatment Requirements

The existing 10 MGD WWTP will be sufficient to cater the sewage generation for Phase I. Additional Capacity of 10 MGD is proposed in Phase 2 in nearby area. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Zindpur (NRL-ZP)

This Sub Drainage Zone spread across Hiranki, Mukhmelpur, Kadipur, Nanglipuna, Alipur, Khusak, Zindpur Budhpur & Kherakalan villages etc. The area is unsewered and has very large green coverage in the form of orchards, forest and farmlands. No sewage treatment facility exists. Land use map is as shown in the **Figure 10**.

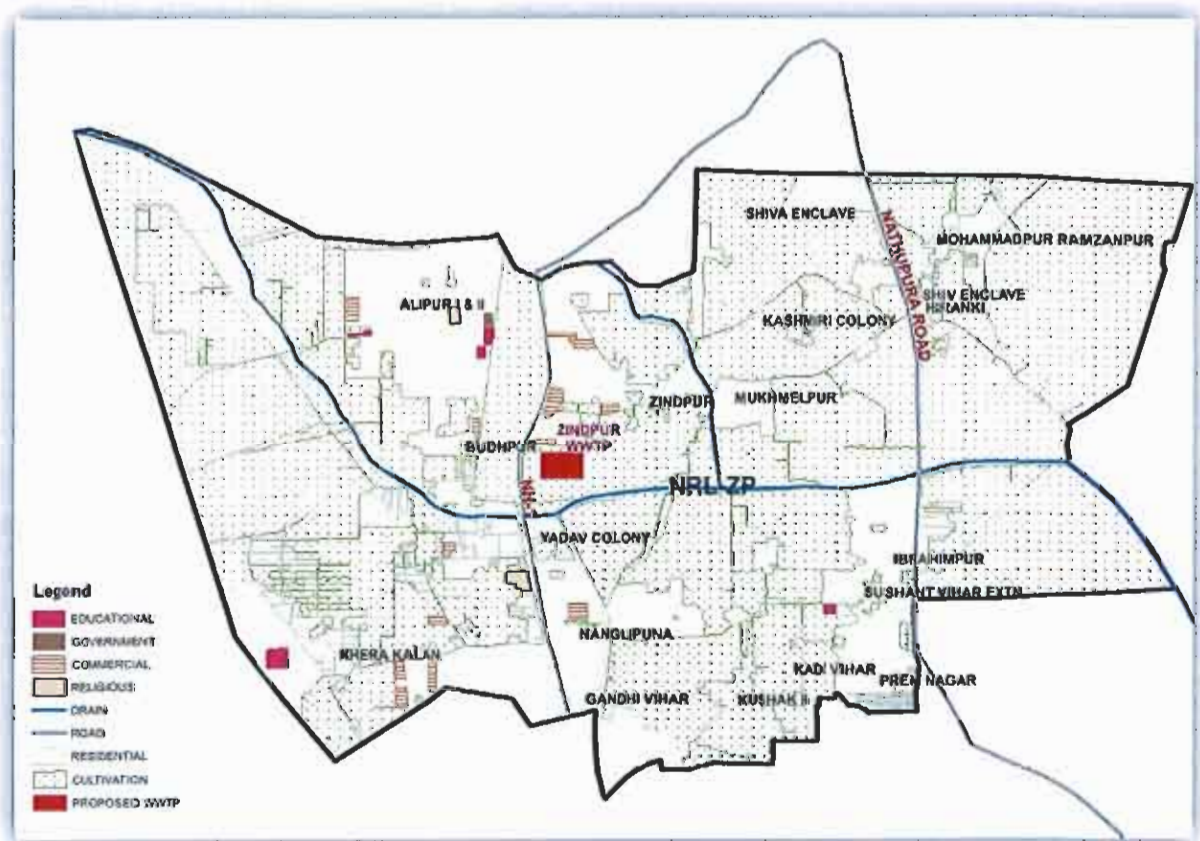


Figure 10: Land Use Map of Zindpur Sub Drainage Zone (NRL-ZP)

Existing Sewerage Infrastructure:

Presently no sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 11**

- One WWTP is proposed at Zindpur.
- Sewage from Alipur, Budhpur, Zindpur, Mukhmelpur, Khera Kalan, Yadav Colony, Nanglipuna, and nearby area is routed to proposed WWPS at Zindpur and then via rising main to proposed WWTP at Zindpur.

- Sewage from Khushak, Hiranki, Kashmiri Colony is routed to Proposed WWPS at Hiranki and then via rising main to nearby gravity sewer towards Zindpur WWPS.
- Sewage from Kadipur, Garhi Khasru, Nathupura, and nearby area is routed to Proposed WWPS at Kadipur and then via rising main to Proposed WWTP at Zindpur.

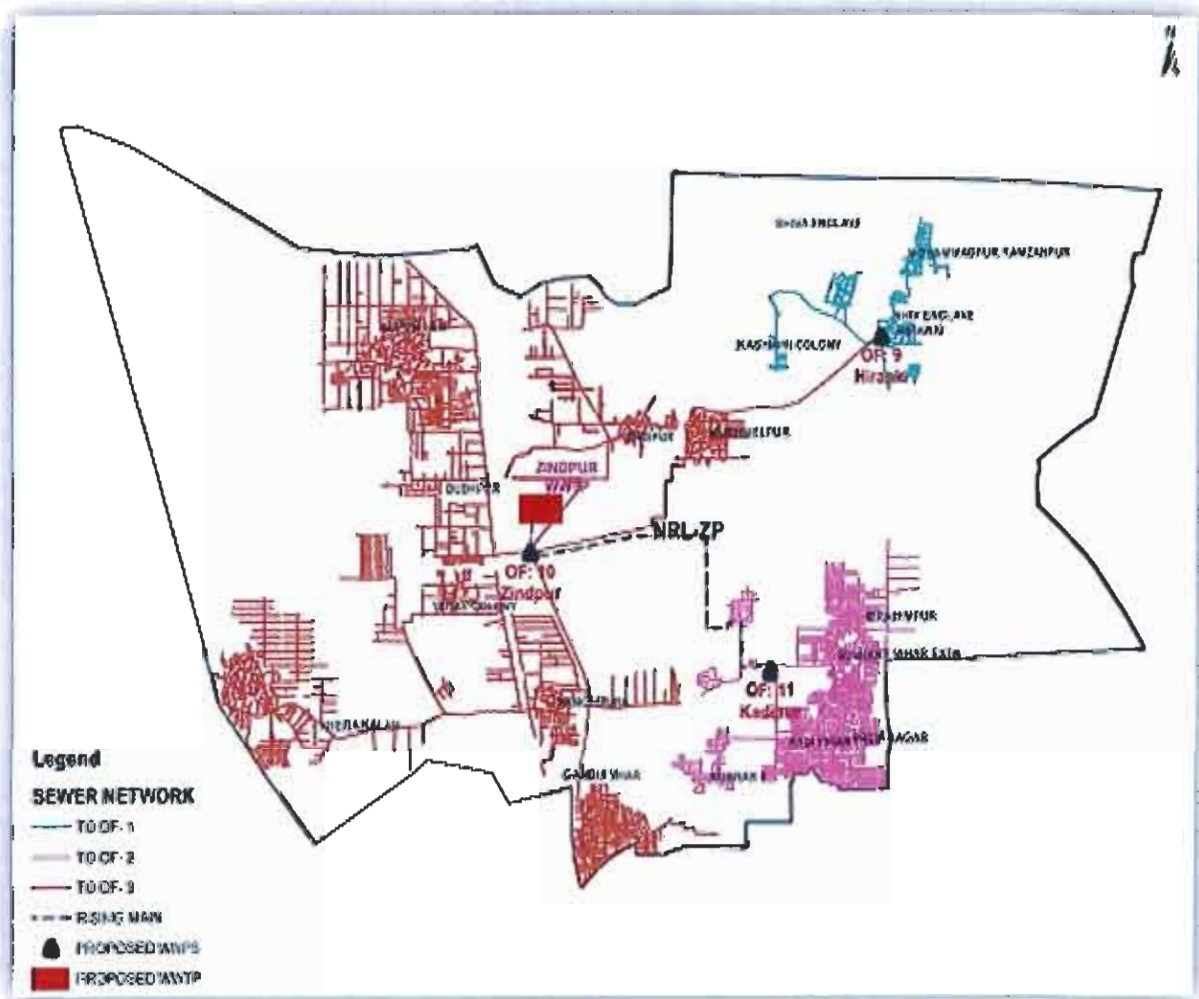


Figure 11: Scheme Map of Zindpur Sub Drainage Zone (NRL-ZP)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Zindpur Sub Drainage Zone is shown in the **Figure 11**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	343591
300	HDPE/DWC	3166
400	HDPE/DWC	9527
500	HDPE/DWC	7527
563.6	HDPE	1987
635.2	HDPE	3791
700	RCC NP3/NP4	3554
800	RCC NP3/NP4	1722
900	RCC NP3/NP4	772
1000	RCC NP3/NP4	262
1100	RCC NP3/NP4	1101
Total		377000

[illegible]

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Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Hiranki	WWPS	2.00	300	1	220	Proposed Trunk
2	Kadipur	WWPS	7.00	700	1	3800	Proposed WWTP
3	Zindpur	WWPS	22.00	1000	1	50	Proposed WWTP

Waste Water Treatment Requirements

One WWTP is proposed at Zindpur (33.3 MGD) in phased manner. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.3 Sub Drainage Zone: Palla (NRL-PL)

This Sub Drainage Zone spread across Palla, Akbarpur, Jhangola, Tajpur Kalan, Qullapur and Akbarpur Majra villages, Bakhtawarpur, Triveni Colony and Tigipur etc. The whole area is unsewered and has very large green coverage in the form of orchards, forest and farmlands. Land use map is as shown in the **Figure 13**.

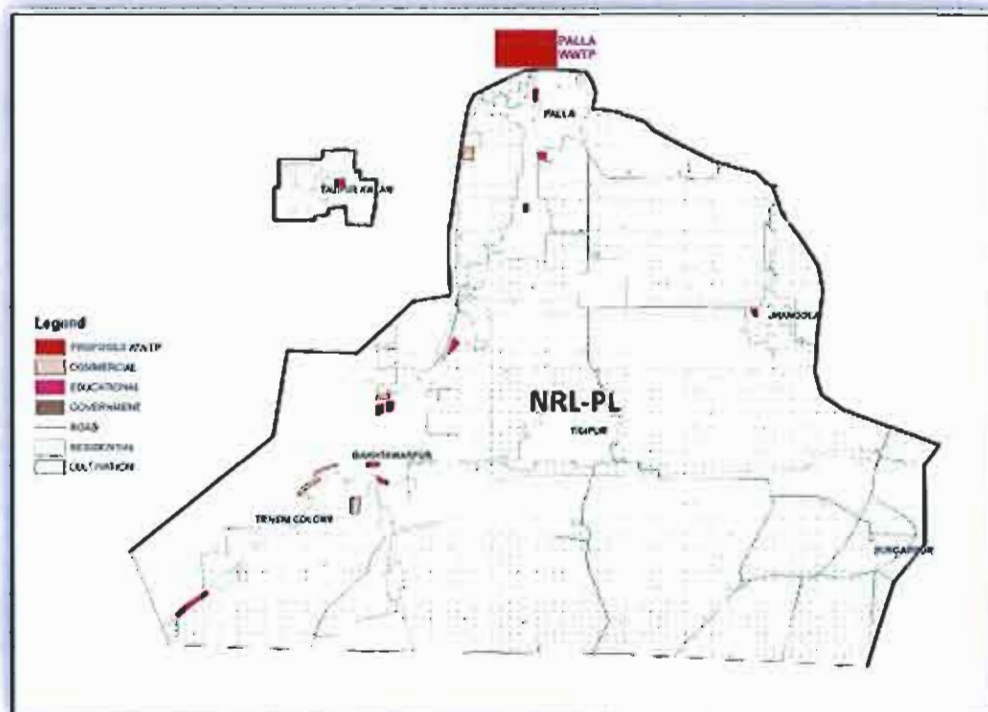


Figure 13: Land Use Map of Palla Sub Drainage Zone (NRL-PL)

Existing Sewerage Infrastructure

Presently no sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 14**:

- One WWTP is proposed at Palla.
- Alternatively, two (2) separate decentralized WWTPs may be constructed: one at Palla and another at Bakhtawarpur. For planning purposes, one WWTP at Palla has been considered.
- Sewage from Tajpur Kalan is routed to Proposed WWPS at Tajpur Kalan and then via rising main to Proposed WWTP at Palla.
- Sewage from Jhangola, Akbarpur Majra and Palla is routed to Proposed WWPS at Akbarpur Majra and then via rising main to Proposed WWTP at Palla.
- Sewage from Triveni Nagar and Bakhtawarpur is routed to Proposed WWPS at Bakhtawarpur and then via rising main to Proposed WWTP at Palla. Alternatively, rising main may be avoided and decentralized WWTP may be provided in Bakhtawarpur.

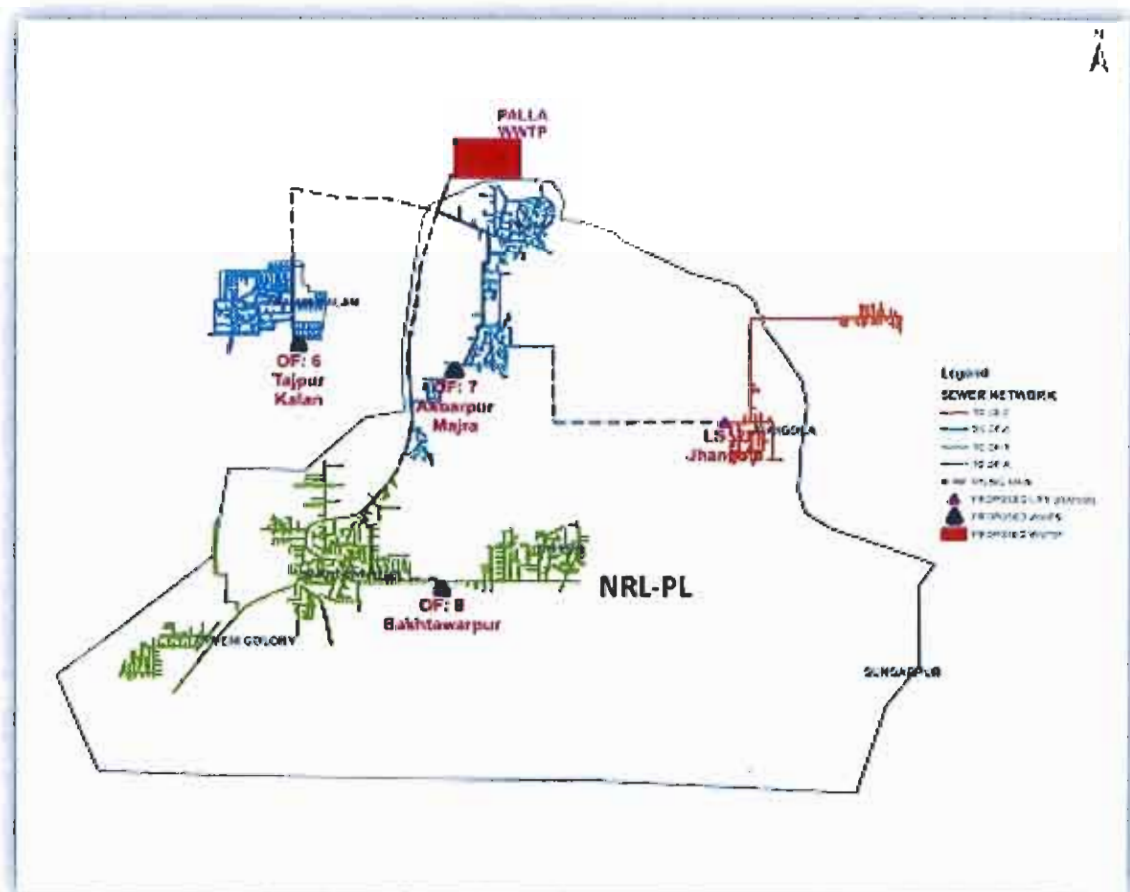


Figure 14: Scheme Map of Palla Sub Drainage Zone (NRL-PL)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Palla Sub Drainage Zone is shown in the figure above.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 6**.

Table 6: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	106207
300	HDPE/DWC	1124
400	HDPE/DWC	5954
500	HDPE/DWC	1936
563.6	HDPE/DWC	594
635.2	HDPE/DWC	474
700	RCC NP3/NP4	236
800	RCC NP3/NP4	475
Total		117000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 15**. However actual categorization with respective details, such as length, diameter and invert levels shall be based on as-built drawings.

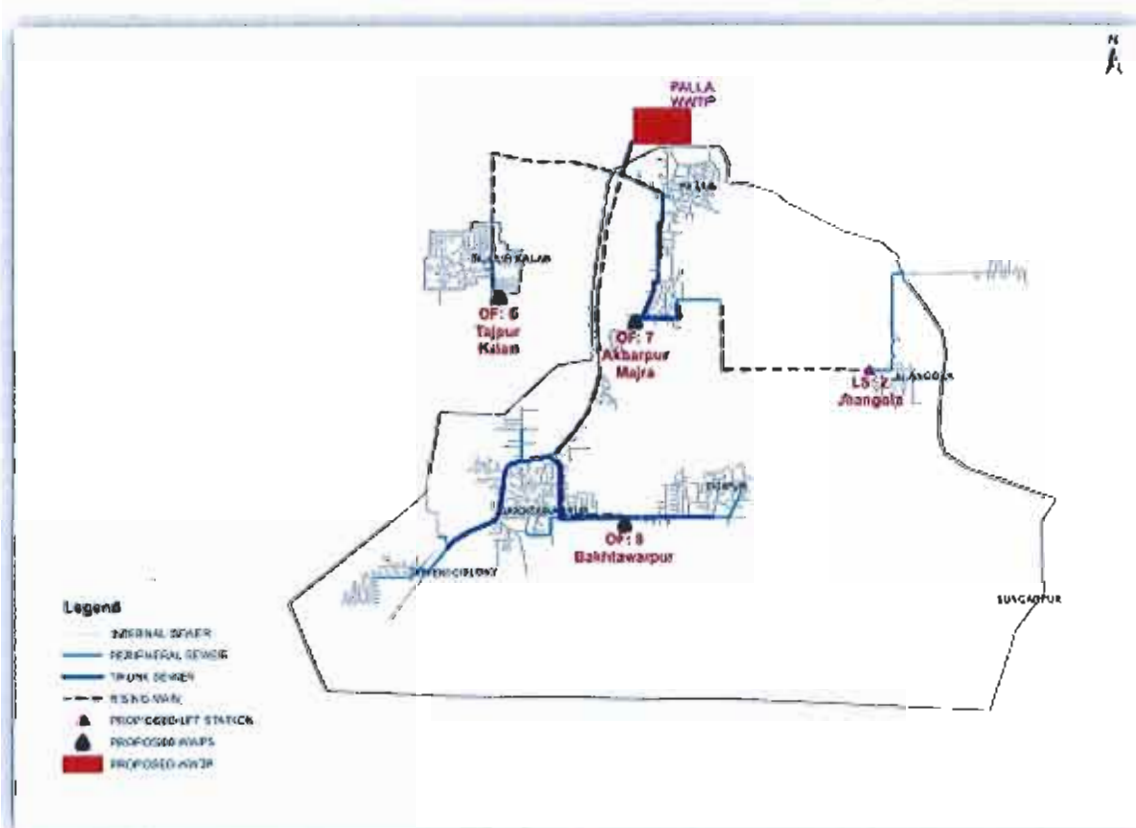


Figure 15: Proposed Sewerage Infrastructure of Palla Sub Drainage Zone (NRL-PL)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 7**.

Table 7: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Tajpur Kalan	WWPS	1.50	300	1	2400	Proposed WWTP
2	Akbarpur	WWPS	3.00	400	1	1800	Proposed WWTP
3	Jangola	LS	1.50	300	1	1600	Nearest Manhole
4	Bhaktawarpur	WWPS	8.00	600	1	50	Proposed WWTP

Waste Water Treatment Requirements

One WWTP is proposed at Palla (6 MGD) in phased manner. Alternatively, two (2) separate decentralized WWTPs may be constructed: one at Palla and another at Bakhtawarpur in phased manner. Location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 8**.

Table 8: Summary of Proposed Sewerage Infrastructure

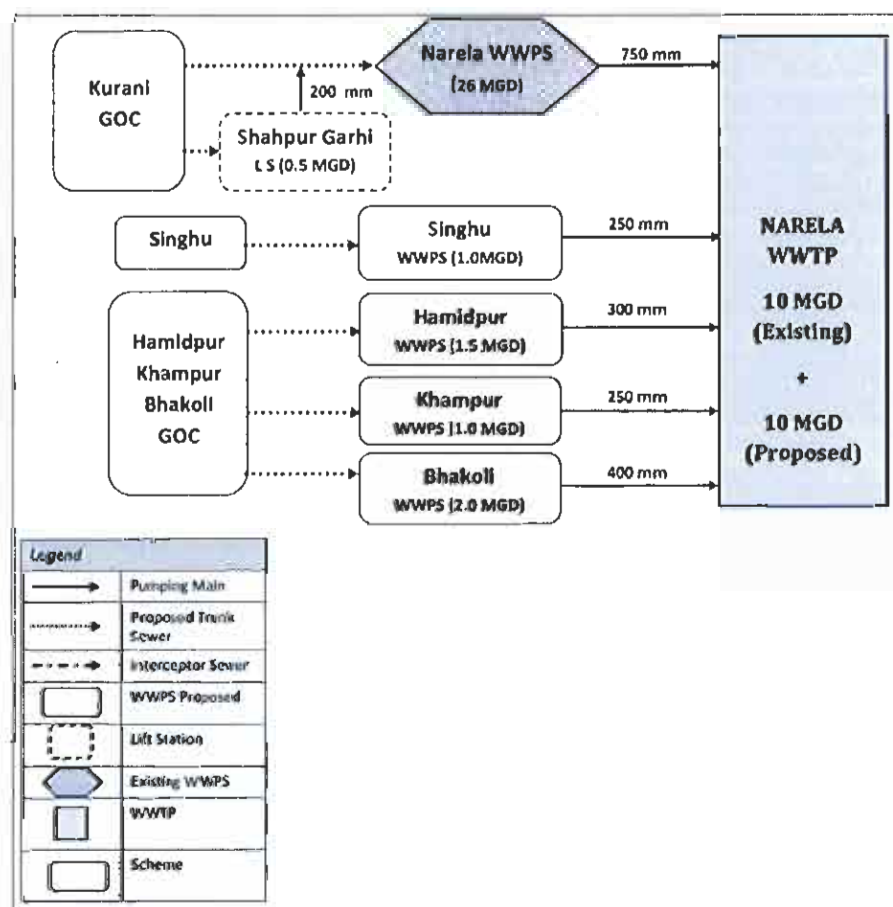
SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Narela	(NRL-NR)	195	4	1	1
Zindpur	(NRL-ZP)	377	3	-	1
Palla	(NRL-PL)	117	3	1	1

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 9**.

Table 9: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Reqd. (ha)	Location	Type	Design Capacity (MGD)	Area Reqd. (sq.mt.)
Narela	Narela	10	5.7 - 7.3	Singhu	WWPS	1	989.72
				Hamidpur	WWPS	1.5	1104
				Khampur	WWPS	1	1025.12
				Bhakoli	WWPS	2	1096.26
				Shahpur Garhi	LS	0.5	36.21
Zindpur	Zindpur	33.3	18.9 - 24.2	Hiranki	WWPS	2	1127
				Kadipur	WWPS	7	2726.9
				Zindpur	WWPS	22	3100
Palla	Palla	6	3.4 - 4.4	Tajpur Kalan	WWPS	1.5	1080
				Akbarpur	WWPS	3	2050
				Jangola	LS	1.5	44.25
				Bhaktawarpur	WWPS	8	2729

Line Diagram for Proposed WWPS and WWTP for Narela is shown in **Figure 16**:

**Figure 16: Line Diagram for Proposed WWPS and WWTP for Narela**

Line Diagram for Proposed WWPS and WWTP for Zindpur is shown in **Figure 17**:

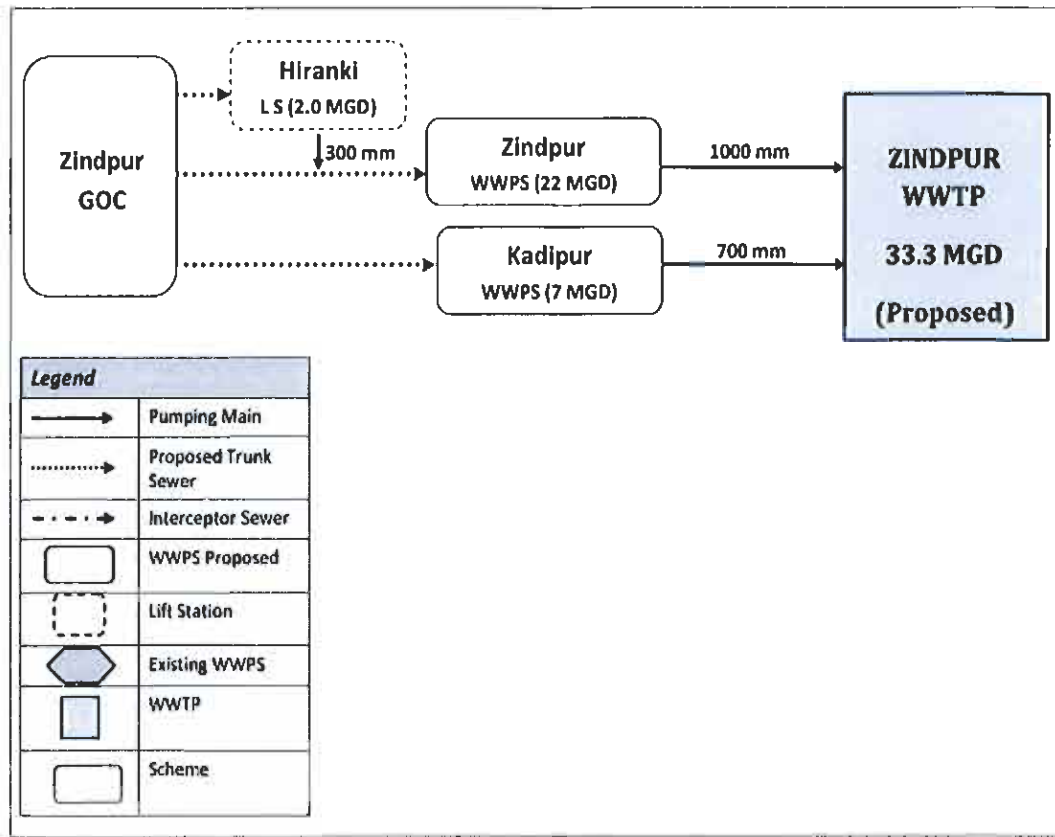


Figure 17: Line Diagram for Proposed WWPS and WWTP for Zindpur

Line Diagram for Proposed WWPS and WWTP for Palla is shown in **Figure 18**:

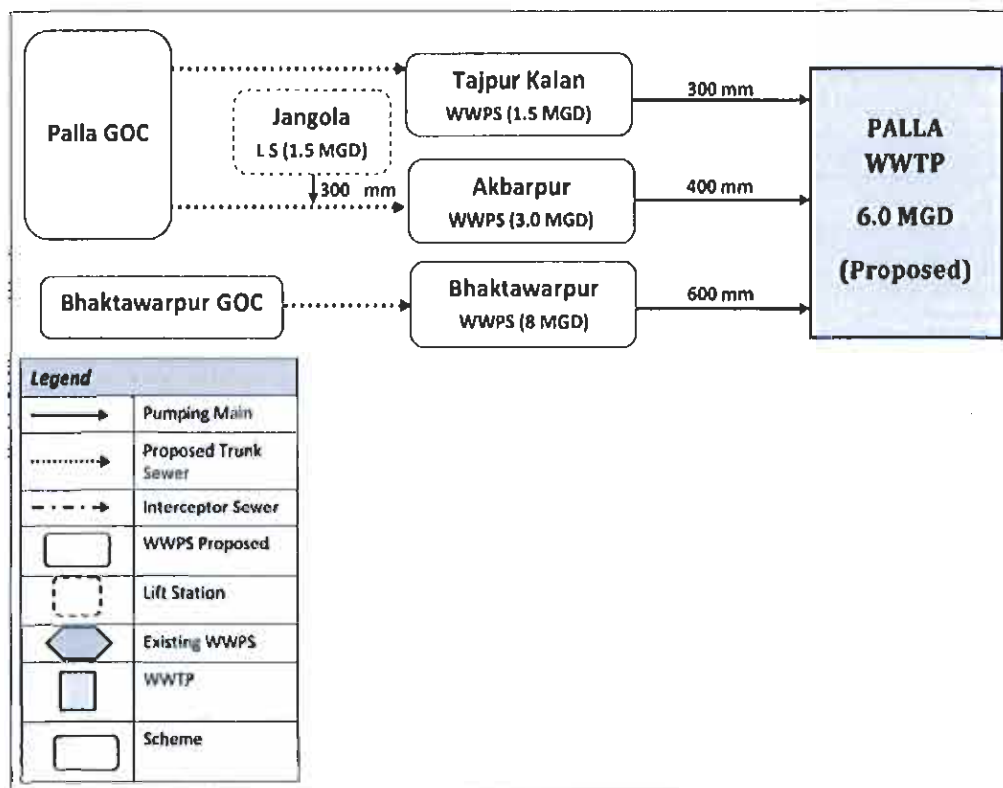


Figure 18: Line Diagram for Proposed WWPS and WWTP for Palla

Disposal of Treated Effluent

Treated effluent from Narela WWTP is being discharged to nearby Drain which ultimately discharges to Yamuna River via Supplementary drain. Treated effluent from proposed WWTP at Zindpur is proposed to be discharged to Supplementary drain. Treated effluent from proposed Palla WWTP is proposed to be discharged to Palla pondage discharging to Yamuna.

Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be DDA. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Narela Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 19**.

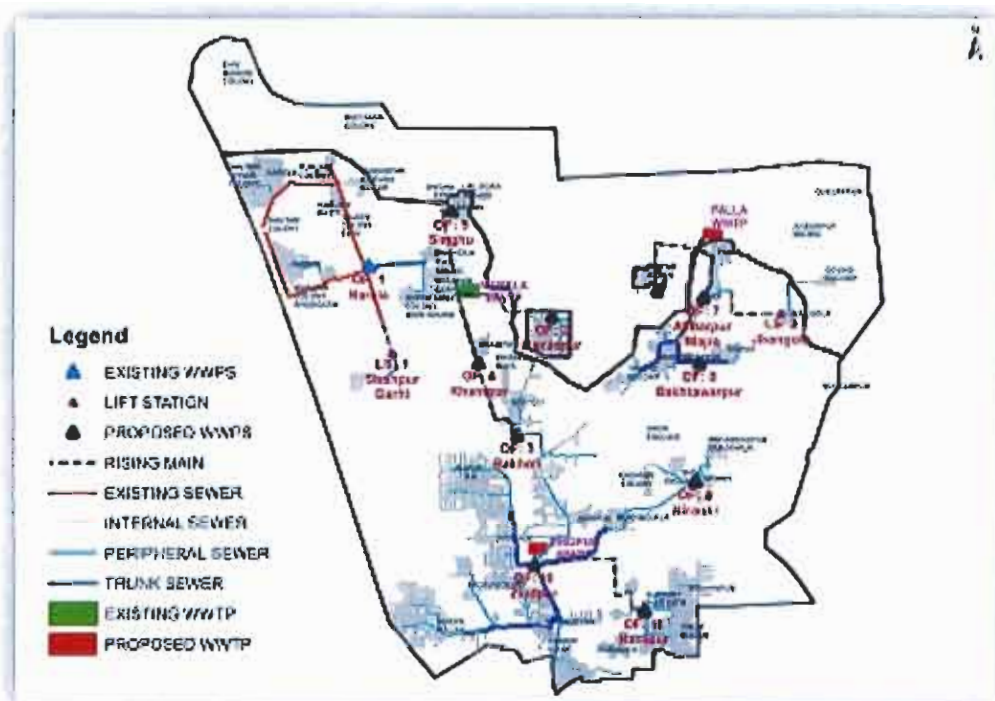


Figure 19: Proposed Sewerage Scheme for Narela Drainage Zone

Various Group of Colonies (GOCs) – wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 20**:

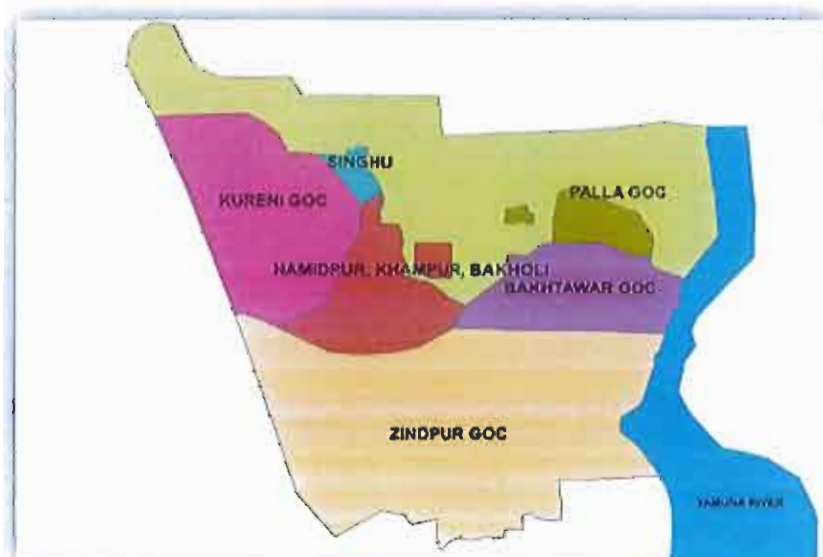


Figure 20: GOC-wise Sewerage Schemes – Narela Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 10: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Narela	NR	NRL-NR-SNG	Singhu				
2	Narela	NR	NRL-NR-HKB	Hamidpur, Khampur, Bakholi				
3	Narela	NR	NRL-NR-KU	Kureni GOC				
4	Palla	PL	NRL-PL	Palla GOC				
5	Palla	PL	NRL-BKP	Bakhtawar GOC				
6	Zindpur	ZP	NRL-ZP	Zindpur GOC				

Table 11: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Colonies Name
1.	Palla	Gari Bakhtawar Pur Akbar Pur Majra Om Vihar Colony, Akbarpur, Mazra, Near Alipur Palla Road, Delhi-36 Jhangola Jhangola Taj Pur Kalan Qullakpur Palla Govind colony Near Jhangola No.2 Alipur Delhi-36
2.	Singhu	Singhu Lal Dora Of Village Singhu Delhi 40 Village Singhu Extn. Delhi 40 Singhu
3.	Kureni	Nai Basti Kureni, Narela, Delhi Kureni Rajeev Colony Extn., Narela, Delhi-40 Gautam Vihar Colony, Narela, Delhi-40 Sanjay Colony, Narela, Delhi-40 Rajiv Colony, Harijan Basti, Narela, Delhi-40 Gautam Vihar Colony, Narela, Delhi-40 Ravi Dass Colony, Narela Krishna Estate, G-Block, Punjabi Colony, Narela, Delhi Shyam Kunj Colony Tikri Khurd Delhi-40 Tikri Khurd Village, Extended Abadi, Narela, Delhi-40 Village Tikri Khurd, Delhi 40 Tikari Kurd
4.	Hamidpur	Hamidpur
5.	Khampur	Khampur Raya Khampur (Part) Kham Pur
6.	Bakholi	Bakholi
7.	Bakhtawar	Bakhtawarpur Extn. III, Bakhtawarpur Delhi 36 Bakhtawar Pur Extn., Bakhtawar Pur, Delhi-36 Bakhtawar Pur Extn.II, Bakhtawar Pur, Delhi-36 Janda Bakhtawarpur Extn.Delhi 36 Bakhtawar Pur Sungarpur Tigi Pur
8.	Zindpur	Nangli Poona Extn. G. T. Karnal Road, Delhi-36 Nangli Poona Extn., Part-II, Delhi-36 Nangali Puna Kushak No.2, Extn., Delhi-36 Kushak II Nathupura D Block Burari Delhi-84 Phool bagh Place (Shastri Park Extn) Nathupura Mode Delhi-36 Nathu Colony, Nathupura, Delhi-84 Pradeep Vihar Nathupura Mode Delhi-36

Sl. No.	Name of GOC	Colonies Name
		Prem Nagar, Nathupura, Delhi-84 Kadi Pur, 'C' Block, Delhi-36 Extended Abadi of Kushak No-1, Village Kadi Pur, Delhi-36 Kushak No-I B- Block Kadipur Village Delhi-36 Extended Abadi Of Kadi Pur Village Kadi Pur Kadipur Extn., Nangli Road, Delhi-36 Inder Prasth Colony Nathu Pura, Burari, Delhi-84 Shastri Park, Nathupura More, Burari, Delhi-87 Shastri Park Extn., Nathupura More, Burari, Delhi-84 Shastri Park Extn.Nathu Pura More Burari Delhi-84 Ibrahim Pur Extn. DCM Colony, Burari, Delhi Ibrahim pur Extn. DCM Colony, Pt-2, Delhi-36 Keshav Nagar Burari Nathupura Road Delhi-36 Kushak 1 Kushak No.1, Extn., Delhi-36 Kadi Vihar Near Nathupura Delhi-36 Kadi Vihar (Kadipur) Delhi 36 Mukti Aashram Colony, Ibrahim Pur. Shiv Vihar Burari Bakhtawar Pur Road Ibrahim Pur Delhi Keshav Nagar, Garhi Khusro, Burari, Delhi Sushant Vihar, Ibrahimpur Extn., Delhi-36 Ibrahim Pur Pawan Dham Trivani Colony Delhi-36 Kadi Vihar Extn. Delhi 36 Kushak III Jind Pur Zind Pur Extn.Delhi-36 Shiva Enclave Hiranki Alipur Delhi-36 Hiranki Mohammadpur Ramjanpur Zindpur Village Extn., Zindpur, P.O.Alipur, Delhi-36 Zindpur Village Extn.Alipur Delhi-36 Laxman Colony Village Jindpur, Alipur Delhi 36 Mukhmelpur Sushant Vihar Delhi 36 Ali Pur I & II Budhpur Saroop Nagar Block A B C D E F G H H1,I G.T. Road Libaspur, Delhi-42 Khera Kalan & Khera Garhi Extnded Abadi, Post Office Khera Khalan Delhi 82 Village Khera Kalan, Delhi 82 Khera Kalan

ANNEXURE - 4

ROHINI-RITHALA DRAINAGE ZONE (RR)

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ROHINI-RITHALA DRAINAGE ZONE (RR)

1. INTRODUCTION

Rohini-Rithala Drainage Zone is bounded by Northern Railway Line towards North East, Okhla and Keshopur Drainage Zone towards South and Kanjhawala Bawana Drainage Zone towards South West and North West. Area consists of planned residential development and mixed commercial establishments throughout the Zone. Location of Rohini-Rithala Drainage Zone is shown in the **Figure 1**.

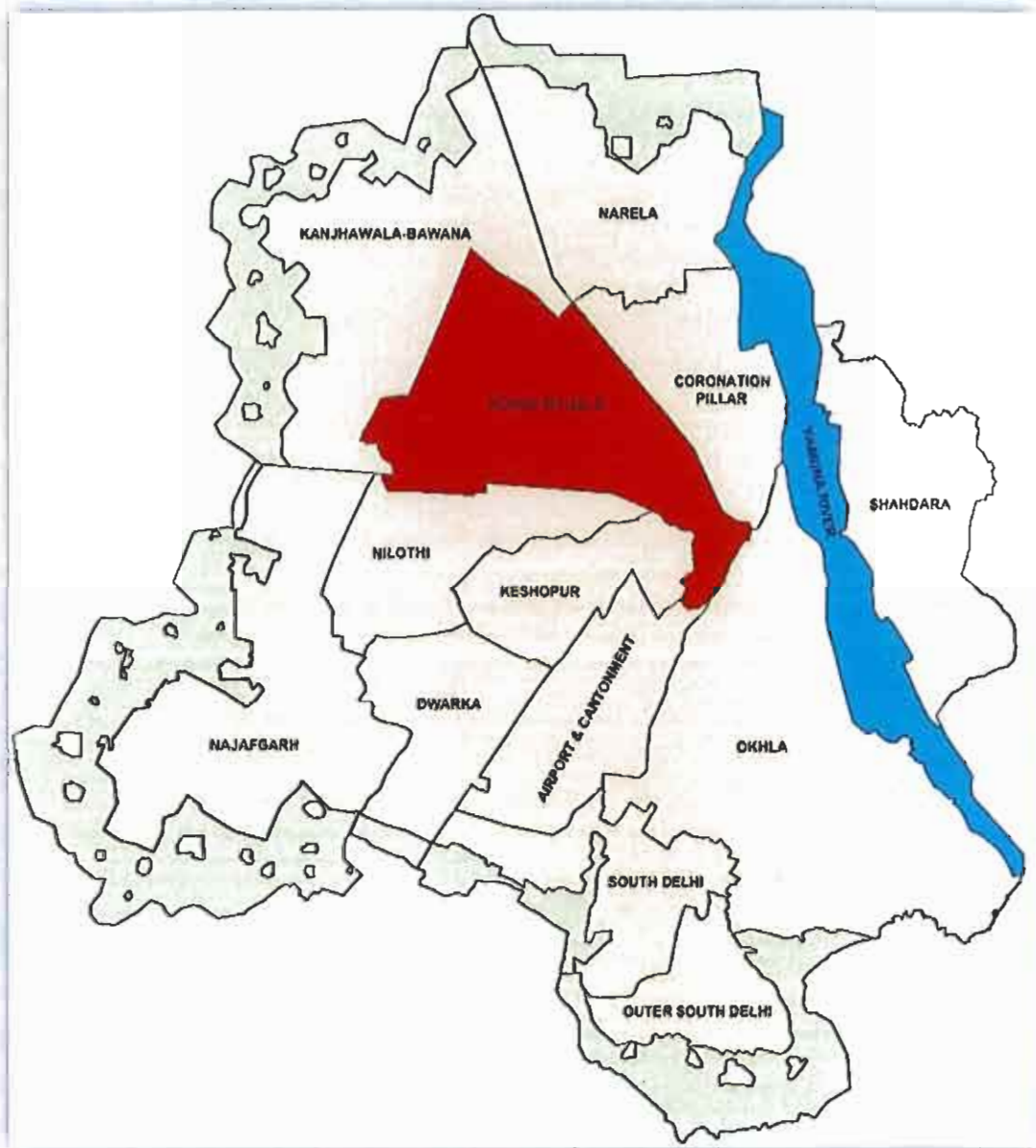


Figure 1: Rohini-Rithala Drainage Zone

Rohini-Rithala Drainage Zone comprises of major areas like Prem Nagar, Kirari, Begampur, Sahibabad, Bhagya Vihar, Rohini, Budh Vihar, Vijay Vihar, Krishna Vihar, Pitampura, Tri Nagar, Shastri Nagar, Shalimar Bagh, Rithala etc. This Drainage Zone falls under DDA Zone M & H and some part of zone B, K-I and N as shown in the **Figure 2**.

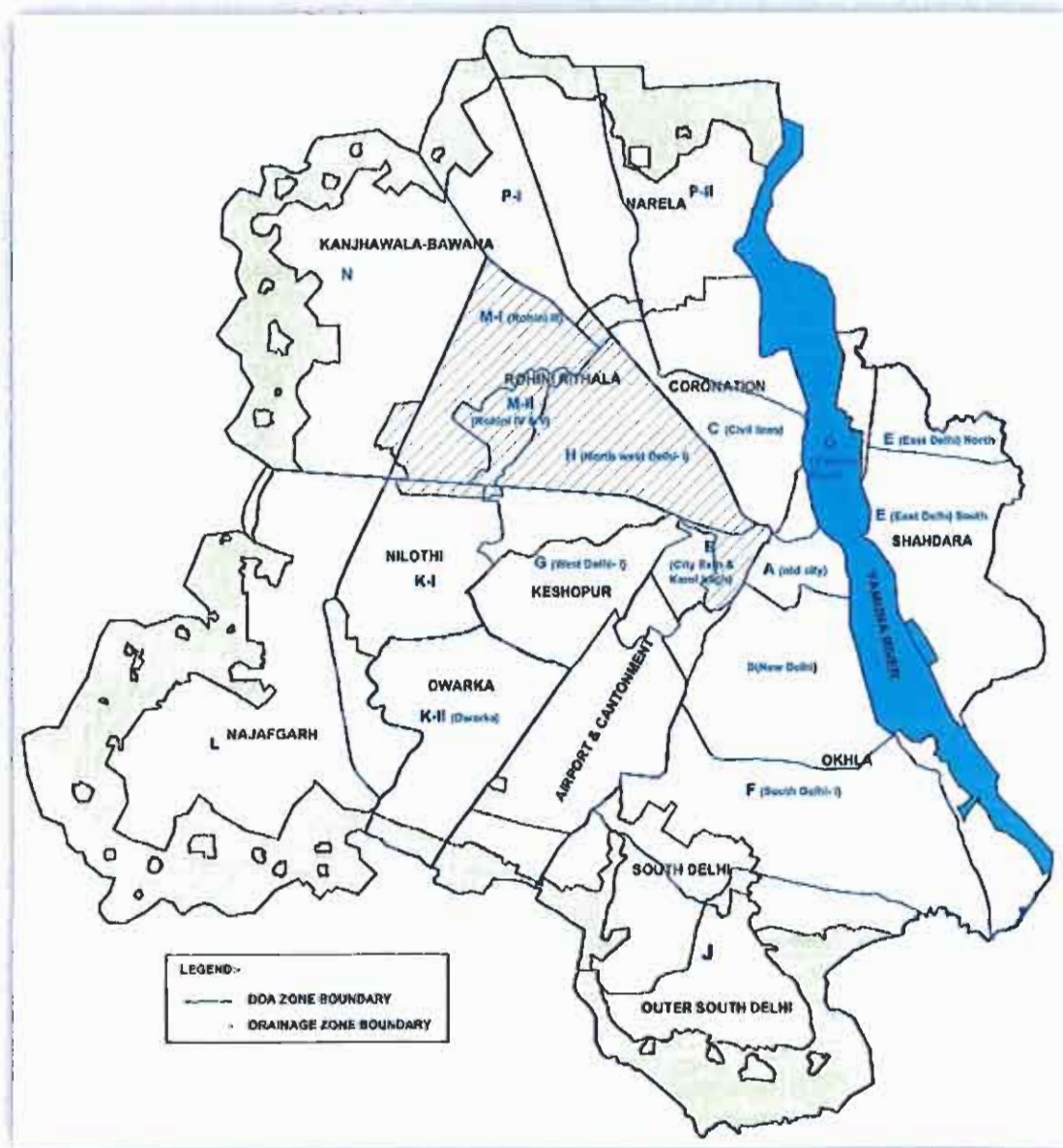


Figure 2: DDA Zones and Rohini-Rithala Drainage Zone

Soil Description of Rohini-Rithala

This zone is fully covered with older alluvium deposits.

North West Delhi plains having areas like Barwala, Rajiv Nagar, Kirari Extension, Krishana Vihar, Sultanpuri etc. full of Bangar have Moderate Hazard due to thick soil cover. South Najafgarh sedimentary fills (Dabar) covering areas like Pritampura, prashant vihar, Rani Bagh etc. is having Moderate Hazard due to high amplification and liquefaction.

The area having water depth 2-10m broadly covers Prashant Vihar, Pritam Pura, Rajiv Nagar, Barwala, Kirari Extension, Rani Bagh etc. The area having water depth 10-20m broadly covers Ashok Vihar, Tri Nagar, Shashtri Nagar, karol Bagh, Rajendra Nagar etc.

Almost whole of the area is covered with Bangar Soil except Kirari Nagar, Udyog Nagar, Mangol Puri, Rajiv Nagar area which is having Dabar kind of soil.

2. MASTER PLANNING FOR ROHINI-RITHALA DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The Drainage Zone is partially sewered. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

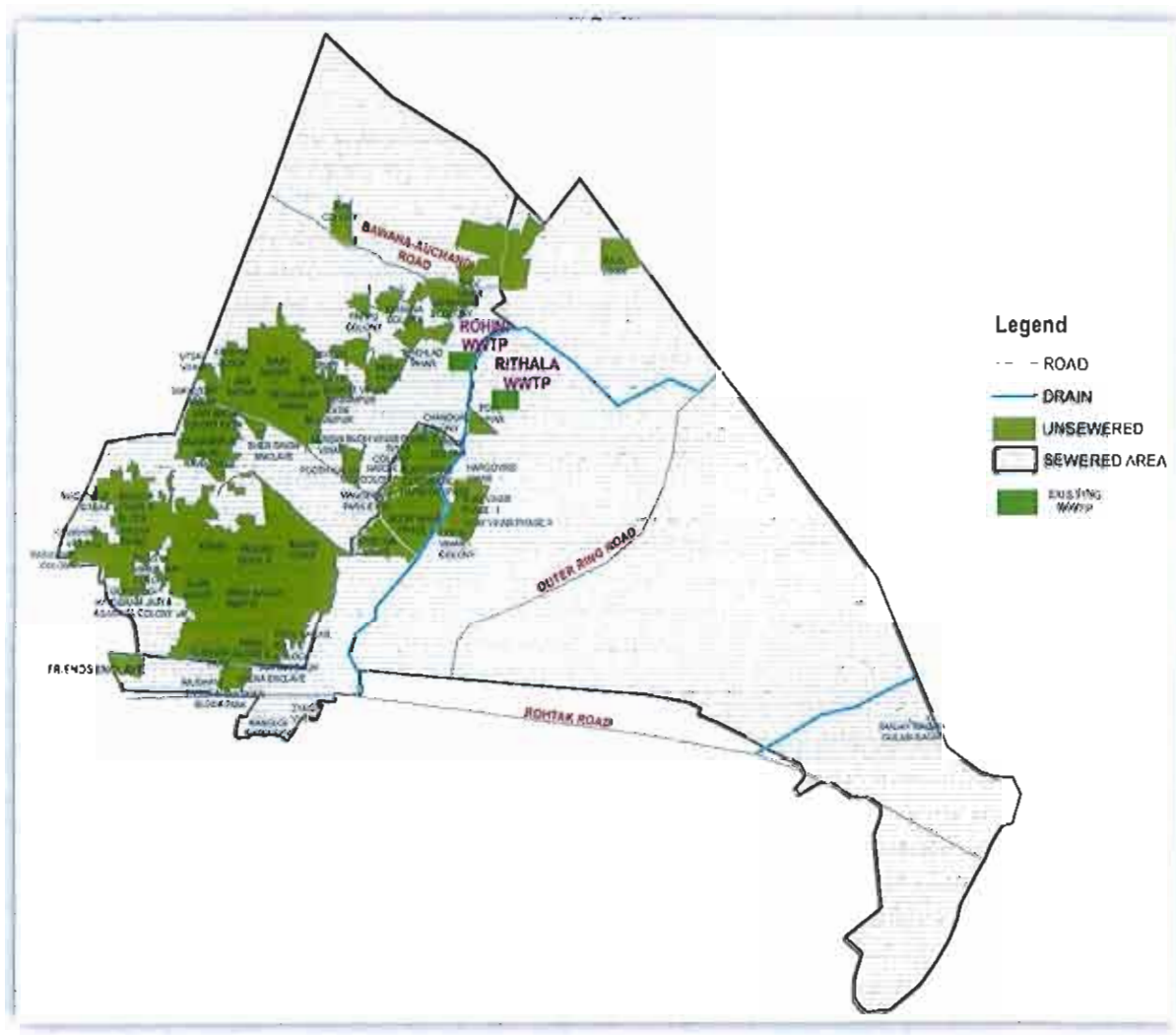


Figure 3: Sewerage Status of Rohini-Rithala Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS

- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Rohini-Rithala Drainage Zone has been divided into two (2) Sub Drainage Zones as below:

- Rohini (RR-RH)
- Rithala (RR-RT)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

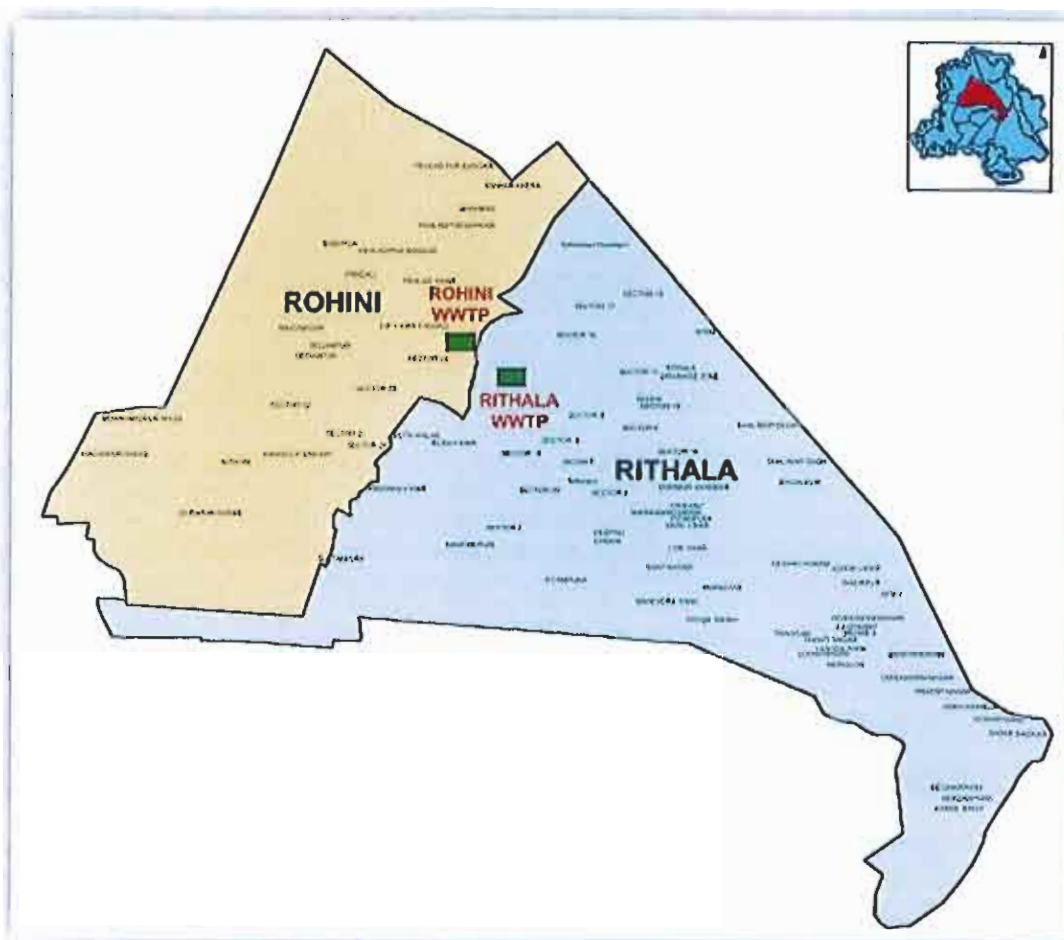


Figure 4: Sub Drainage Zone Map of Rohini-Rithala Drainage Zone (RR)

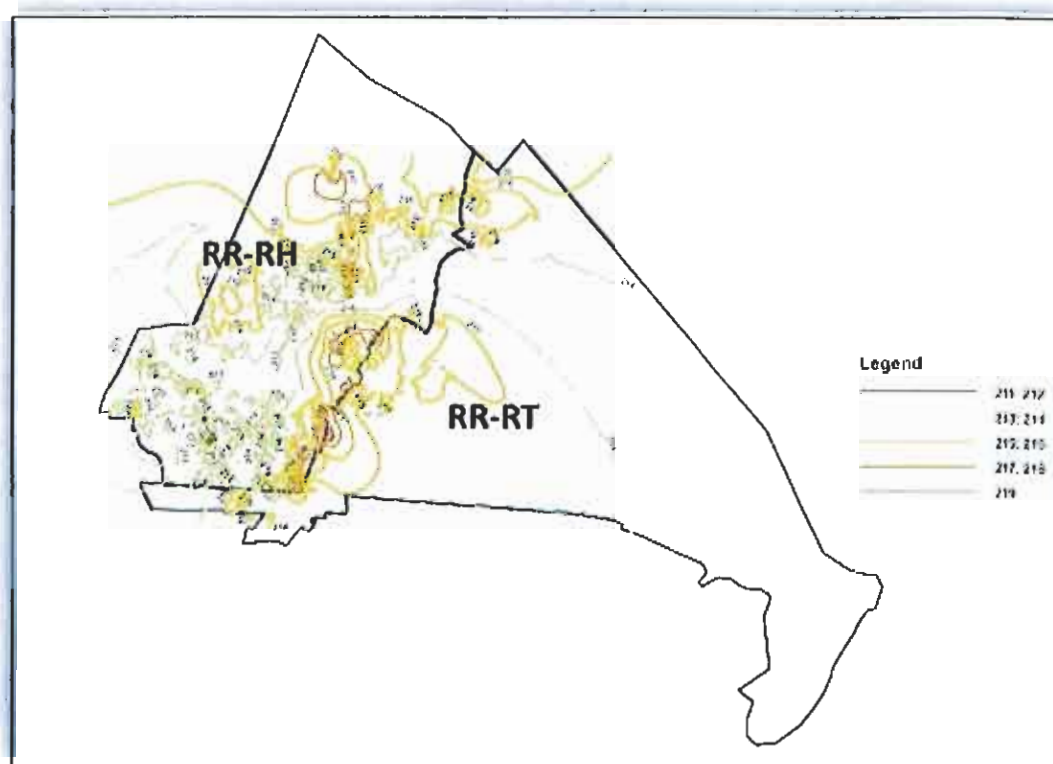


Figure 5: Contour Map of Rohini-Rithala Drainage Zone (RR)

Based on population projections, Sub-Drainage Zone wise estimated sewage generation for the zone is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Rohini-Rithala Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
RR-RH	144.49	163.50	182.51	31.80	36.00	40.20
RR-RT	286.81	324.55	362.29	63.20	71.50	79.80
Total	431.30	488.05	544.80	95.00	107.50	120.00

3.1 Sub Drainage Zone: Rohini (RR-RH)

This Sub Drainage Zone spread across Prem Nagar, Kirari, Begampur, Sahibabad, Bhagya Vihar, Rohini etc. The area is partially sewered with one existing WWTP at Rohini. Land use map is as shown in the **Figure 6**.

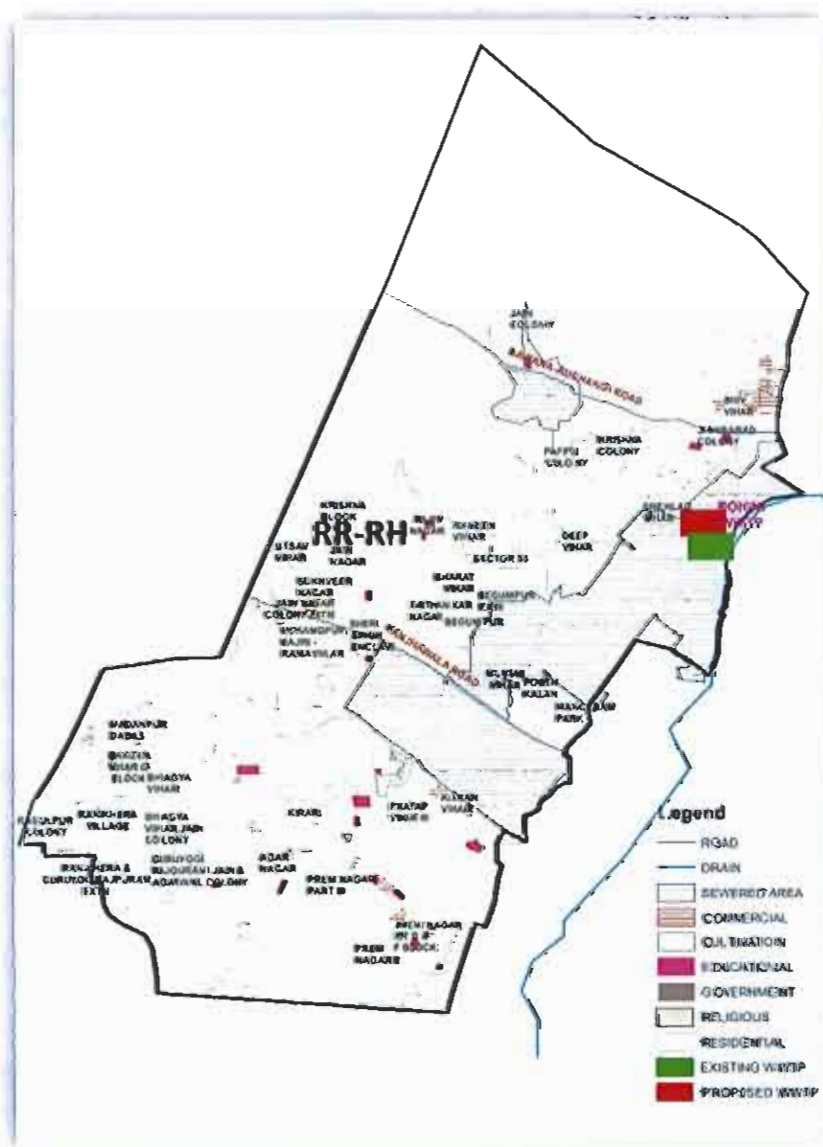


Figure 6: Land Use Map of Rohini Sub Drainage Zone (RR-RH)

Existing Sewerage Infrastructure

The Sub Drainage Zone is partially sewerred with major pockets of unsewered areas.

The wastewater generated from this Sub Drainage Zone leads to two major WWPSs namely Sector 23, 25 and Sector 26. The wastewater from these WWPS's is pumped to WWTP at Rohini.

The sub drainage zone has existing one WWTP with a capacity of 15 MGD.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 7** below:

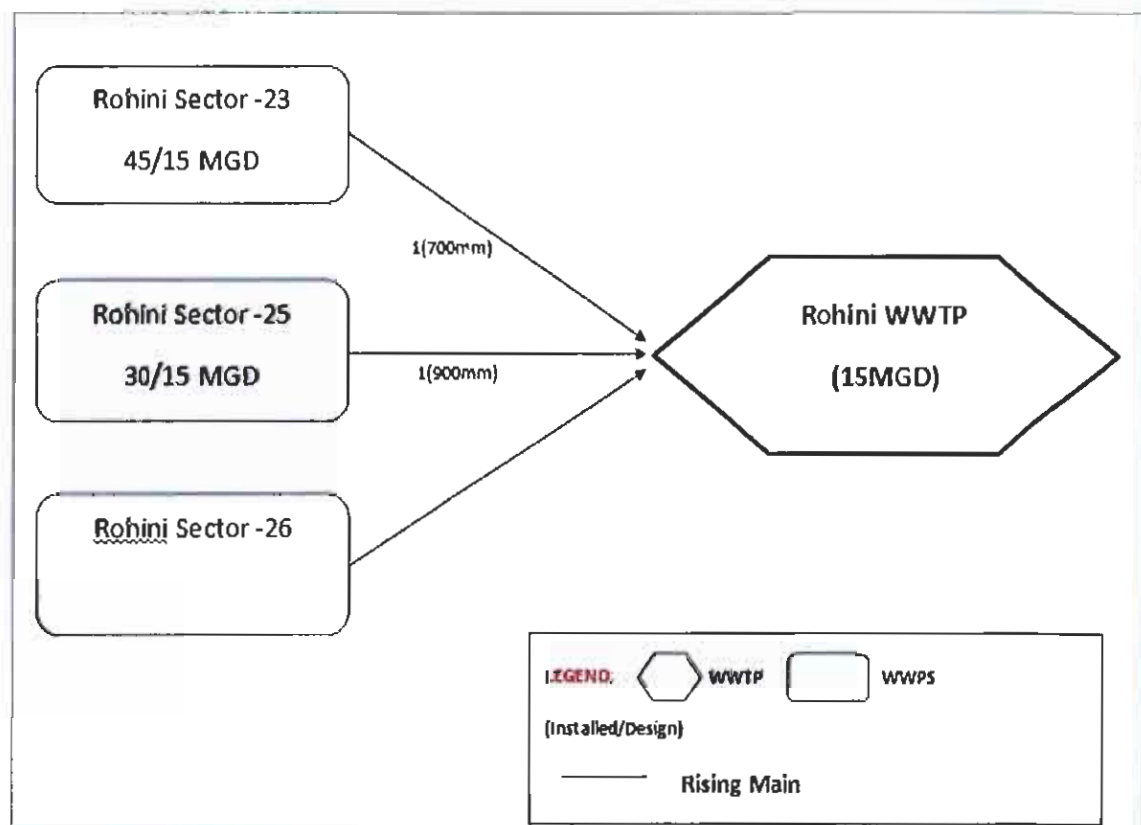


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

Sector 23, 25 and 26 WWPS's are utilized to carry partial sewage load from the Sub Drainage Zone while framing the sewerage schemes. Additional capacity and location may be required for pumping in future; however it has to be assessed after implementation of the scheme. For master planning purposes, treatment capacities have been worked out considering zonal load at ultimate stage.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 8**.

- Area is partially sewerred. Trunk Sewers are already laid and outfall into various existing WWPSs and pumped towards Existing WWTP.
- There is an existing WWTP known as **Rohini WWTP (15 MGD)**. Additional capacity of 25 MGD is proposed at ultimate stage.

- Sewage from Sahibabad Colony, Shiv Vihar, Krishna Colony, Deep Vihar and nearby area is routed to existing gravity sewer towards existing WWPS at Sector 26. One intermediate Lift Station is proposed.
- Sewage from Jain Colony is routed to proposed WWPS at Jain Colony then via rising main to existing gravity sewer towards existing WWPS at Sector 26.
- Sewage from unsewered part of Sector 27 and nearby area is routed to Proposed LS at Shiv Vihar via rising main to existing WWPS at Sector 17.
- Sewage from Utsav Vihar, Sukhveer Vihar, Rama Vihar, Tirthankar Nagar, Bharat Vihar, Sher Singh Enclave, Begaumpur, Pooth Kalan, Mange Ram Park is routed to existing WWPS at Sector 23.
- Sewage from various blocks of Prem Nagar and Pratap Vihar and nearby area is routed to Proposed Pratap Vihar WWPS and then via rising main to Rohini WWTP.
- Sewage from Rasulpur, Bhagya Vihar, Madanpur Dabas, Guru Yogirajpuram, Jain and Agrawal Colony and nearby area is routed to Proposed Bhagya Vihar WWPS and then via rising main to Pratap Vihar WWPS.
- Sewage from few parts of Prem Nagar and nearby area is routed to Proposed Prem Nagar WWPS and then via rising main to Pratap Vihar WWPS.

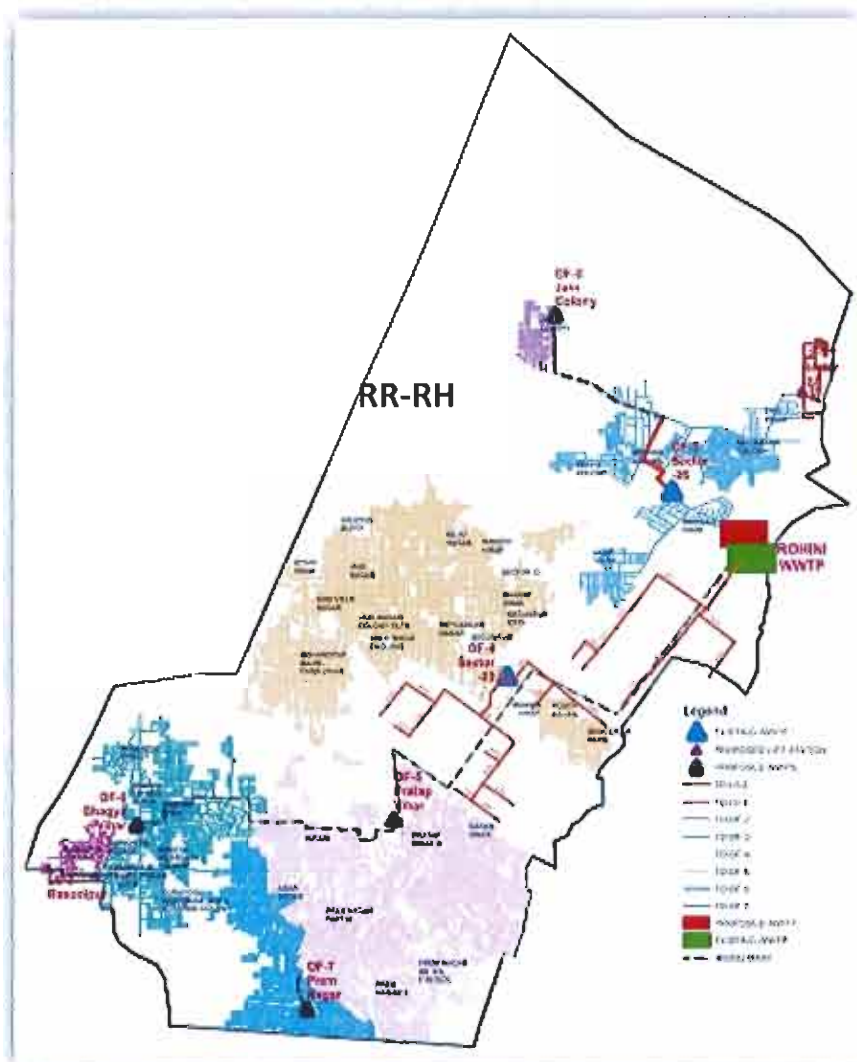


Figure 8: Scheme Map of Rohini Sub Drainage Zone (RR-RH)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping Station and Waste Water Treatment requirements. Scheme map for Rohini Sub Drainage zone is shown in the figure 8.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	792844
300	HDPE/DWC	4805
350	HDPE/DWC	80
400	HDPE/DWC	18986
500	HDPE/DWC	13016
563.6	HDPE	4022
635.2	HDPE	3523
700	RCC NP3/NP4	2420
800	RCC NP3/NP4	1591
900	RCC NP3/NP4	1775
1000	RCC NP3/NP4	1404
1100	RCC NP3/NP4	794
1200	RCC NP3/NP4	155
1400	RCC NP3/NP4	1451
1600	RCC NP3/NP4	134
Total		847000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 9**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

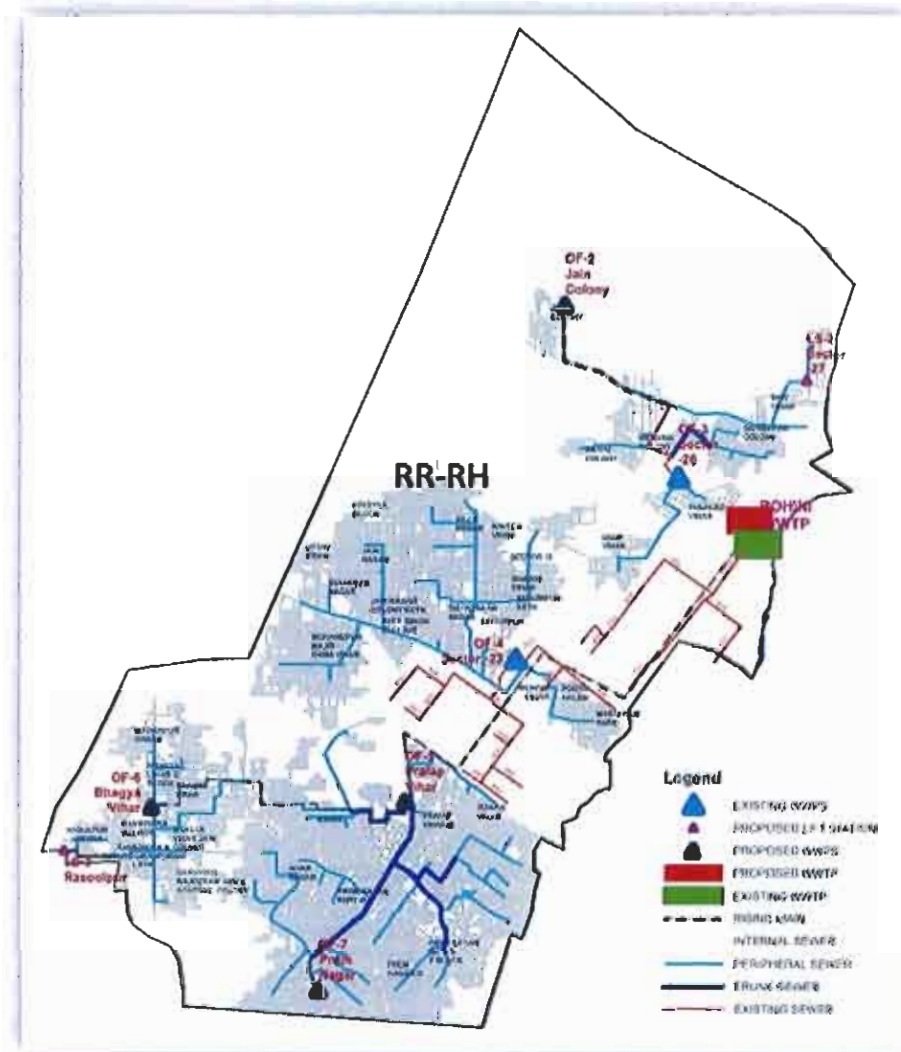


Figure 9: Proposed Sewerage Infrastructure of Rohini Sub Drainage Zone (RR-RH)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Rasulpur	LS	1.5	300	1	700	Nearest Manhole
2	Pratap Vihar	WWPS	41.00	1000	2	7300	Rohini WWTP
3	Prem Nagar	WWPS	6.50	500	1	450	Rohini WWTP
4	Bhagya Vihar	WWPS	9.00	800	1	3900	Pratap Vihar WWPS
5	Shiv Vihar	LS	1.50	250	1	40	Nearest Manhole
6	Jain Colony	WWPS	1.50	250	1	1900	Nearest Manhole

Waste Water Treatment Requirements

The existing 15 MGD WWTP will be sufficient to cater the sewage generation for Phase I. Additional Capacity of 25 MGD is proposed in Phase 2 in nearby area adjoining the existing WWTP. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Rithala (RR-RT)

This Sub Drainage Zone spread across , Budh Vihar, Vijay Vihar, Krishna Vihar, Pitampura, Tri Nagar, Shastri Nagar, Shalimar Bagh, Rithala etc. Area is mainly a residential with four industrial areas viz. Wazirpur Industrial Estate, Badli industrial area, Lawrence road industrial Estate and Mangolpuri industrial area. The area is mostly sewered with one existing WWTP at Rithala. Land use map is as shown in the **Figure 10**.

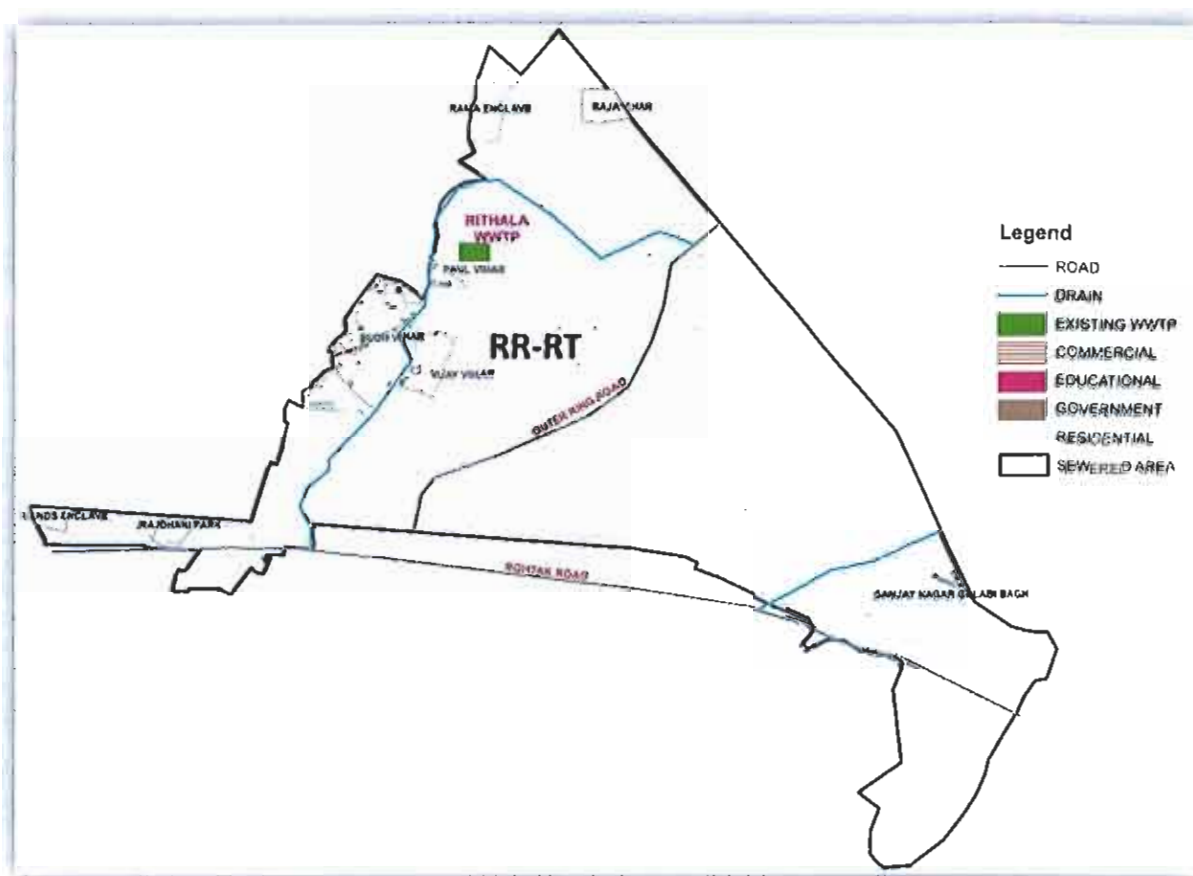


Figure 10: Land Use Map of Rithala Sub Drainage Zone (RR-RT)

Existing Sewerage Infrastructure

Sewerage Network already exists in parts of the Sub Zone and there is an existing WWTP of 80 MGD capacity known as Rithala WWTP.

The wastewater generated from this Sub Drainage Zone leads to major WWPSs namely Rithala, Haidarpuri, Avantika, Roini Sector 17 and Rohini Sector 19 and ultimately to Rithala WWTP.

DJB is in process of implementing Interceptor Sewer Project in this sub drainage zone to intercept all sub drains by Interceptor Sewer. Further, it is proposed to utilize Interceptor Sewer as trunk sewer for unserved areas with integration to proposed network.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 11**:

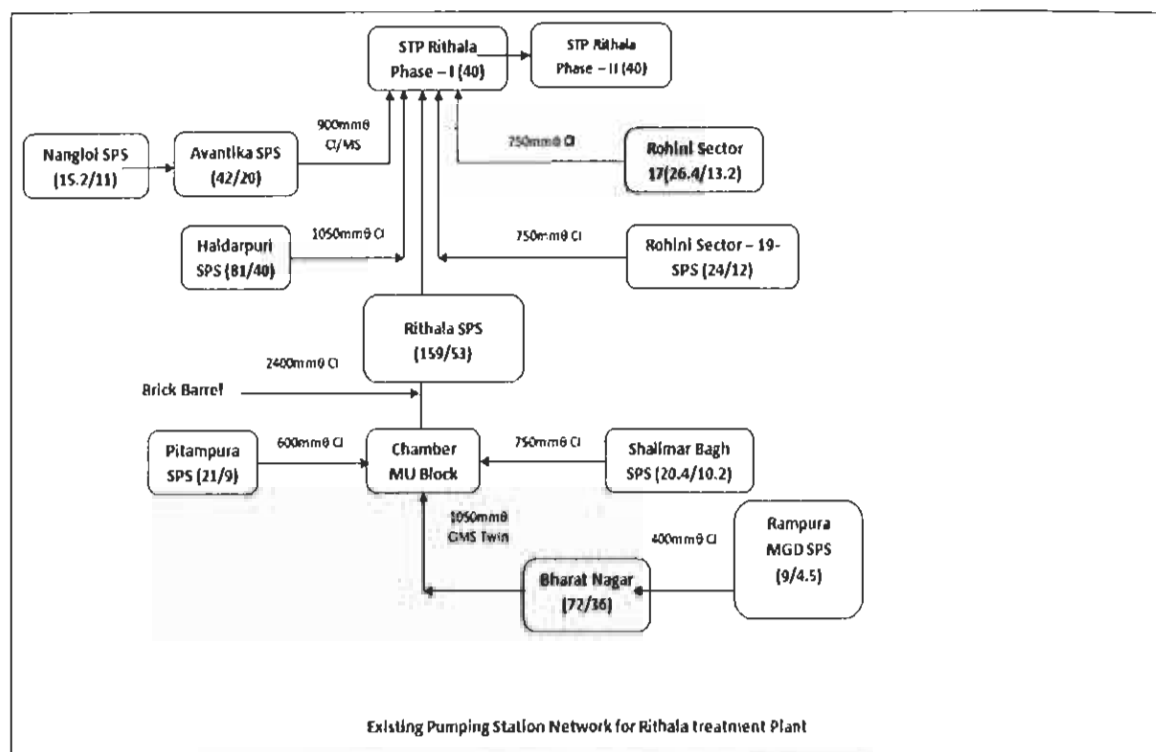


Figure 11: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Interceptor Sewer is being utilized as trunk sewer for the Sub Drainage Zone. The hydraulic analysis shows that the capacity of proposed Interceptor Sewer and WWPS will be sufficient to cater to their individual designated 2031 loads from this sub zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 12**.

- Area is partially sewered. Trunk Sewers are already laid and outfalls into various existing WWPSs and pumped towards Existing WWTP.
- There is an existing WWTP known as **Rithala WWTP** of 80 MGD capacity.
- Sewage from Budh Vihar, Krishna Vihar, Vijay Vihar, Paul Vihar is routed to already proposed Interceptor Sewer and ultimately to Rithala WWTP.
- Sewage from Friends Enclave and Rajdhani Park is routed to existing trunk sewer towards existing Nangloi WWPS.
- Sewage from Raja Vihar is routed to existing Sector 19 WWPS.
- Sewage from unsewered parts of Sector 27 is routed to existing Sector 17 WWPS.

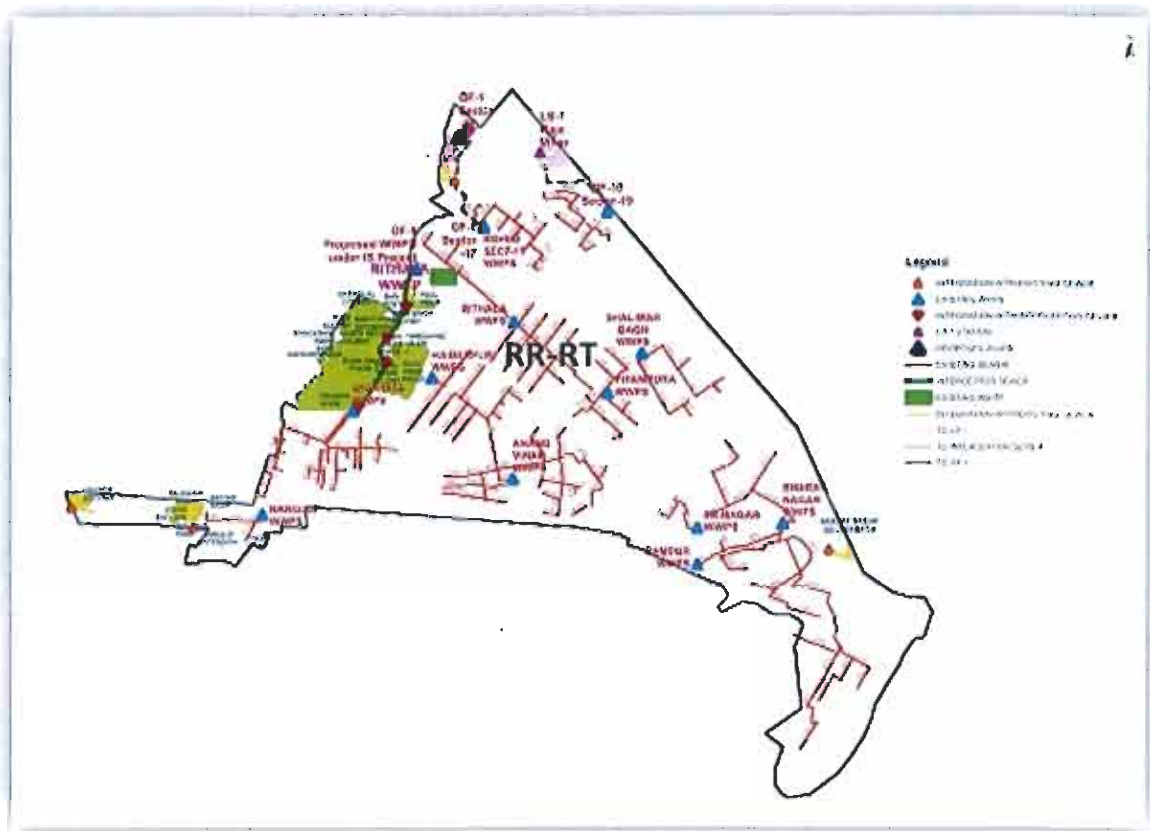


Figure 12: Scheme Map of Rithala Sub Drainage Zone (RR-RT)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping stations and Waste Water Treatment requirements. Scheme map for Rithala Sub Drainage zone is shown in the **Figure 13**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Table 4: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	200776
300	HDPE/DWC	1143
350	HDPE/DWC	1046
400	HDPE/DWC	3186
500	HDPE/DWC	3494
563.6	HDPE	46
635.2	HDPE	530
700	RCC NP3/NP4	427

Diameter (mm)	Material	Length (m)
800	RCC NP3/NP4	78
900	RCC NP3/NP4	258
1000	RCC NP3/NP4	16
Total		211000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 13**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

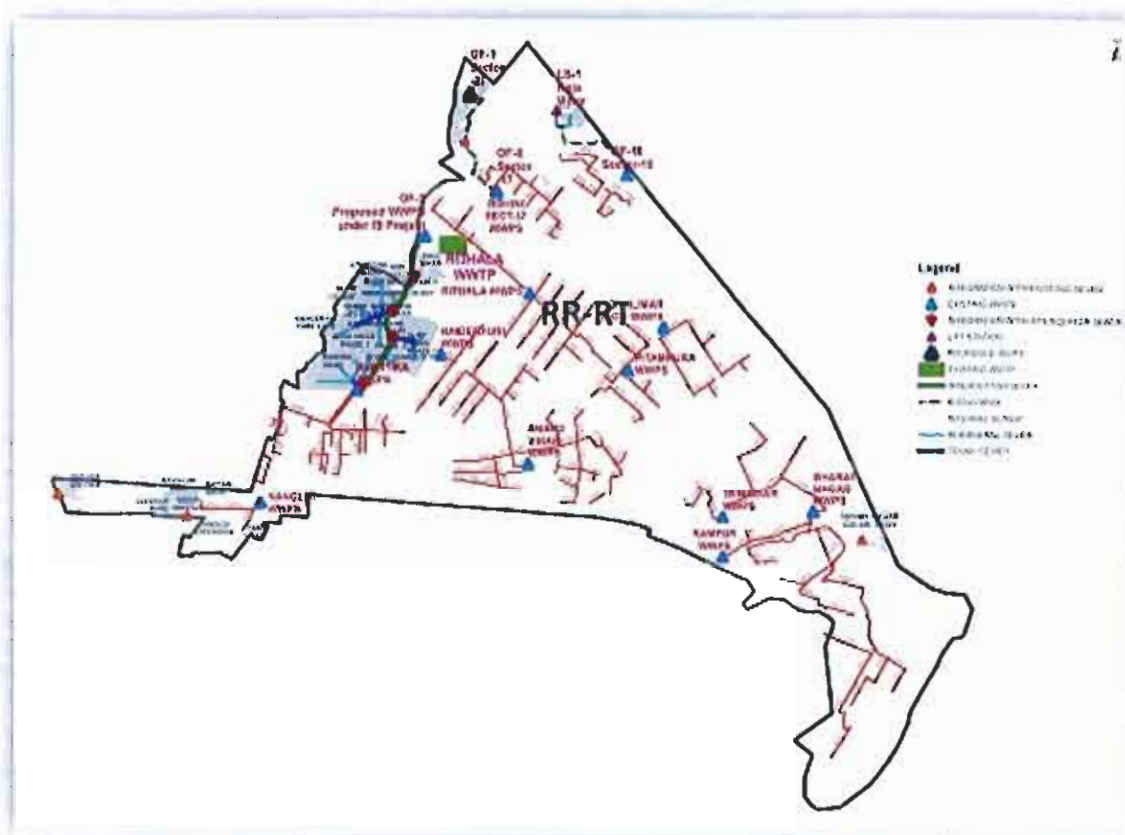


Figure 13: Proposed Sewerage Infrastructure of Rithala Sub Drainage Zone (RR-RR)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Sector 27	WWPS	2.00	400	1	2600	Existing Sector 17 WWPS
2	Raja Vihar	WWPS	1.50	250	1	2400	Existing Sector 19 WWPS

Waste Water Treatment Requirements

The existing Waste Water Treatment capacity of 80 MGD at Rithala was found to be sufficient to cater anticipated sewage load for design year 2031 from the sub drainage zone. No additional treatment capacity has been proposed for this Sub Drainage Zone.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 6**.

Table 6: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Rohini	(RR-RH)	847	4	2	1
Rithala	(RR-RT)	211	2	-	-
Total		1058	6	2	1

The capacity and anticipated area requirements for proposed Pumping stations and Sewage Treatment facilities are summarized in the **Table 7**.

Table 7: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Rohini	Rohini	25	14.2 - 18.2	Rasulpur	LS	1.5	51.2
				Pratap Vihar	WWPS	41.0	4023.0
				Prem Nagar	WWPS	6.5	2747.3
				Bhagya Vihar	WWPS	9.0	2805.0
				Shiv Vihar	LS	1.5	49.6
				Jain Colony	WWPS	1.5	1157.1
Rithala	Rithala			Sector 27	WWPS	2.0	1247.5
				Raja Vihar	WWPS	1.5	1157.1

Line Diagram for Proposed WWPS and WWTP of Rohini is shown in **Figure 14**:

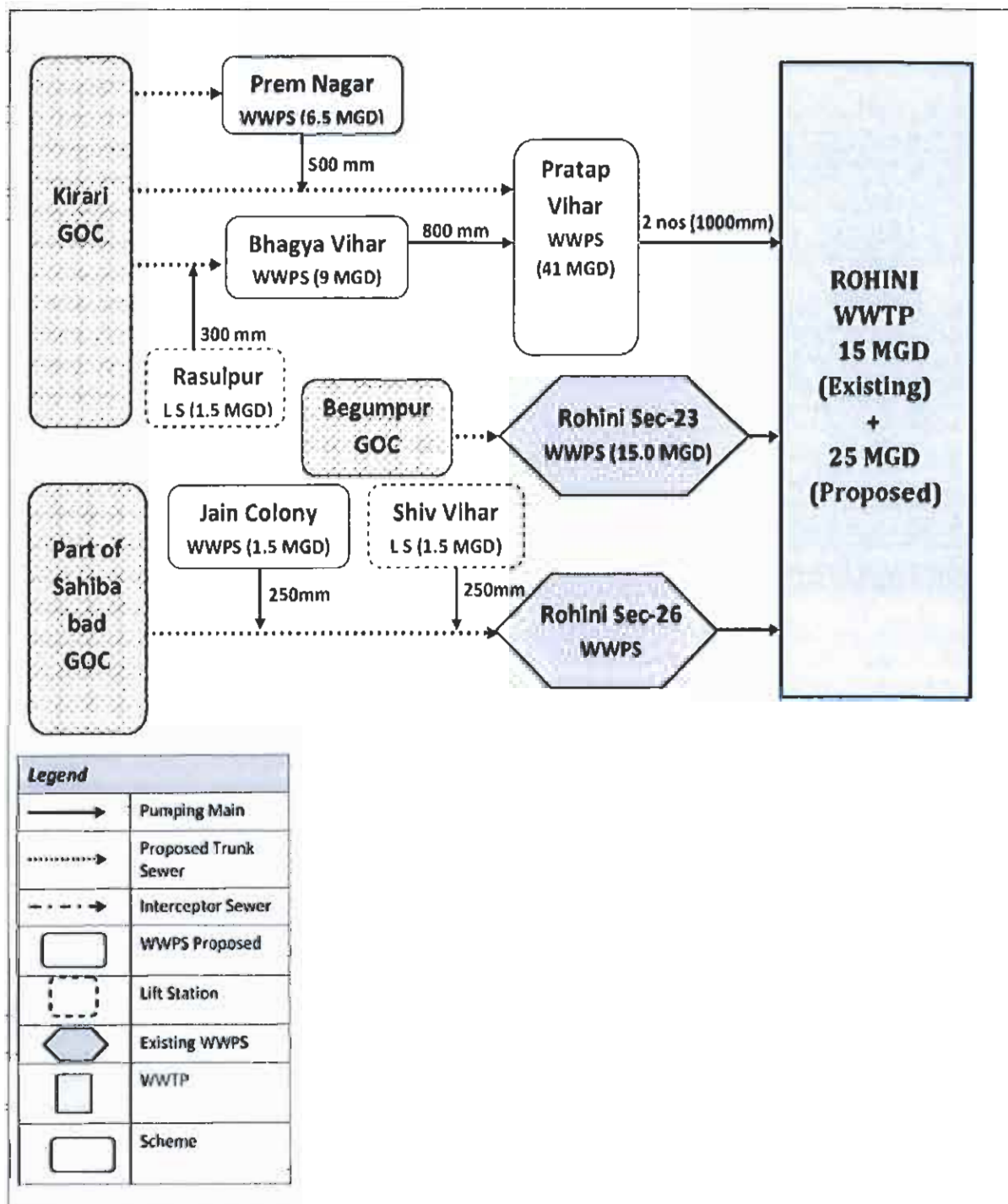


Figure 14: Line Diagram for Proposed WWPS and WWTP of Rohini

Line Diagram for Proposed WWPS and WWTP of Rithala is shown in **Figure 15**:

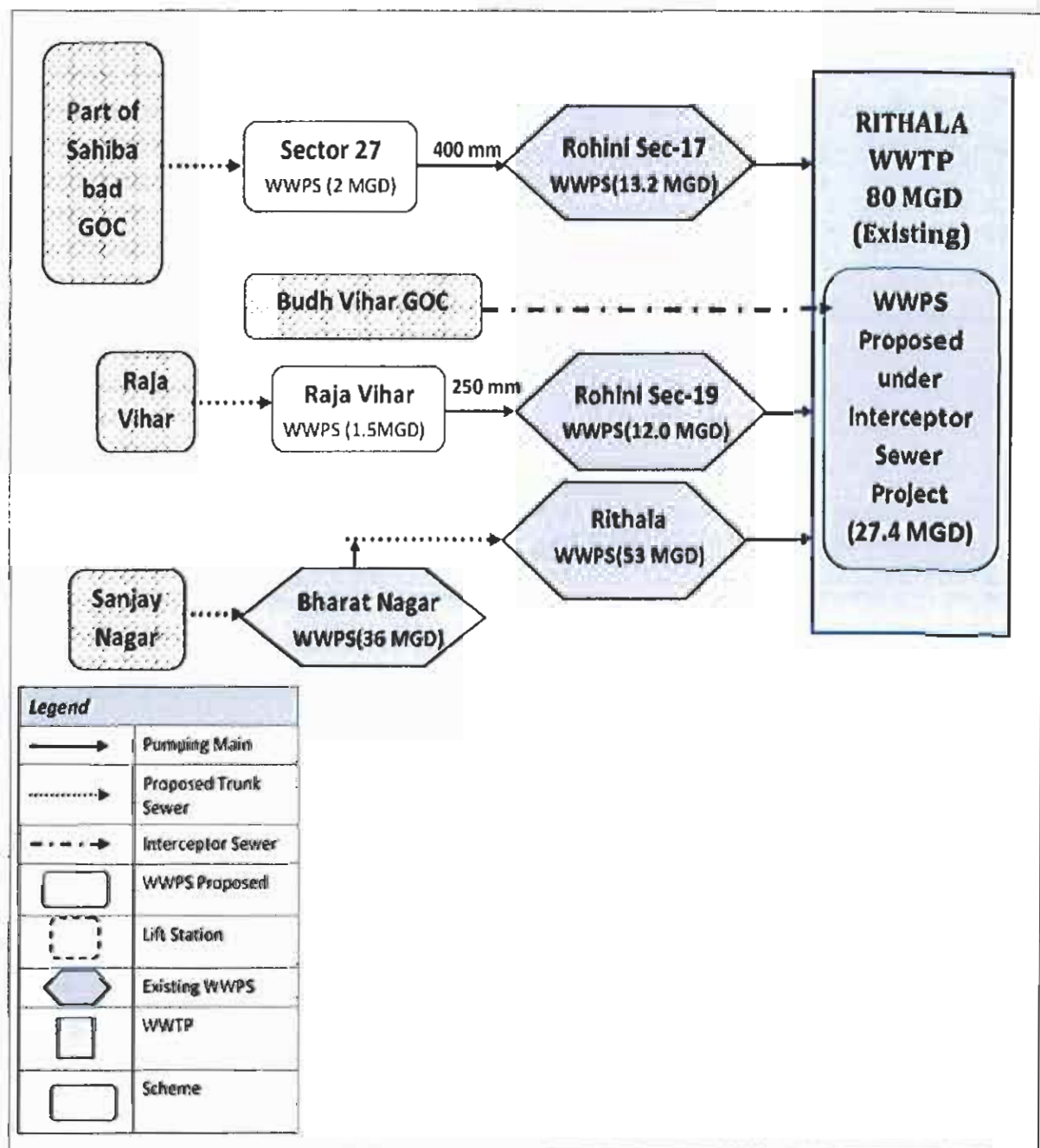


Figure 15: Line Diagram for Proposed WWPS and WWTP for Rithala

Disposal of Treated Effluent:

Current practice of disposal of treated effluent is to discharge it to nearby drain out falling to Supplementary drain. Likely users of Treated Effluent are PPCL, NDPL and DDA for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Rohini-Rithala Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 16**.

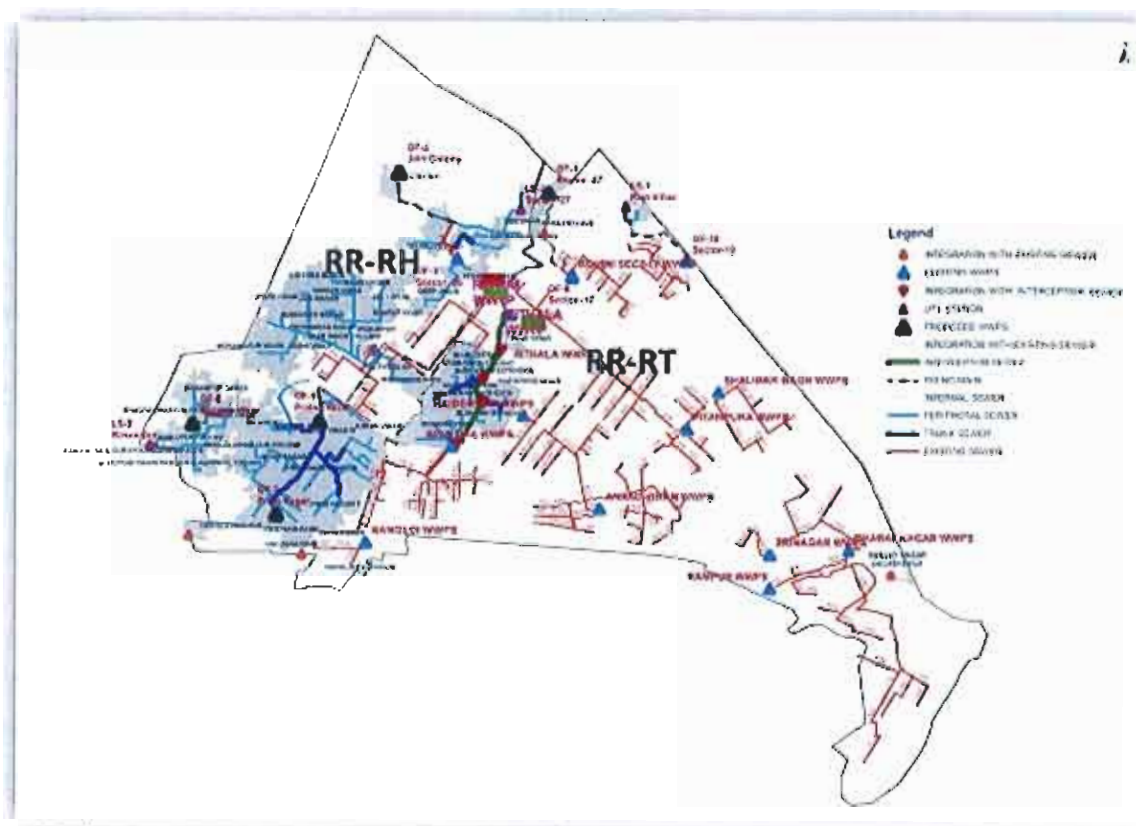


Figure 16 : Proposed Sewerage Scheme for Rohini-Rithala Drainage Zone

Various Group of Colonies (GOCs) - wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 17**.

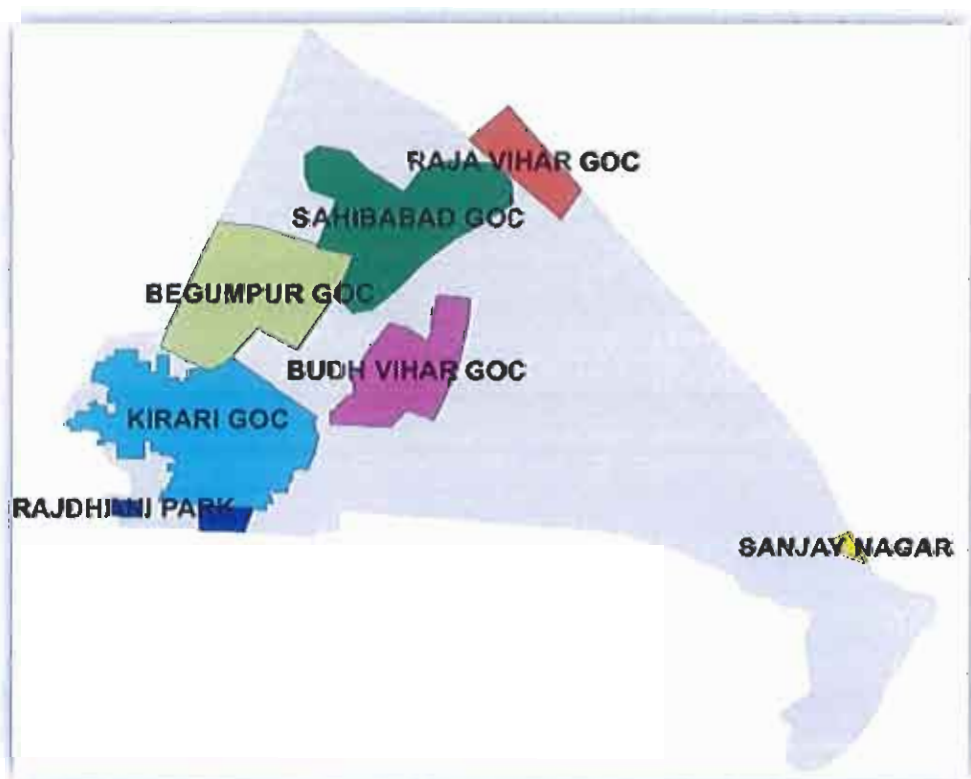


Figure 17: GOC-wise Sewerage Schemes – Rohini-Rithala Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 8: Implementation Schedule

Scheme Details					Implementation Schedule			
Sl. No.	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Rithala	RT1	RR-RT1-SN	Sanjay Nagar				
2	Rithala	RT2	RR-RT2-BV	Budh Vihar GOC				
3	Rithala	RT3	RR-RT2-RP	Rajdhani Park				
4	Rohini	RH2	RR-RH2-KI	Kirari GOC				
5	Rohini	RH2	RR-RH2-BP	Begumpur GOC				
6	Rohini	RH2	RR-RH2-SB	Sahibabad GOC				
7	Rohini	RH2	RR-RH2-RV	Raja Vihar				

Table 9: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Raja Vihar GOC	Raja Vihar
2	Sahibabad GOC	
3	Begumpur GOC	Village Pansali & Extn. Abadi, Delhi 85 Trithankar Nagar Jain. Colony Karala, Delhi-81 Jain Nagar Karala, Delhi 81 Jain Nagar Colony Extn., Karala Krishna Block Tirthankar Nagar Jain colony Karala, Delhi-81 Sher Singh Enclave Karala, Delhi-81 Sukhvir Nagar Karala, Delhi-81 Utsav Vihar, Karala, Delhi-81 Prahlad Vihar, Gupta Colony, Bawana Prahlad Vihar, Phase-II, Pappu Colony, Block A & B, Bawana, Delhi Prahlad Vihar Near-Sect-25 Rohini, Delhi Begumpur Naveen Vihar, Begampur, Delhi-41 Rajiv Nagar Begum Pur Ph-II, Delhi-41 Rajeev Nagar, Begampur, Ph-3, Main Kanjhawala Road, Delhi-41 Begam Pur Begam Pur Extn. , Delhi-41 Begampur Extn.(Begam Vihar Block A B C D E, Delhi-41 Begumpur Extn. Rajiv Nagar, Delhi-41 Rajiv nagar Extn.Begumpur Delhi-41 Village Begumpur Delhi 86 Rajni Vihar Begum Pur Extn. Barwala Road Delhi-41 Deep Vihar Pansali, Pooth Kalan Perladpur Delhi-42 Kailash Vihar Pansali Post Parhladpur Bangar Delhi-42 Deep Vihar Colony, Pansali, Delhi Sri Enclave Pansali, Rohini, Delhi-42 Kailash Vihar near Aman Vihar, Nangloi, Delhi-41
4	Budh Vihar GOC	Mange Ram Park, Pooth Kalan, Sector-23, Rohini Vijay Vihar Ph-1, near Rithala Vijay Vihar, Phase-II, Rithala near Sector-4, Rohini, Delhi-85 Rithala Budh Vihar Colony, Phase-I & II, Delhi Ladakh Budh Vihar Colony Budh Vihar Ph-II Extn. Delhi-41 Budh Vihar Extn. Ph-II, Vir Singh Colony Delhi-41 Budh Vihar Extn. Near Sector-23 & 24, Rohini, Rithala Road, Delhi-41 Vir Singh Colony Chandu Lal Colony Gopal Vihar Colony, Kanjhawla, Delhi-41 Mange Ram park Extn. Budh vihar Ph-II Delhi-41 Mange Ram park Extn. Pooth Kalan Rohini, Sector-23, Delhi-41

Sl. No.	Name of GOC	Name of Colonies
		Budh Vihar Phase-II, Near Rohini, Sect-24, Delhi-41 Krishna Vihar, (Pooth Kala) Pooth Kalan Extended Abadi Village Pooth Kalan, Delhi 86 Harsh Dev Park Budh Vihar Ph-II , Delhi Paul Colony, North Rithala, Rohini, Delhi Poul Vihar
5	Kirari GOC	Rasulpur Colony Ranikhera Village Ranikhera Guru yogiraj puram Extn, Bhagya Vihar Jain Colony Agrawal Colony Bhagya Vihar G Block Madanpur Dabas Prem Nagar II Prem Nagar III Prem Nagar Ist D & F Block Pratap Vihar III Karan Vihar
6	Rajdhani Park	Rajdhani Park
7	Sanjay Nagar	Sanjay Nagar

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

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VOLUME – VI	MAPS

JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
JUNE 2014

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ANNEXURE - 5
KANJHAWALA-BAWANA DRAINAGE ZONE
(KB)

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KANJHAWALA-BAWANA DRAINAGE ZONE (KB)

1. INTRODUCTION

Kanjhawala-Bawana drainage is located in the North West of NCT Delhi and is bounded by Northern Railway Line in East and South, NCT Boundary in North-West, and by Rohini Rithala Zone in South East. A peripheral green belt exists on Northern and Western boundary of the zone. The zone is primarily rural in character scantily populated interspersed with villages. Location of Kanjhawala-Bawana Drainage Zone is shown in the **Figure 1**.

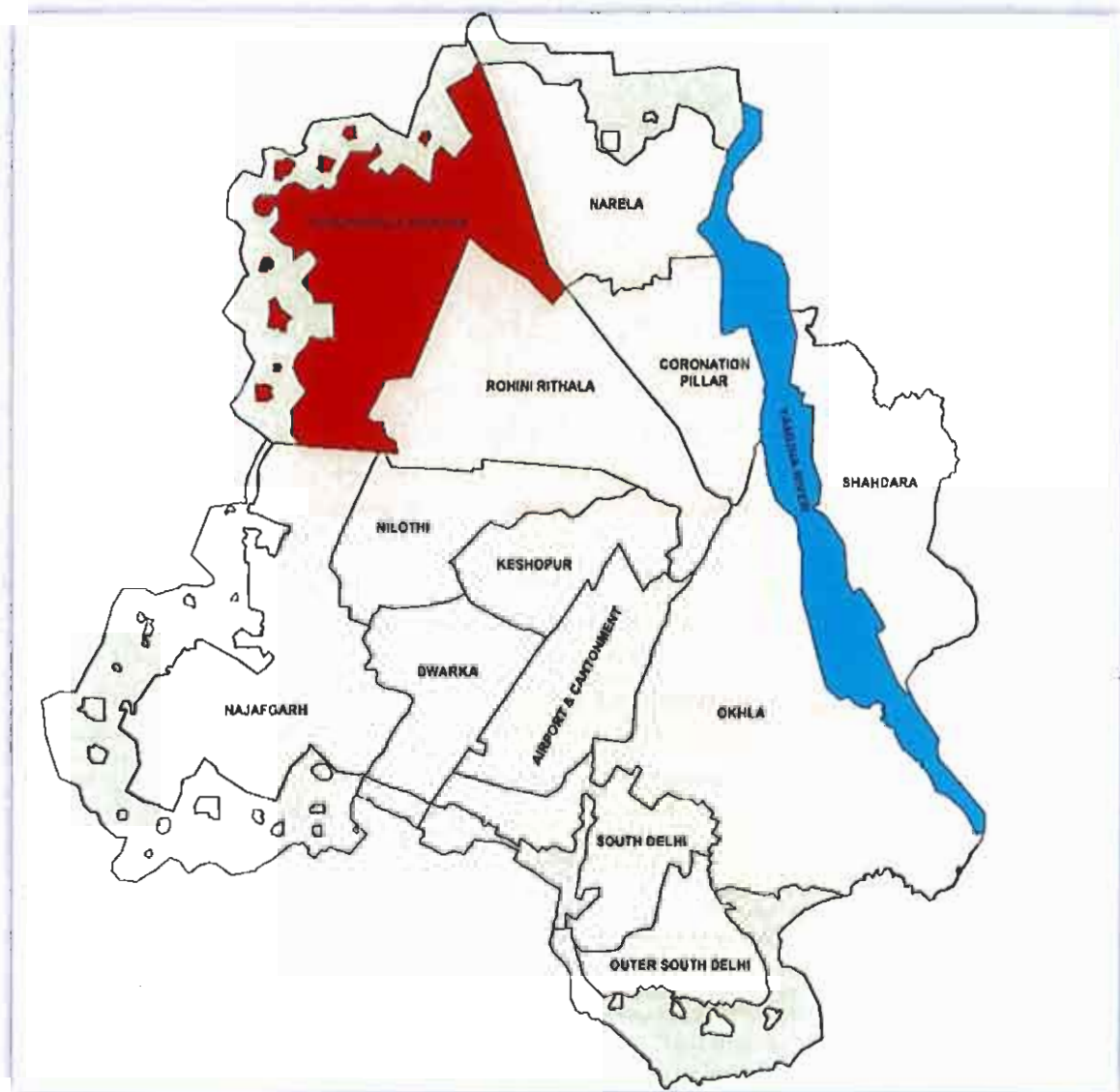


Figure 1: Kanjhawala-Bawana Drainage Zone

The Drainage Zone majorly comprises of agricultural land, few industrial areas, open plots, and so many isolated villages in between. This Drainage Zone falls under DDA Zone N and P-I as shown in the **Figure 2**.

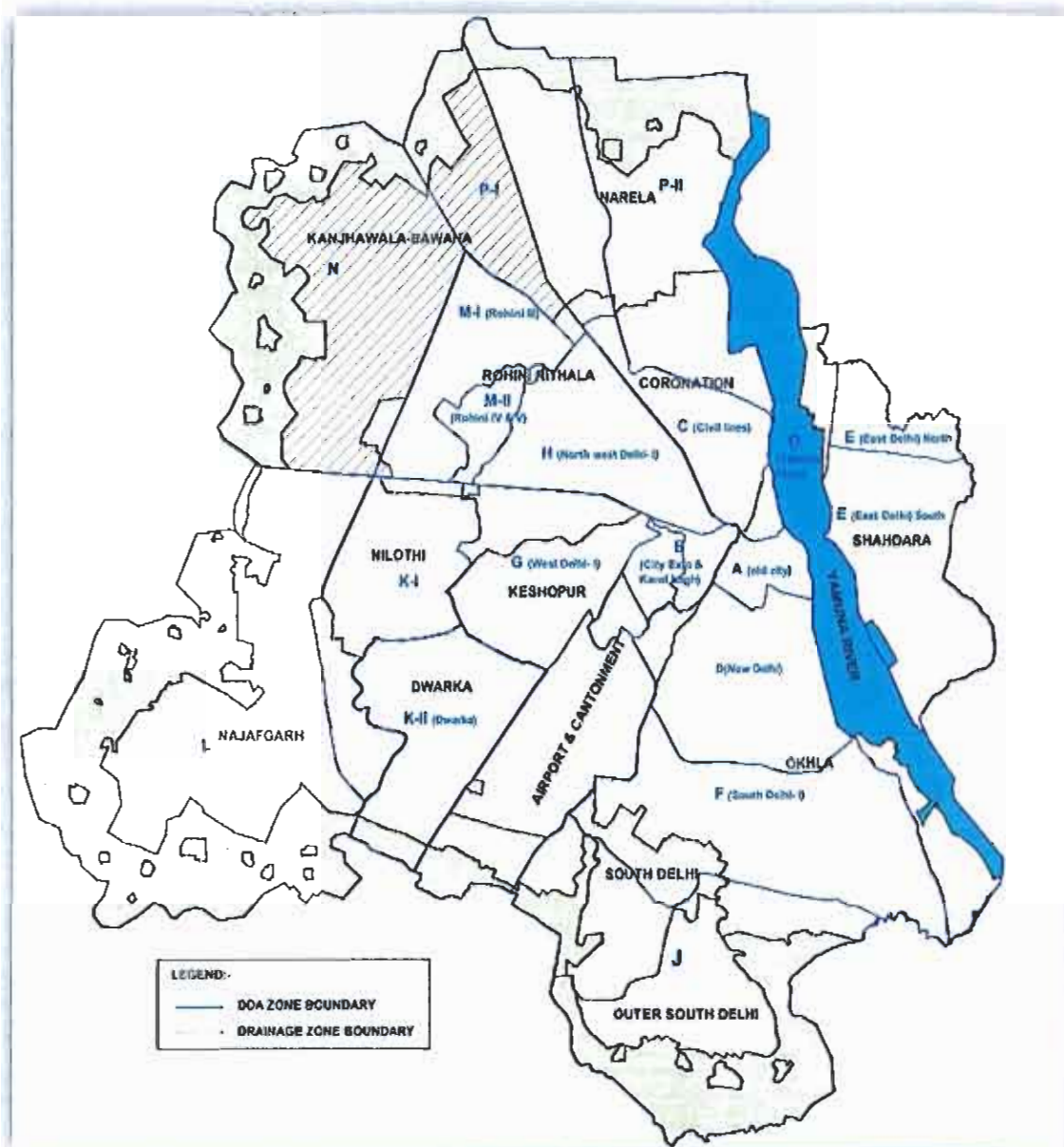


Figure 2: DDA Zones and Kanjhawala-Bawana Drainage Zone

Soil Description of Kanjhawala-Bawana Drainage Zone

This zone is mainly covered with older alluvium deposits. North West outer Delhi zone comes under the category of Moderate hazard due to thick soft sediments as per seismic microzonation. This drainage zone covering areas like Bawana, DaryaPur Kalan, Hareoli, Kanjhawala etc. is majorly having water at 2-5m. Some small pockets like Swatantar Nagar, Puth Khurd, Kateora etc. is having water depth at 5- 10m. Whole of the area Bawana, DaryaPur Kalan, Hareoli, Kanjhawala, Swatantar Nagar, Puth Khurd, Kateora etc. is covered with Bangar soil.

2. MASTER PLANNING FOR KANJHAWALA-BAWANA DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, natural boundaries and direction of gravity flow of sewage to arrive at most economical and feasible sewer network alignment.

The Drainage Zone is completely unsewered. Topographical Survey & GIS integration has been carried out for the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

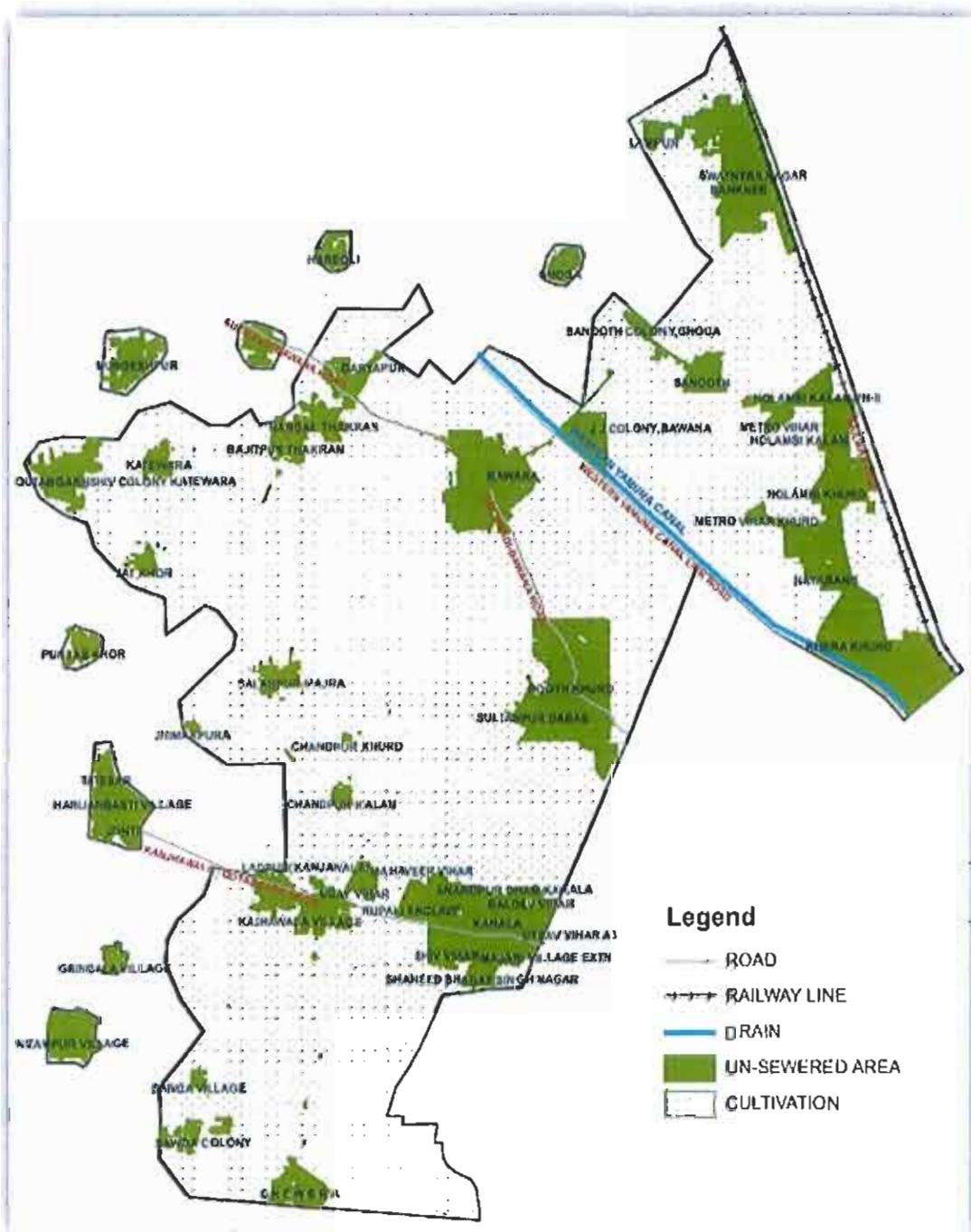


Figure 3: Sewerage Status of Kanjhawala-Bawana Drainage Zone

Sub-zoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load

- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints.

Utilization of Existing Sewerage Infrastructure

This zone is completely unsewered.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

No WWTP exists in the Drainage Zone. Feasibility of new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Kanjhawala-Bawana Drainage Zone has been divided into two (2) Sub Drainage Zones as below:

- Kanjhawala (KB-KJ)
- Bawana (KB-BW)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

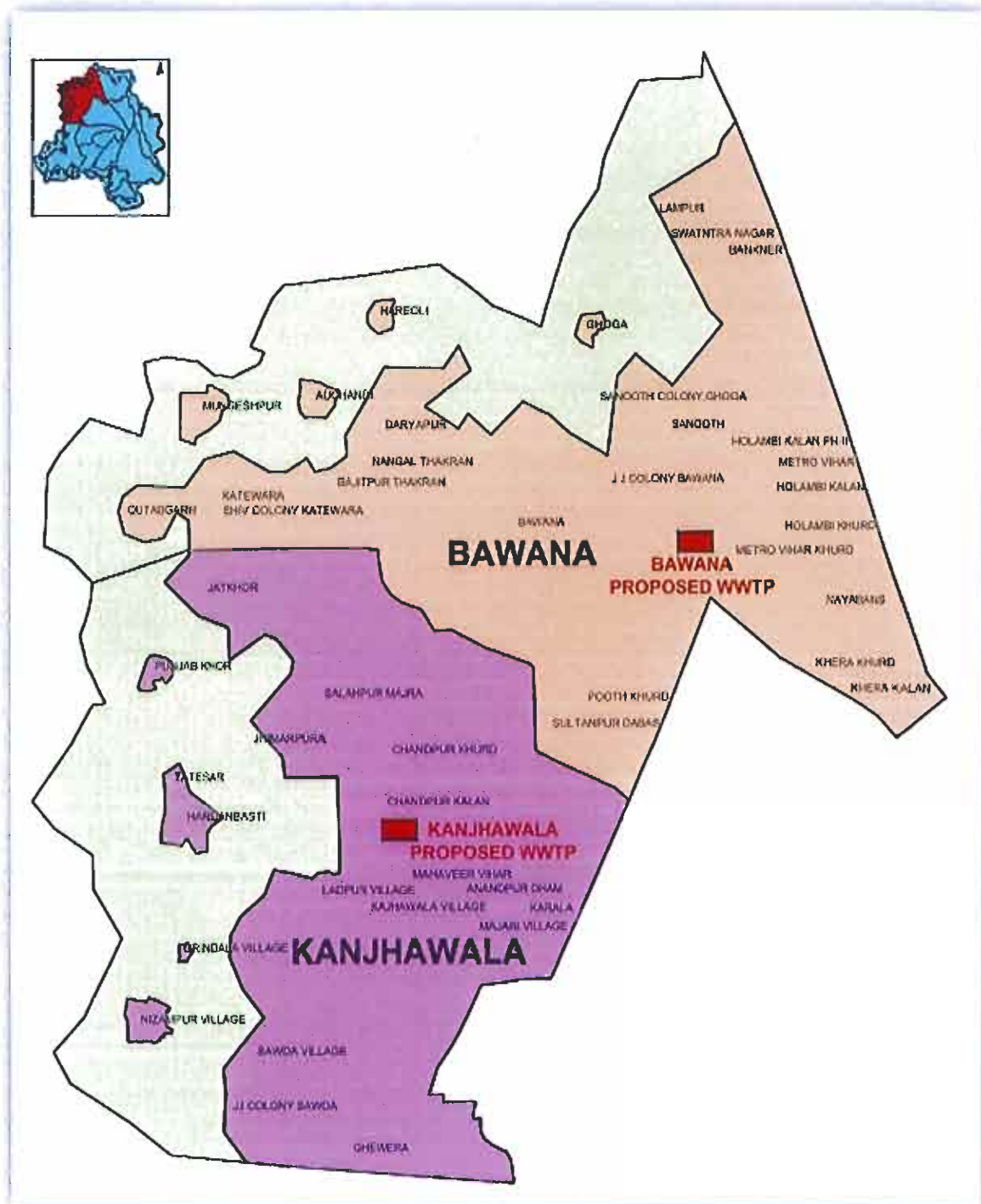


Figure 4: Sub Drainage Zone Map of Kanjhawala-Bawana Drainage Zone (KB)

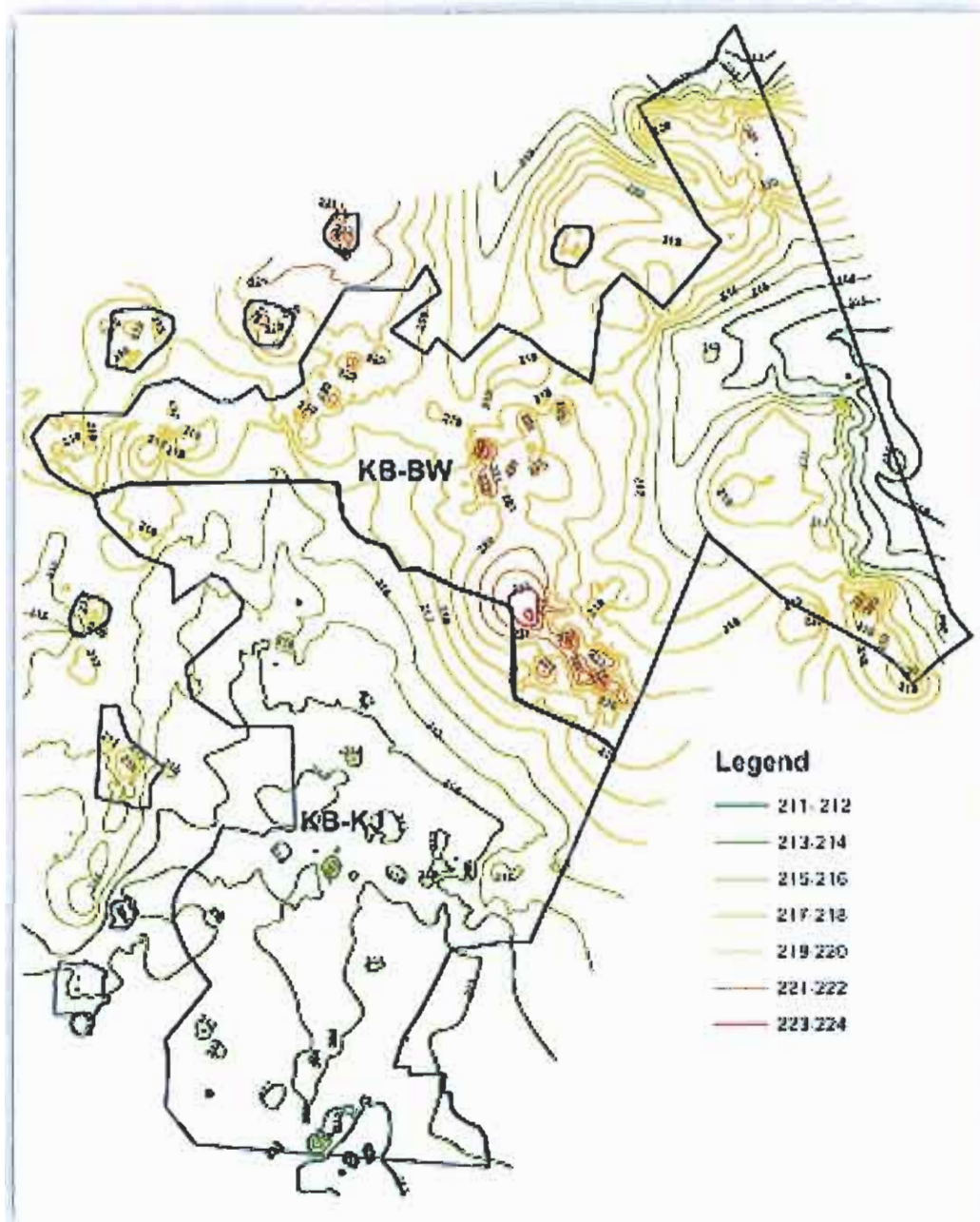


Figure 5: Contour Map of Kanjhawala-Bawana Drainage Zone (KB)

Based on population projections Sub-Drainage Zone wise estimated sewage generation is presented in the *Table 1*.

Table 1: Estimated Sewage Generation of Kanjhawala-Bawana Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
KB-BW	85.56	167.63	249.70	18.80	36.90	55.00
KB-KJ	75.61	148.13	220.64	16.70	32.60	48.60
Total	161.17	315.76	470.34	35.50	69.50	103.60

3.1 Sub Drainage Zone: Kanjhawala (KB-KJ)

This Sub Drainage Zone spread across villages Jatkhori, Salahpur Majra, Kanjhawala, Ghewara, Nizampur, Grindala, Tatesar, Punjabkhori etc. A peripheral green belt exists on Northern and Western boundary of the zone. Land use map is as shown in the **Figure 6**.

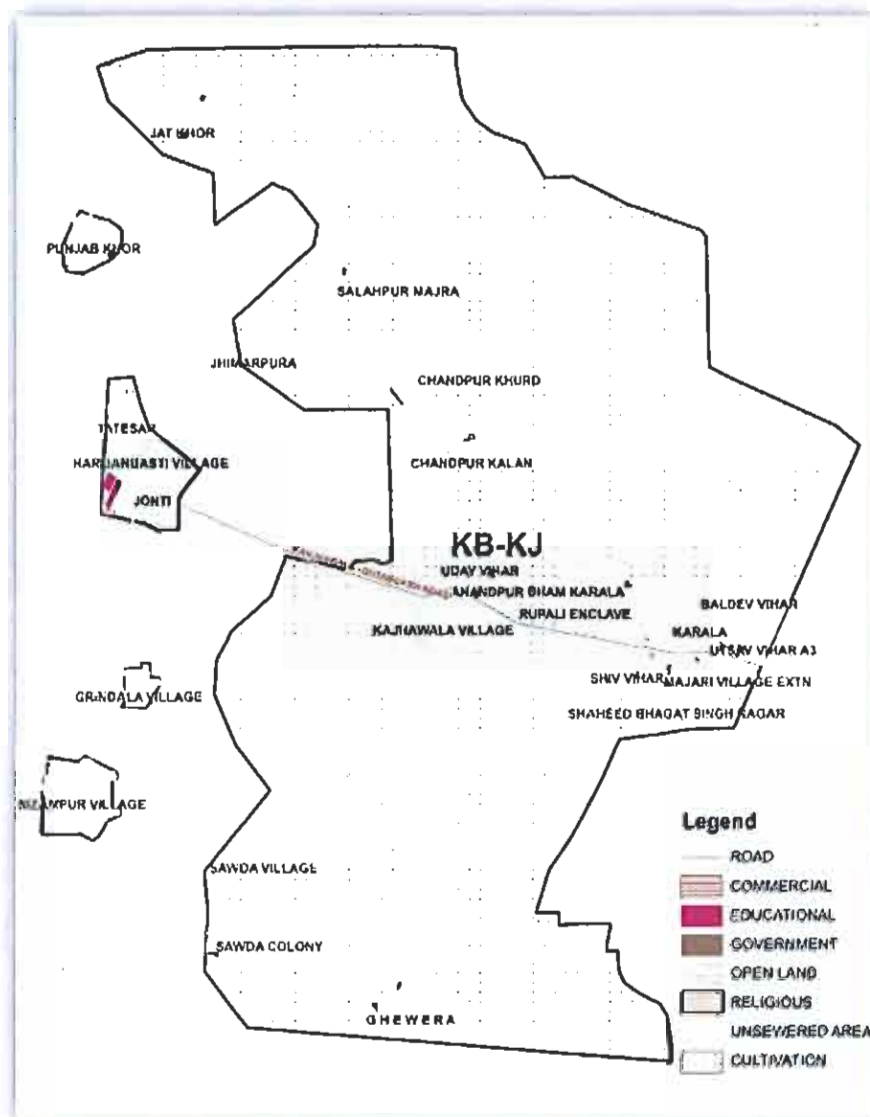


Figure 6: Land Use Map of Kanjhawala Sub Drainage Zone (KB-KJ)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 7**.

- The area is unsewered and no sewage treatment facility exists.
- Sewage from Salahpur Majra, Jhimarpura, Punjabkhori and Jatkhori is planned to discharge to proposed WWTP at Salahpur Majra via terminal pumping station.

- Sewage from Kanjhawala, Mahaveer Vihar, Chandpur, Karala, Shiv Vihar, Shaheed Bhagat Singh Nagar and nearby area is planned to discharge to proposed WWTP at Kanjhawala via terminal pumping station.
- Sewage from Ghewara, Sawda Colony is planned to discharge to proposed WWTP at Ghewara via terminal pumping station.
- Sewage from Grindala, Nizampur Village, Sawda Village is planned to discharge to proposed WWTP at Sawda Village via terminal pumping station.

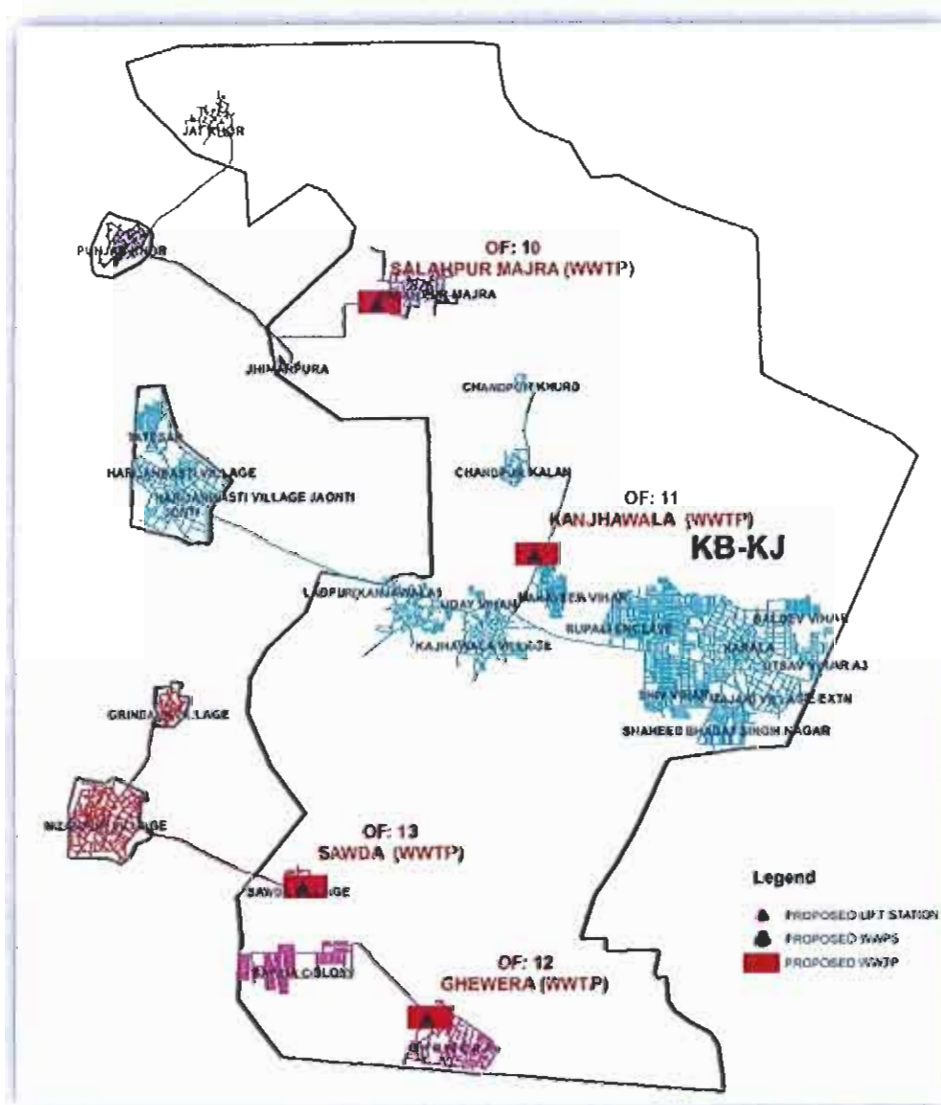


Figure 7: Scheme Map of Kanjhawala Sub Drainage Zone

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Kanjhawalan Sub Drainage zone is shown in the **Figure 8**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	376690
300	HDPE/DWC	4420
400	HDPE/DWC	7370
500	HDPE/DWC	7035
563.6	HDPE	1784
635.2	HDPE	3790
700	RCC NP3/NP4	4516
800	RCC NP3/NP4	1936
900	RCC NP3/NP4	1672
1000	RCC NP3/NP4	674
1100	RCC NP3/NP4	1345
1400	RCC NP3/NP4	768
Total		412000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 8**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

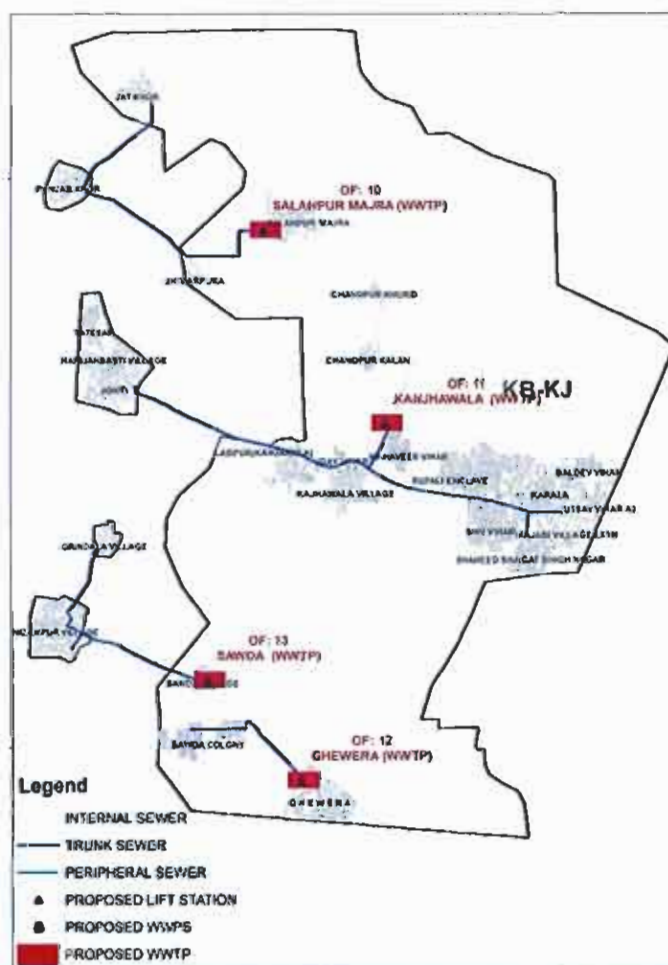


Figure 8: Proposed Sewerage Infrastructure of Kanjhawala Sub Drainage Zone (KB-KJ) Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Salahpur Majra	Terminal WWPS	8.00	-	-	-	-
2	Kanjhawala Village	Terminal WWPS	22.00	-	-	-	-
3	Sawda Village	Terminal WWPS	7.00	-	-	-	-
4	Ghewera WWPS	Terminal WWPS	9.00	-	-	-	-

Waste Water Treatment Requirements

Four (4) nos. of WWTPs are proposed to cater the sewage flow generated from Kanjhawala Sub-Drainage Zone in phased manner. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

Table 4: Proposed Waste Water Treatment Plants

Sl. No.	Location	WWTP Capacity (MGD) Phase I	WWTP Capacity (MGD) Phase II
1.	Salahpur Majra	1	3
2.	Kanjhawala Village	6	5
3.	Sawda Gaon	1.5	2
4.	Ghewera WWPS	1.7	2.9
Sub Total (MGD)		10.2	12.9

The overall sewage generation from the sub drainage zone is 48.6 MGD. The capacities are proposed in phase-wise manner, for phase I & II as shown above in **Table 4**. Remaining capacity of 25.5 MGD has been proposed in phase III. Locations and capacities may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Bawana (KB-BW)

This Sub Drainage Zone spread across villages Katewara, Bajitpur Thakran, Sanooth, Bankner, Metro Vihar, Holambi Kalan, Nayabans, Pooth Khurd and few Industrial areas. Bawana Industrial area spreads up over 606.90 Ha, and another industrial area of 477 ha land is under industrial development of DSIIIDC. DDA has developed a township extending over 516 ha area. A peripheral green belt exists on Northern and Western boundary of the zone. Land use map is as shown in the **Figure 9**.

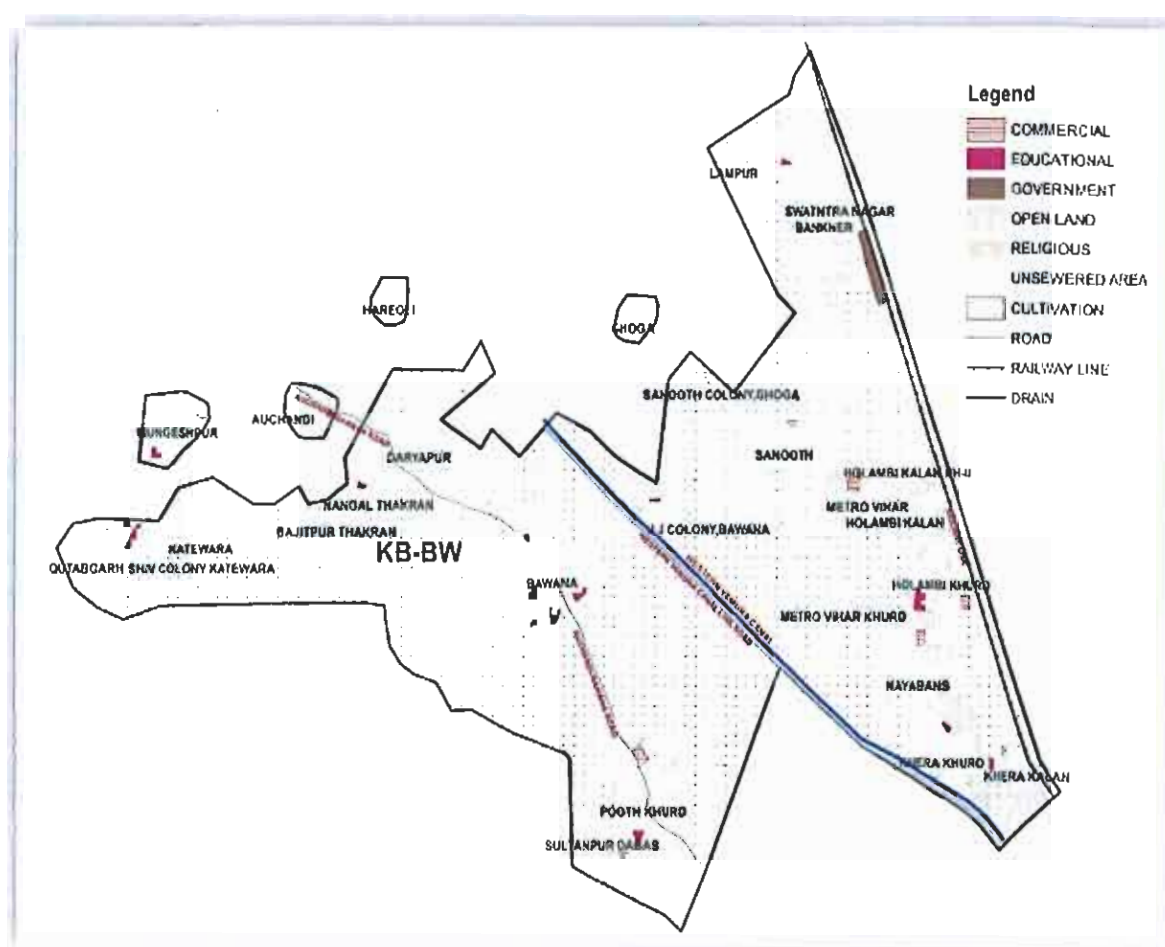


Figure 9: Land Use Map of Bawana Sub Drainage Zone (KB-BW)

Existing Sewerage Infrastructure

The area is completely unsewered and no sewage treatment facility exists in the drainage zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 10**.

- Seven (7) nos. of WWTPs are proposed for Bawana Sub-drainage zones.
- Sewage from Bankner, Lampur, Swatantra Nagar and nearby area is routed to proposed WWTP at Bankner via terminal WWPS. One intermediate Lift Station is proposed.
- Sewage from Ghoga, Sanooth, JJ Colony, Bawana, Metro Vihar, Holambi Kalan, Holambi Khurd, Khera Khurd and nearby area is routed to proposed WWTP at Bawana via various WWPS.
- Sewage from Pooth Khurd and nearby area is routed to proposed WWTP at Pooth Khurd via terminal WWPS.
- Sewage from Sultanpur Dabas and nearby area is routed to proposed WWTP at Sultanpur Dabas via terminal WWPS.
- Sewage from Hareoli, Auchandi, Daryapur and nearby area is routed to proposed WWTP at Daryapur via terminal WWPS.
- Sewage from Mungeshpur, Qutubgarh, Katewara and nearby area is routed to proposed WWTP at Katewara via terminal WWPS.

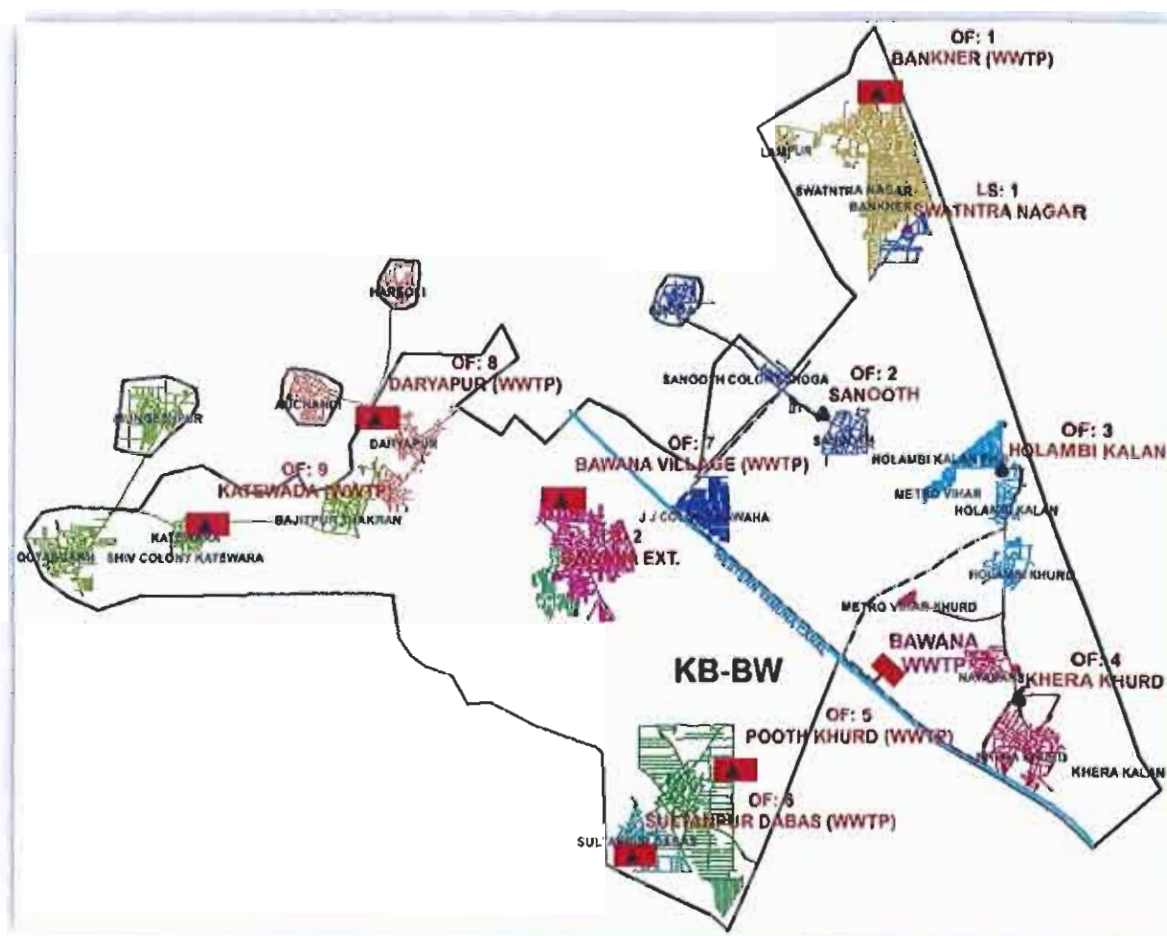


Figure 10: Scheme Map of Bawana Sub Drainage Zone (KB-BW)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Yamuna Sub Drainage zone is shown in the **Figure 11**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. . The proposed sewer network details are shown in **Table 5**.

Table 5: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	456103
300	HDPE/DWC	3508
400	HDPE/DWC	16318
500	HDPE/DWC	12057
563.6	HDPE	5615
635.2	HDPE	1923

Diameter (mm)	Material	Length (m)
700	RCC NP3/NP4	398
800	RCC NP3/NP4	2888
900	RCC NP3/NP4	3660
1000	RCC NP3/NP4	1530
Total		504000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 11**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

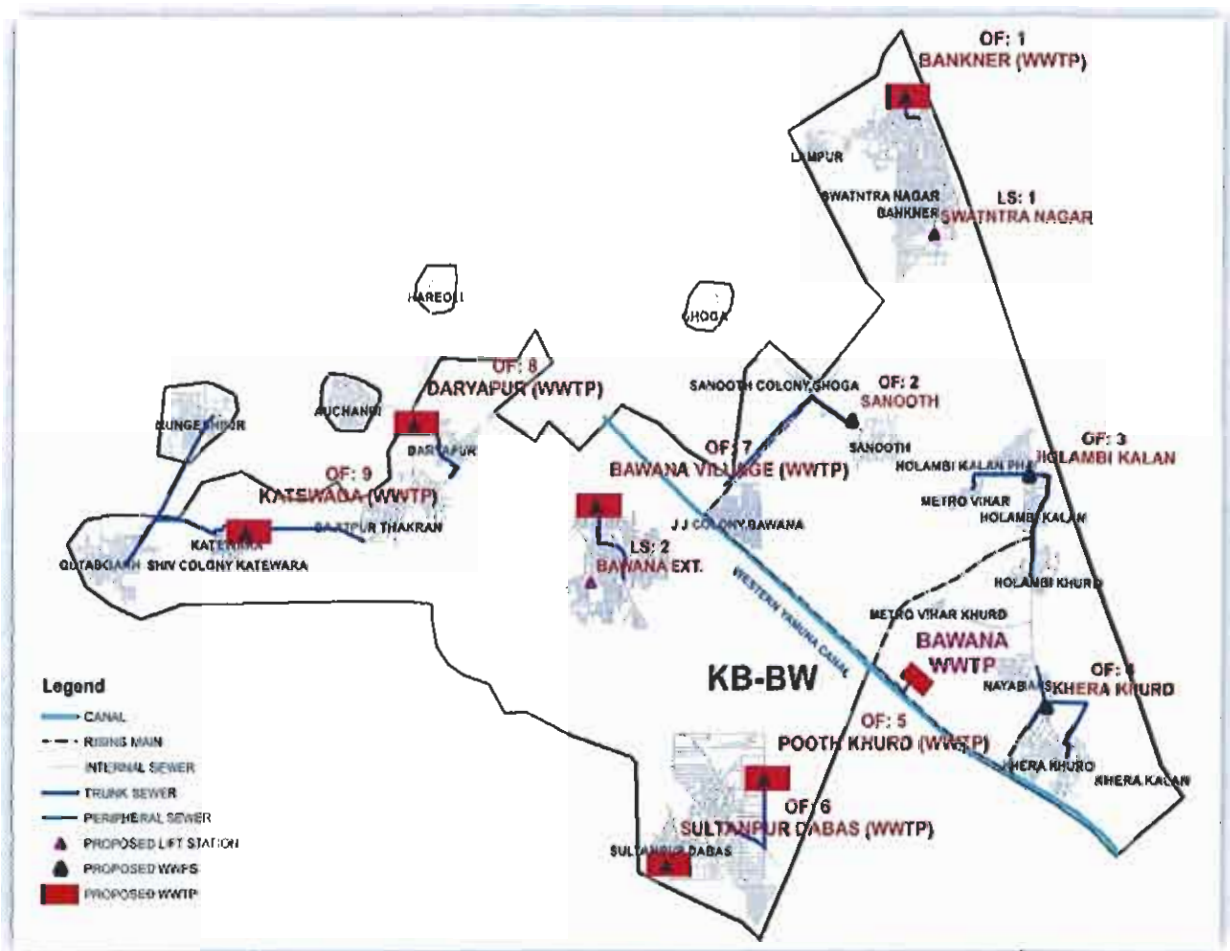


Figure 11: Proposed Sewerage Infrastructure of Bawana Sub Drainage Zone (KB-BW) Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWSs and details of proposed Rising Mains are listed in the **Table 6**.

Table 6: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Katewara	Terminal WWPS	9.00	-	-	-	-
2	Daryapur	Terminal WWPS	8.00	-	-	-	-
3	Bawana Village	Terminal WWPS	10.00	-	-	-	-
4	Bawana LS	LS	1.50	250	1	30	Nearest Manhole
5	Sultanpur Dabbas	Terminal WWPS	6.00	-	-	-	-
6	Pooth Khurd	Terminal WWPS	12.00	-	-	-	-
7	Swatntra Nagar	LS	1.50	250	1	30	Nearest Manhole
8	Bankner	Terminal WWPS	13.00	-	-	-	-
9	Sanooth	Terminal WWPS	10.00	800	1	3600	Proposed WWTP at Bawana
10	Holambi Kalan	Terminal WWPS	7.00	700	1	4500	Proposed WWTP at Bawana
11	Khera Khurd	Terminal WWPS	5.00	600	1	4300	Proposed WWTP at Bawana

Waste Water Treatment Requirements

Seven (7) nos. WWTPs are proposed for Bawana sub drainage zone as shown in **Table 7**.

Table 7: Proposed Waste Water Treatment Plants

Sl. No.	WWTP Location	WWTP Capacity Phase I (MGD)	WWTP Capacity Phase II (MGD)
1.	Katewara	2.6	2
2.	Daryapur	1.7	2
3.	Bawana Village	2.8	2
4.	Sultanpur Dabbas	1	2
5.	Pooth Khurd	3.8	2
6.	Bankner	4.3	2
7.	Bawana	9	2.8
Sub Total		25.2	14.8

The overall sewage generation from the sub drainage zone is 55 MGD. The capacities are proposed in phase-wise manner, for phase I & II as shown above in Table 6. Remaining capacity of 15 MGD has been proposed in phase III. Locations and capacities may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 8**.

Table 8: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Kanjhawala	KB-KJ	412	4	-	4
Bawana	KB-BW	504	9	2	7
Total		916	13	2	13

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 9** below:

Table 9: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Kanjawala	Kanjawala	4	2.6 - 3.3	Salahpur Majra	WWPS	8.0	2793.9
		11	7.1 - 8.9	Kanjhawala Village	WWPS	22.0	3069.0
		3.5	2.3 - 2.8	Sawda Gaon	WWPS	7.0	2202.4
		4.6	3.0 - 3.7	Ghewera WWPS	WWPS	9.0	2202.4
Bawana	Bawana	4.6	3.0 - 3.7	Katewara	WWPS	9.0	2726.6
		3.7	2.4 - 3.0	Daryapur	WWPS	8.0	2182.0
		4.8	3.1 - 3.9	Bawana Village	WWPS	10.0	2982.2
				Bawana LS	LS	1.5	49.6
		3	1.9 - 2.4	Sultanpur Dabbas	WWPS	6.0	1151.8
		5.8	3.8 - 4.7	Pooth Khurd	WWPS	12.0	2793.0
				Swatantra Nagar	LS	1.5	49.6
		6.3	4.1 - 5.1	Bankner	WWPS	13.0	2667.0
		11.8	7.6 - 9.5	Sanooth	WWPS	10.0	2751.0
				Holambi Kalan	WWPS	7.0	2752.2
				Khera Khurd	WWPS	5.0	2161.5

Line Diagram for Proposed WWPS and WWTP for Kanjhawala is shown in **Figure 12**:

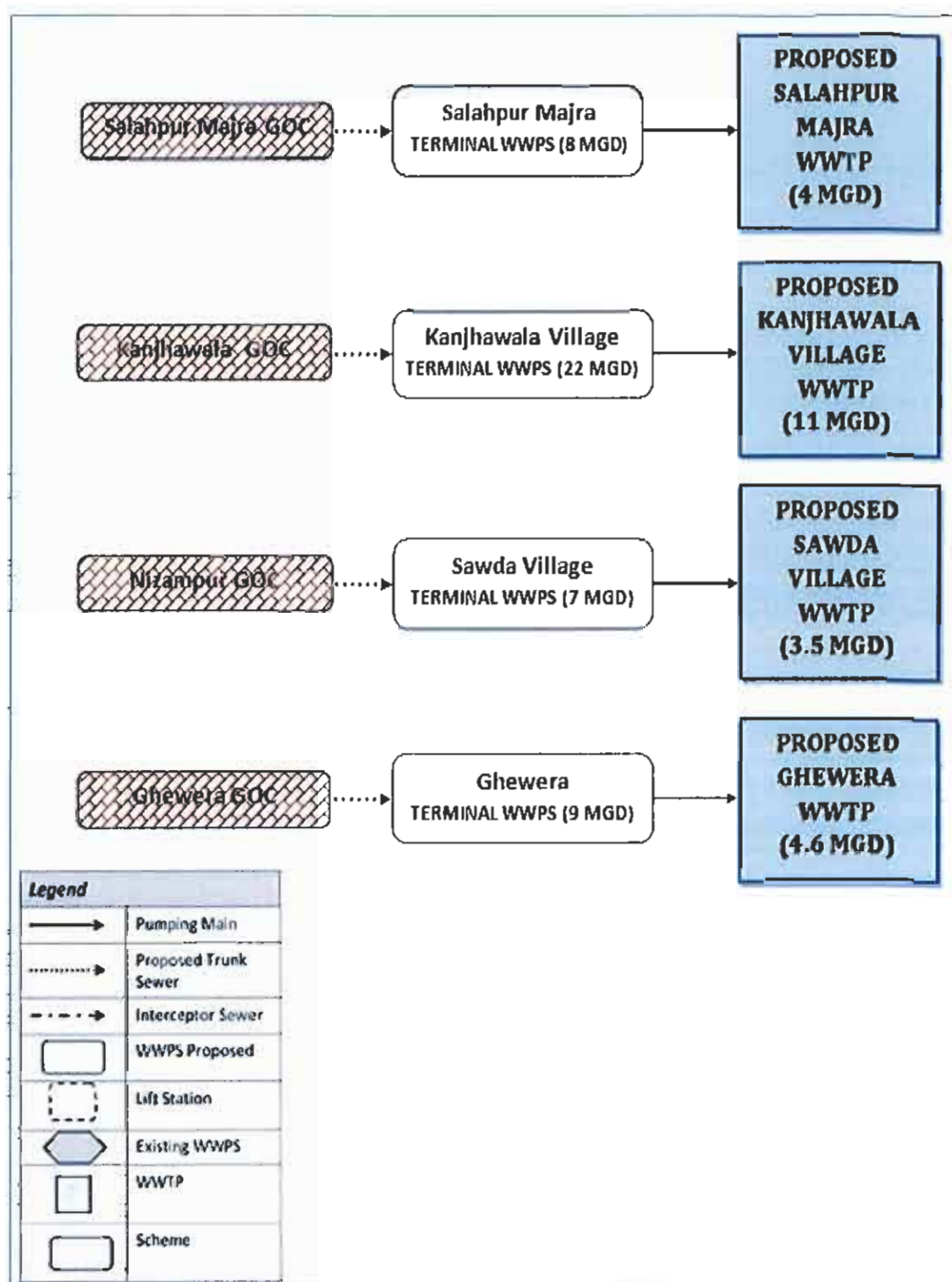


Figure 12: Line Diagram for Proposed WWPS and WWTP for Kanjhawala

Line Diagram for Proposed WWPS and WWTP for Bawana is shown in **Figure 13**:

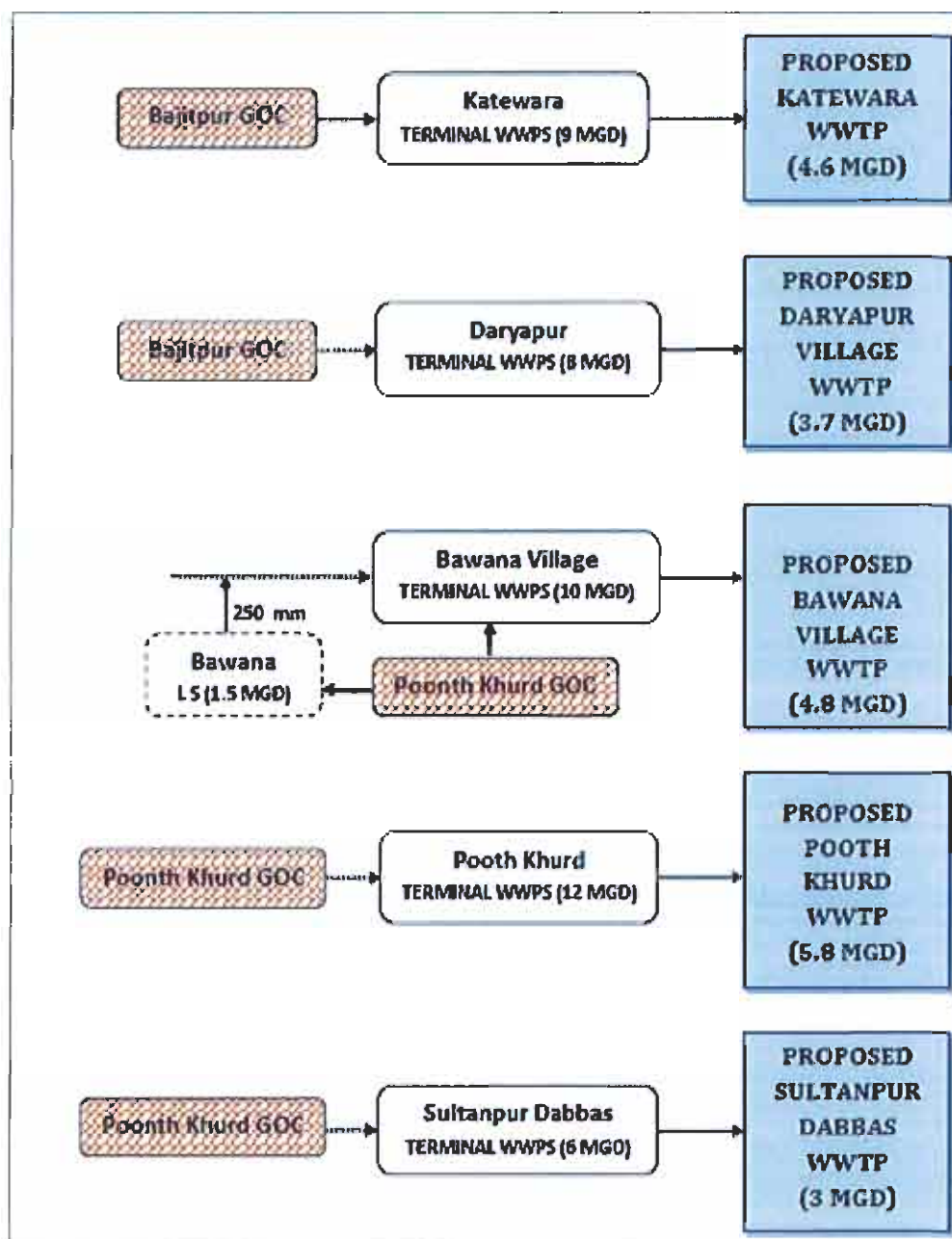


Figure 13: Line Diagram for Proposed WWPS and WWTP for Bawana

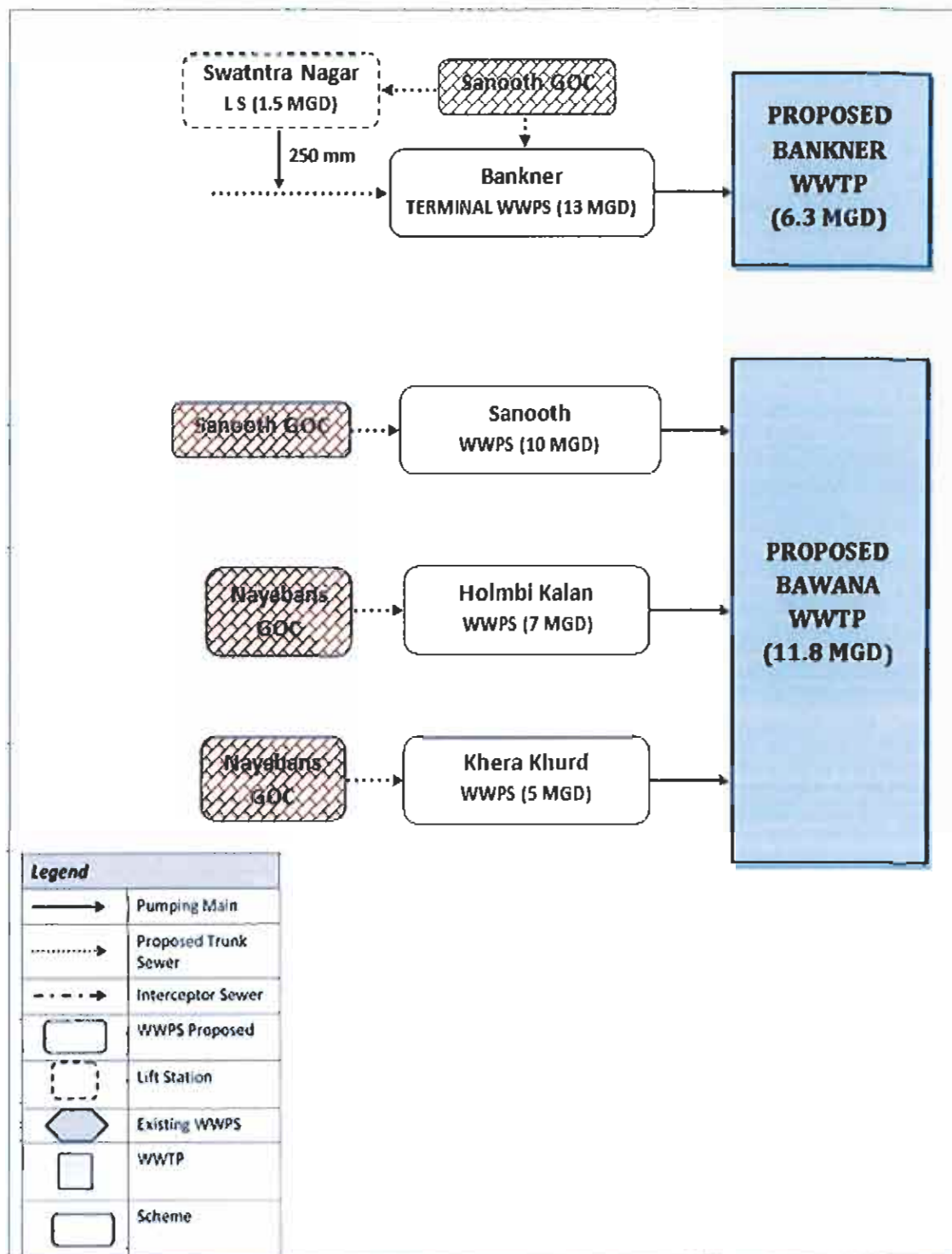


Figure 14: Line Diagram for Proposed WWPS and WWTP for Bawana Contd..

Disposal of Treated Effluent

Likely users of Treated Effluent are Flood Irrigation Deptt., DTC, DDA, MCD for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area. Remaining treated effluent from proposed WWTP in Kanjhwalan sub drainage zone is proposed to be discharged to Najafgarh drain via nearby drains while remaining sewage from proposed WWTP in Bawana sub drainage zone is proposed to be discharged to Supplementary drain via nearby drains.

The proposed sewerage scheme for Kanjhawala Drainage Zone including trunk sewers, proposed WPPSs and WWTPs is shown in the **Figure 15**.

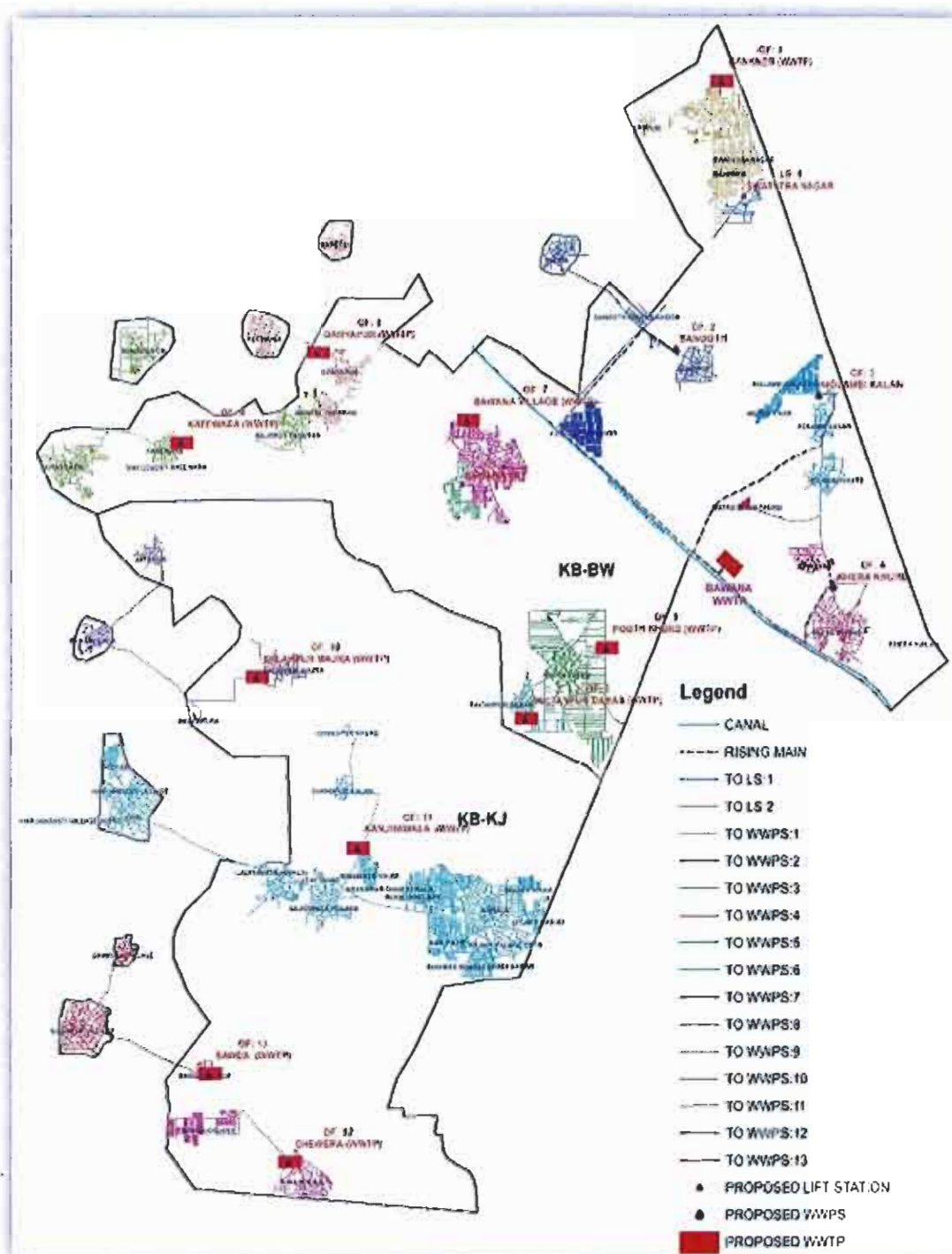


Figure 15: Proposed Sewerage Scheme for Kanjhawala- Bawana Drainage Zone

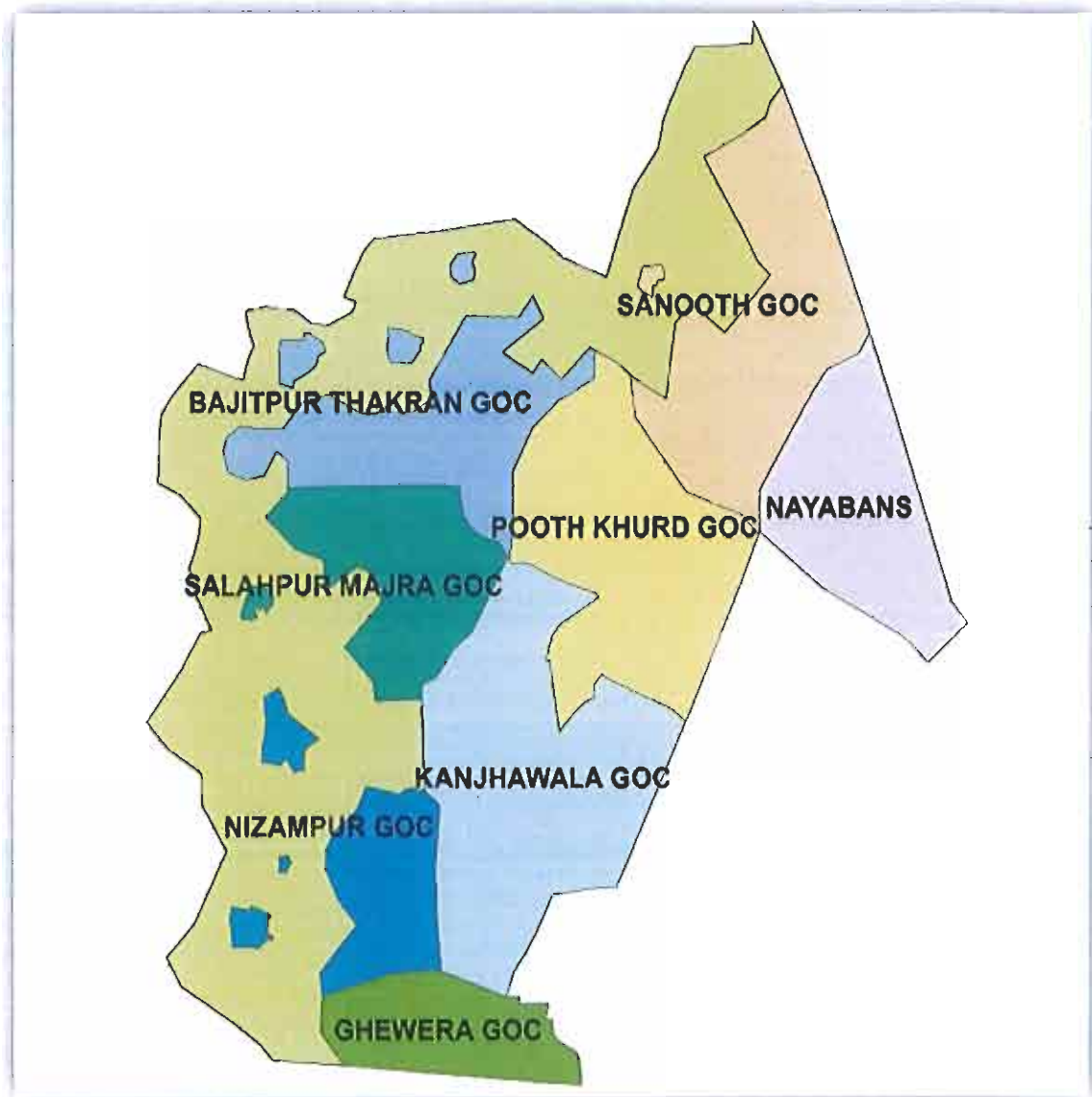


Figure 16: GOC-wise Sewerage Schemes – Kanjhawalan-Bawana Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 10: Implementation Schedule

Sl. No.	WWTP Catchment	SubZone	Scheme Details		Implementation Schedule			
			Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Kanjhawala	KJ	KB-KJ-SM	Salahpur Majra GOC				
2	Kanjhawala	KJ	KB-KJ-KV	Kanjhawala GOC				
3	Kanjhawala	KJ	KB-KJ-NP	Nizampur GOC				
4	Kanjhawala	KJ	KB-KJ-GV	Ghewra GOC				
5	Bawana	BW	KB-BW-BP	Bajitpur GOC				
6	Bawana	BW	KB-BW-PK	Pooth Khurd GOC				
7	Bawana	BW	KB-BW-ST	Sanooth GOC				
8	Bawana	BW	KB-BW-NB	Nayabans GOC				

Table 11: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Sanooth	Sanoth Ghoga Village Ghoga Extn. , Delhi 39 Ghoga Extn., Narela, Delhi-39 New Colony, Sannot Ghoga More, Narela, Bawana
2	Bajitpur Thakran	Auchandi Nangal Thakran Bazid Pur Thakran Shiv Colony, Katewada, Delhi-39 Qutub Garh Extn.Nai Basti Delhi-59 Harijan Colony B-Block, Harewali, Delhi-39 Harijan Colony, Village- Harewali, Delhi-39 Katewera Katewada Village Mungesh Pur Qutab Garh Qutab Garh Enclave Qutab Garh Delhi-39 Qutabgarh Extn.Colony, Kanjhawla Delhi-39 Uzala Harijan Colony Santi Road Qutab Garh Delhi-39 Shri Krishana Colony Harewali, Delhi-39
3	Pooth Khurd	Anand Vihar Colony Pooth Khurd Bawana Road Delhi-39 Vijay Nagar, Bawana, Delhi-37 Vijay Colony Barwala Jain Colony (Nanesh Enclave) Village Barwala, Bawana Road, Delhi-39 Buddhanpur Hareweli Sultan Pur Dabbas
4	Nayabans	NayabansVashu Vihar Colony Holambi Kalan Ankur Vihar Colony Holambi Kalan Sapt Rishi Garden, Holambi Kalan, Narela, Delhi-82 Hazari Park, Holambi Kalan, Delhi-82 Holambi Khurd Extn., Delhi-82 Holambi Kalan Holambi Khurd Metro Vihar Naya Bas Mann Enclave Khera Khurd Delhi-82 Khera Khurd Extn Village Khera Khurd.Delhi Khera Khurd Extn. Khera Khurd, Delhi 82 Khera Khurd J J Colony
5	Salahpur Majra Village	Salahpur Majra Village

6	Kanjhawala Village	Shiv Mandir Colony, Safiabab Border Narela, Delhi-40 Om Vihar Colony Lampur Road Narela, Delhi Nai Basti Lampur, Narela, Delhi-40 Vishal Enclave Bawana Road, Narela, Delhi-40 Swatantra Nagar Ph-II (Left out portion), Narela Basti Banker South, Lampur Road, Delhi-40 Village Bakner Ambedkar Colony Extn. Part II, Delhi 40 Ambedkar Colony Extn., Vill Bankner, Narela Nai basti Bakner Paschim, Delhi Bankner Basti (Firani Road), Narela Bankner Swatantra Nagar Extn. West Gonda Road, Narela, Delhi-40 Chandpur Khurd Anandpur Dham C-Block Delhi-81 Anandpur Dham, Karala, Delhi-81 Baldev Vihar, Karala Extn., Delhi-81 Harijan Basti Village, Jaunti, New Delhi-81 Harijan Basti Village Jonti Lad Pur Mahavir Vihar Kanjhawala Delhi-81 Majri Village Extn., Majri P.O. Karala, Delhi-81 Ghewra Sawda Shaheed Bhagat Singh Nagar, Majri Karala, Delhi-81 Shiv Vihar Main Kanjhawala Road, Delhi-81 Tatesar Udai Vihar Kanjhawala Delhi-81 Utsav Vihar, A-3, Karala, New Delhi Vardhman Enclave, Shiv Vihar, Karala, Delhi Kanjhawala
7	Nizampur Village	Nizampur Village
8	Ghewra Village	Ghewra Village

ANNEXURE - 6

KESHOPUR DRAINAGE ZONE (KSP)

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KESHOPUR DRAINAGE ZONE (KSP)

1. INTRODUCTION

Keshopur Drainage Zone is bounded by Najafgarh Drain and Northern Railway main line on the North, by Pankha road on the West. Keshopur Zone is mainly residential in nature with pockets of industrial areas as in IAR, Udyog Vihar, Mayapuri and Pusa Complex. Cantonment area is discharging sewage to this Drainage Zone. Nearby Palam Airport have its own sewerage infrastructure and is not connected to any drainage zone by and large. For report purposes, Airport and Cantonment has been considered part of this Zone. Location of Keshopur Drainage Zone is shown in the **Figure 1**.

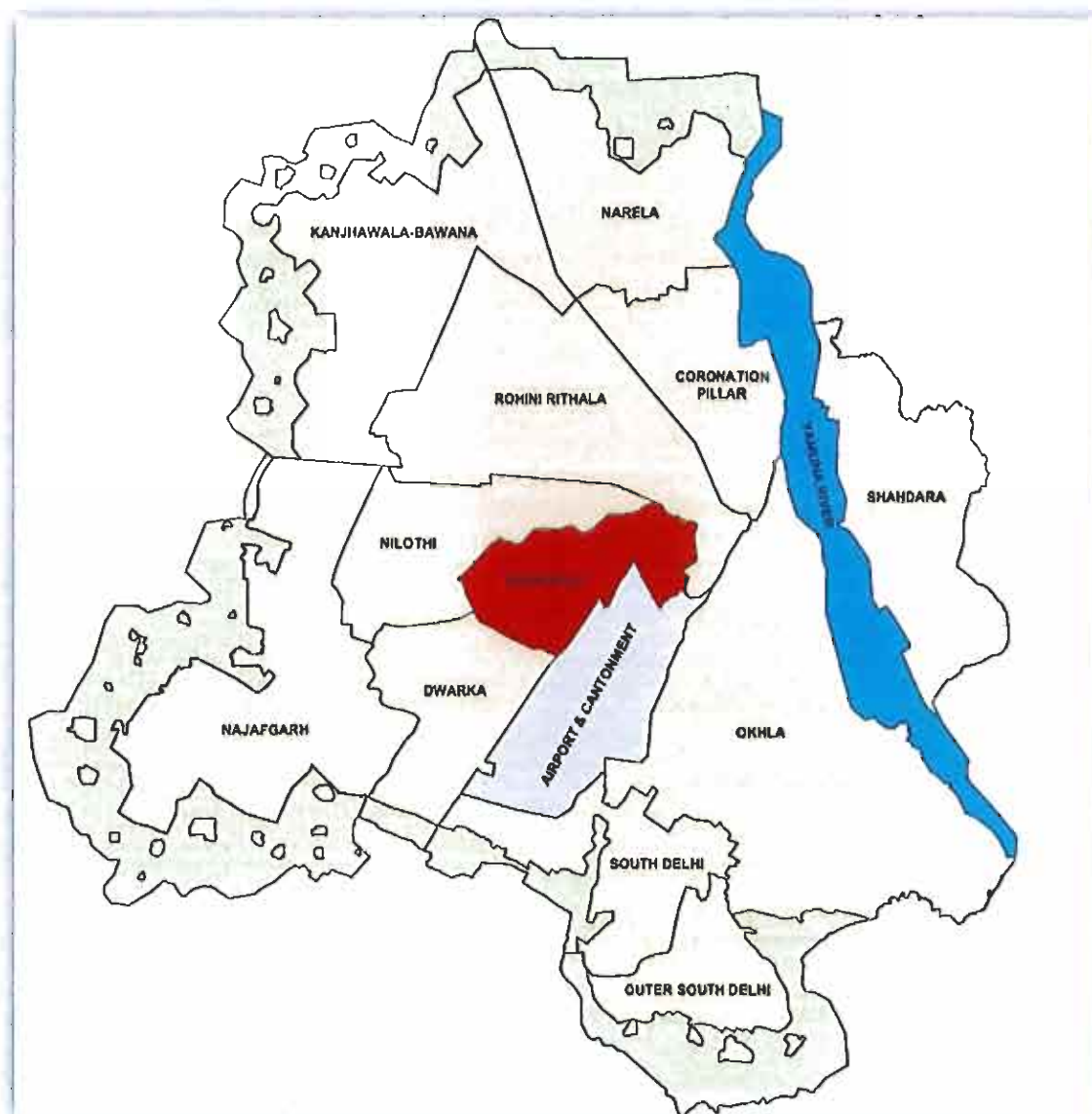


Figure 1: Keshopur Drainage Zone

Keshopur Drainage Zone consists of major areas like Rajouri Garden, Tilak Nagar, Subhash Nagar, Ramesh Nagar, Moti Nagar, Tagore Garden, Kirti Nagar, Baljit Nagar, Pratap Nagar, Janakpuri etc. This drainage zone falls under the DDA planning zone B, D, F and G as shown in the **Figure 2**.

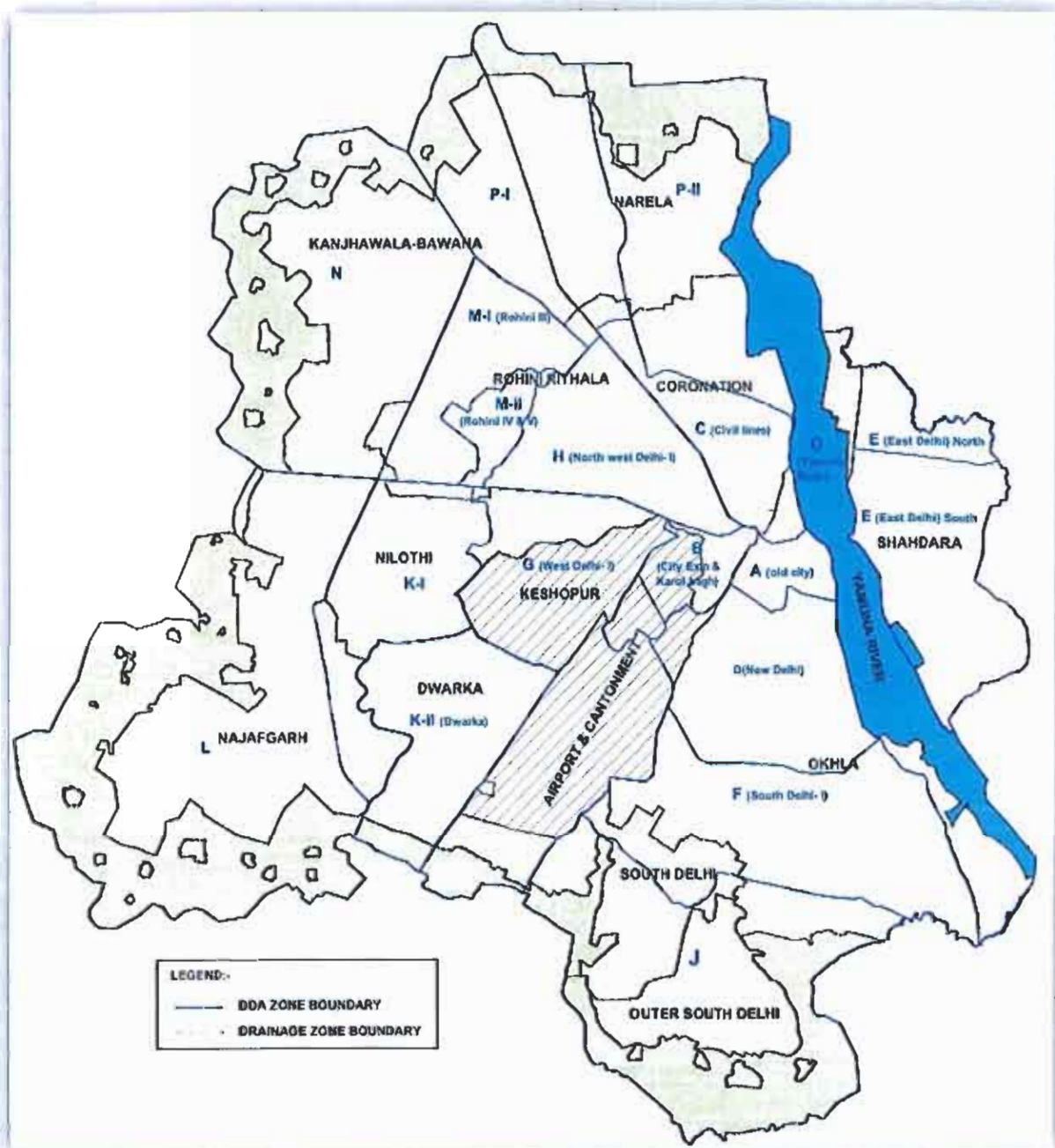


Figure 2: DDA Zones and Keshopur Drainage Zone

Soil Description of Keshopur

This zone is fully with older alluvium deposits.

Zone of Basin margin effect west of Delhi ridge (JanakPuri, Hari Nagar, MayaPuri, Kirti Nagar etc.) is High Hazardous. South Najafazgarh (Uttam Nagar, Vikas Puri, Tilak Nagar, Vishnu Garden, Raja Graden etc.) having sedimentary fill (Dabar) with Moderate hazard due to high amplification and liquefaction.

The upper belt along the Nilothi having areas like Vishu Garden, Tilak Nagar, Vikas puri, Raja Graden etc. is having Water depth ranging from 2- 10m. Whereas, the lower belt of this region adjoining to Dwarka and Okhla zones covering areas like Patel Nagar, MayaPuri, Kirti Nagar, Janak puri, HariNagar, Anand Parbat etc. is having water depth ranging from 10 -40m.

In this zone half of the portion is covered with Bangar soil i.e MayaPuri, Kirti Nagar, Janak puri, HariNagar, Vikaspuri etc. & 30 % of the portion with Dabar soil i.e Vishu Garden, Tilak Nagar, Vikas puri, Raja Graden etc and remaining portion covered with Kohi soil i.e. Patel Nagar, Anand Parbat.

2. MASTER PLANNING FOR KESHOPUR DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

Keshopur Drainage Zone is mostly sewered with few unsewered pockets covering colonies namely Ravi Nagar R&Z Block, Dharampur, and Vishnu Garden etc. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

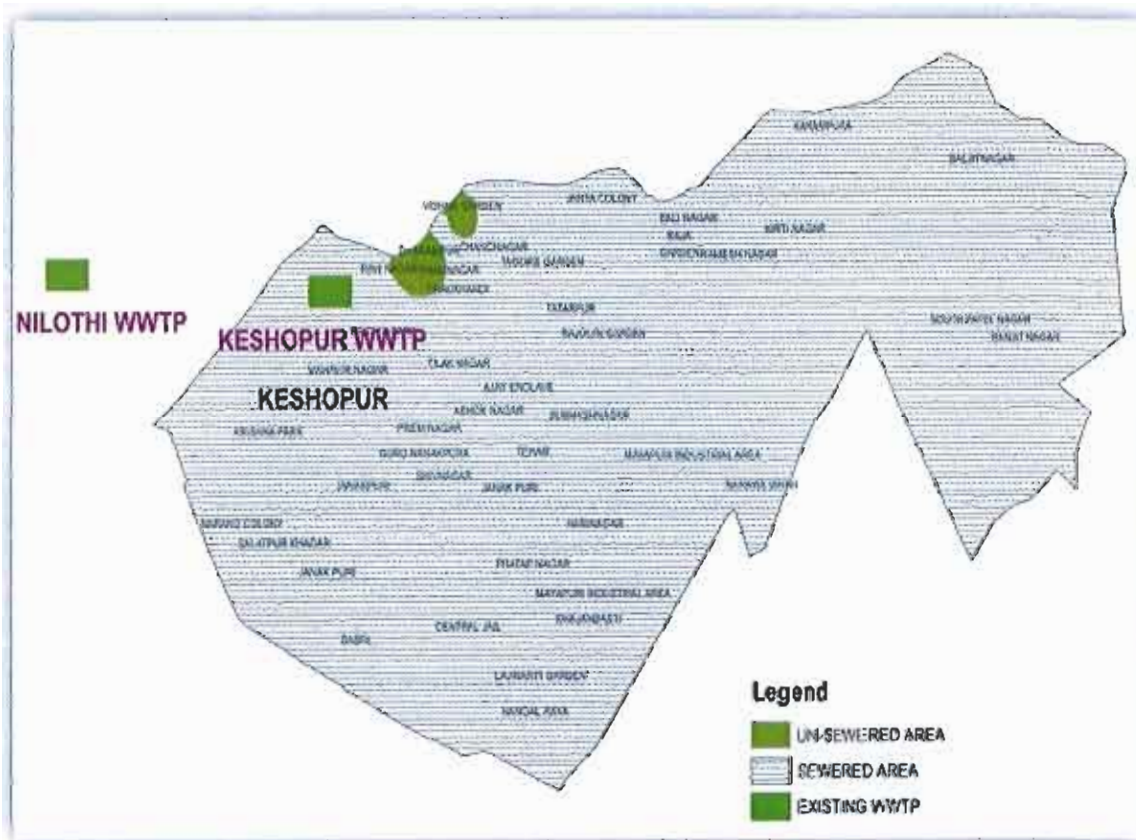


Figure 3: Sewerage Status of Keshopur Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS

- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

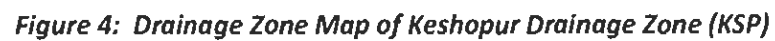
The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Most of the area under Keshopur Drainage Zone is already sewered and discharging to existing Keshopur WWTP. The Zone has not been divided into sub drainage zones. However, for report purposes, Airport and Cantonment areas have been considered part of this Drainage Zone as shown in the **Figures 4**.



Contours maps for unsewered areas of Drainage Zones are as shown in **Figure 5** below:

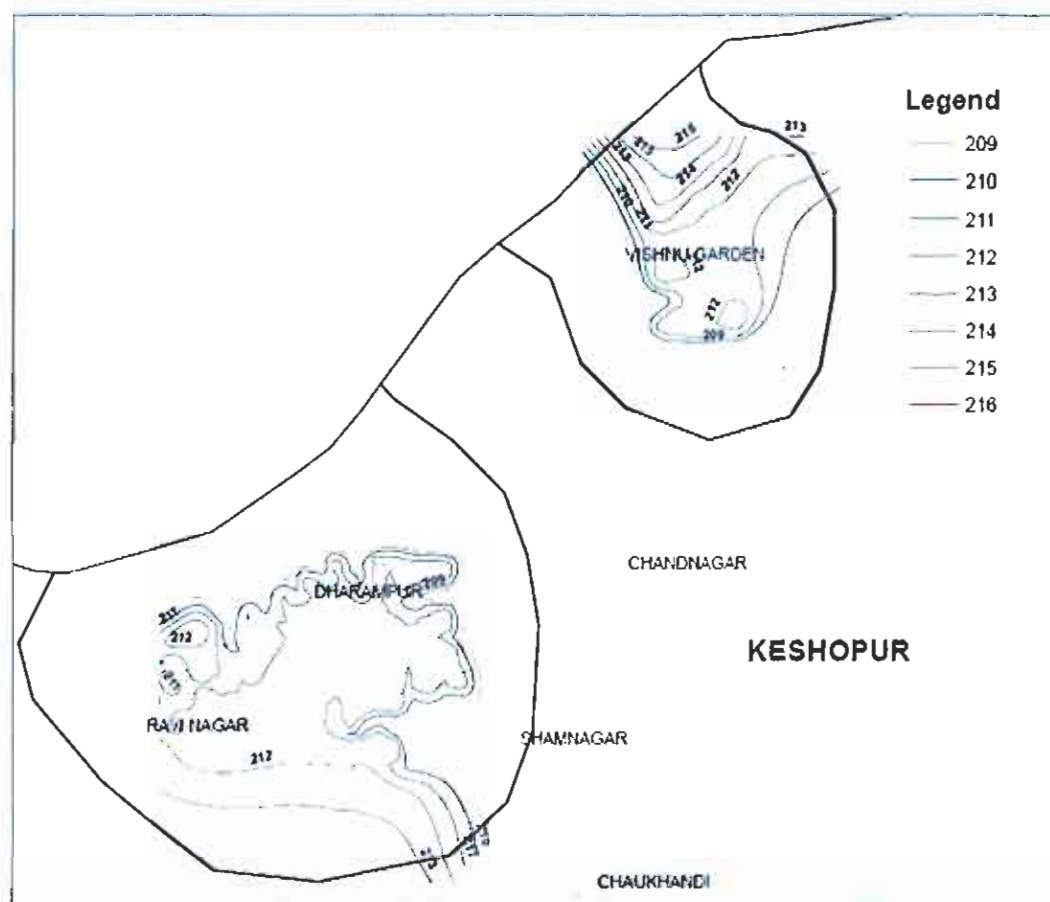


Figure 5: Contour Map of Keshopur Drainage Zone (KSP-KP)

Based on population projections Sub-Drainage Zone wise estimated sewage generation for the zone is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Keshopur Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
KSP-KSP	281.48	304.18	326.88	62.00	67.00	72.00
Total	281.48	304.18	326.88	62.00	67.00	72.00

Land use map is as shown in the **Figure 6**.



Figure 6: Land Use Map of Keshopur Drainage Zone (KSP-KP)

Existing Sewerage Infrastructure

Presently a treatment plant of 72 MGD is located at Keshopur and caters to entire Drainage Zone which is mostly sewerage. Three large existing pumping stations are located at the site of the treatment plant itself. There is another Pumping Station constructed at Uttam Nagar, situated to the South West of the Keshopur.

The details of existing WWPS and their integration arrangement have been shown in the line diagram as *Figure 7*.

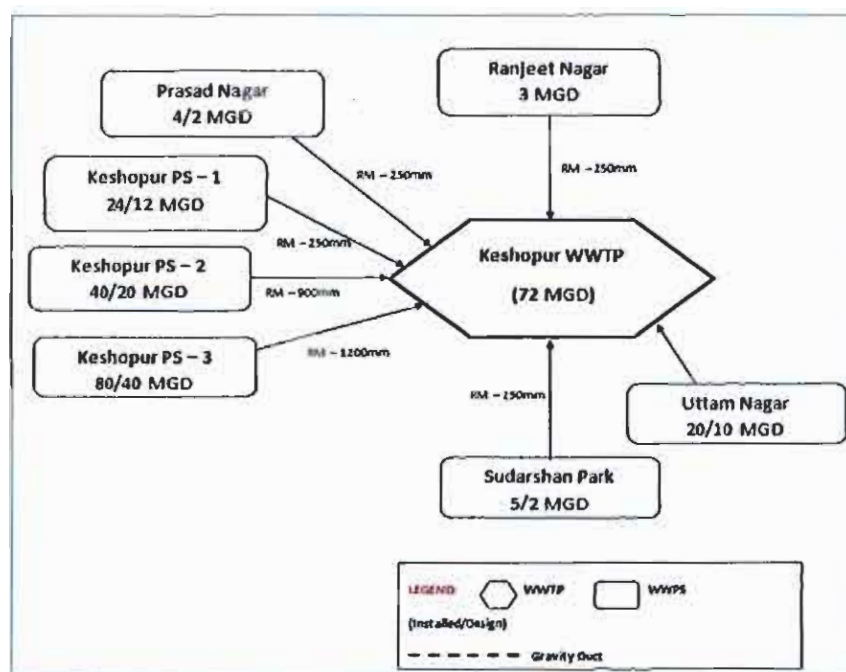


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Drainage Zone

DJB has proposed Interceptor Sewer in this sub drainage zone. At initial stage, all sub drains out falling into supplementary drain will be intercepted by this sewer, however, as the catchment of most of the drains falls within the Sub Zone, it is proposed to utilize Interceptor Sewer as trunk sewer for the sub drainage zone. One WWPS is proposed within Keshopur WWTP area to pump sewage from this Interceptor Sewer to another Interceptor Sewer towards Niloti WWTP.

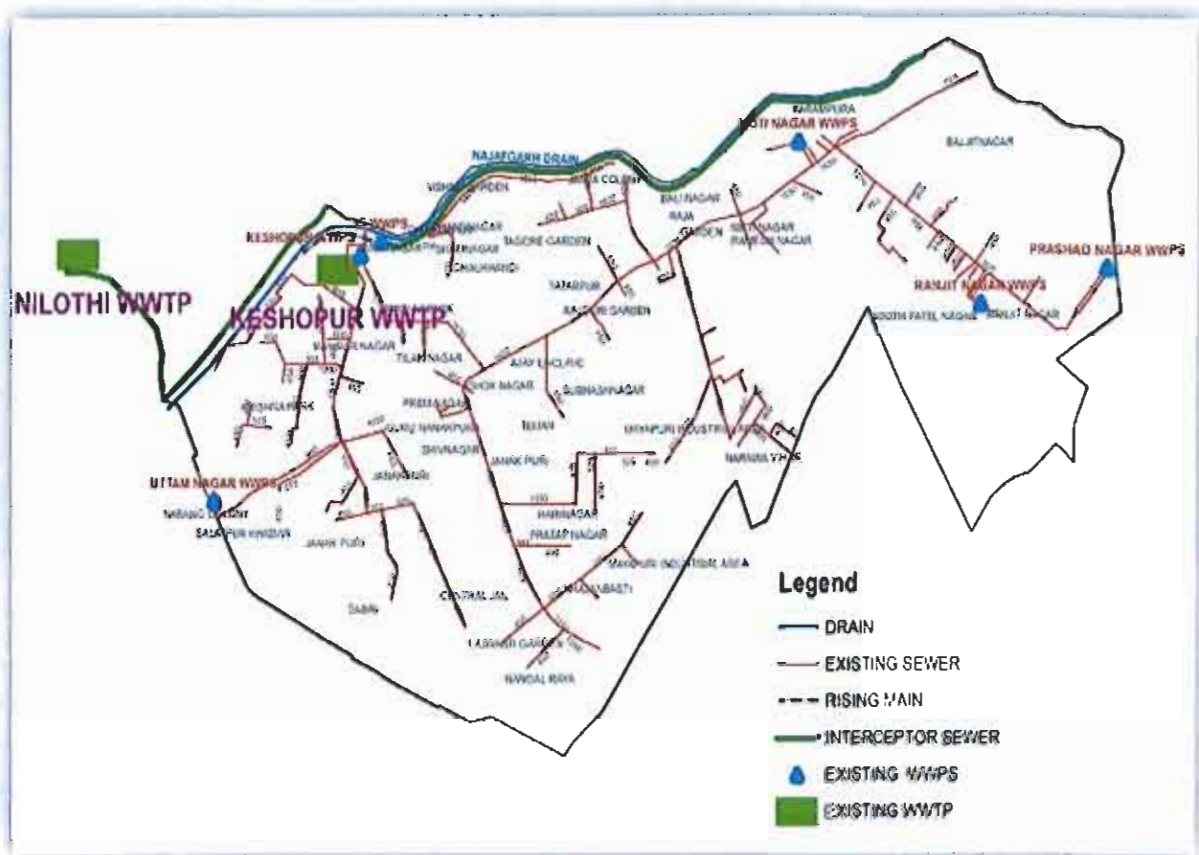


Figure 8: Existing Sewerage Infrastructure of Keshopur Drainage Zone (KSP)

Utilization of Existing Sewerage Infrastructure

The hydraulic analysis shows that the capacity of proposed Interceptor Sewer and WWPS will be sufficient to cater to their individual designated 2031 loads from this sub zone. Proposed sewerage scheme is integrated to Interceptor Sewer as explained in the section below.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 9**.

- The area is mostly sewerage.
- Sewage from part of Ravi Nagar R & Z Block, Dharampur and Vishnu Garden and nearby areas is routed to proposed Interceptor Sewer.

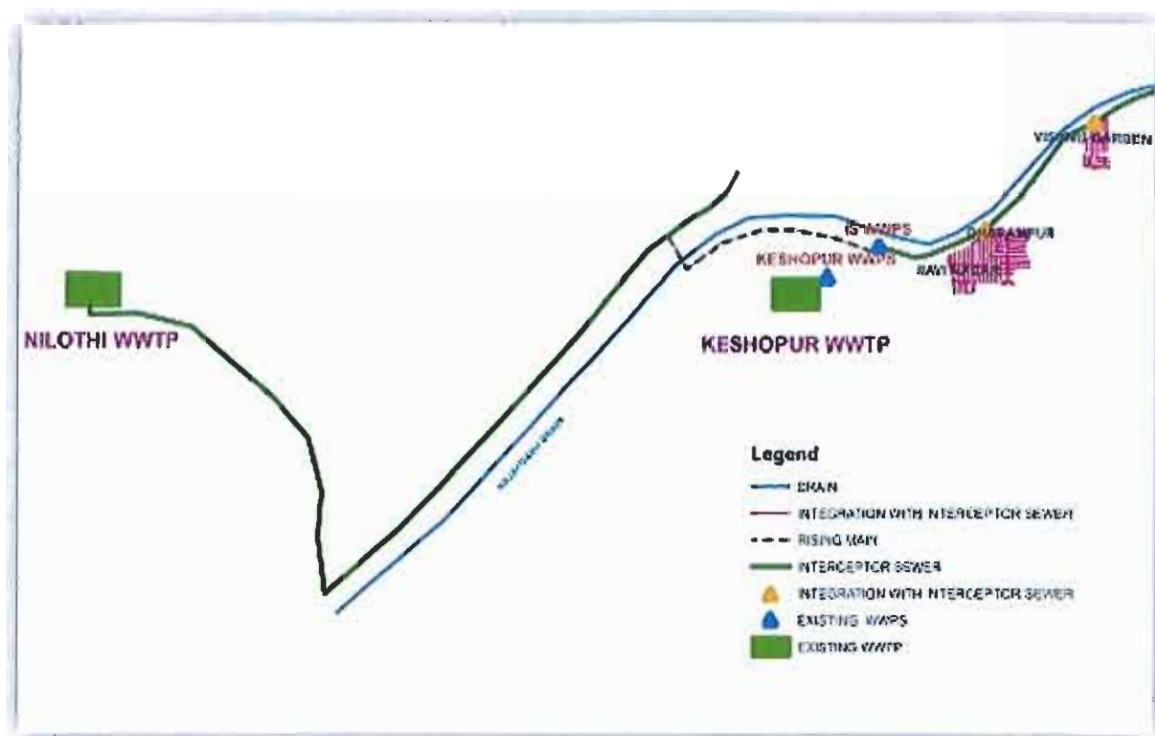


Figure 9: Scheme Map of Keshopur Drainage Zone (KSP)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Keshopur Sub Drainage zone is shown in the **Figure 7**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	7755
300	HDPE/DWC	197
400	HDPE/DWC	48
Total		8000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 10**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

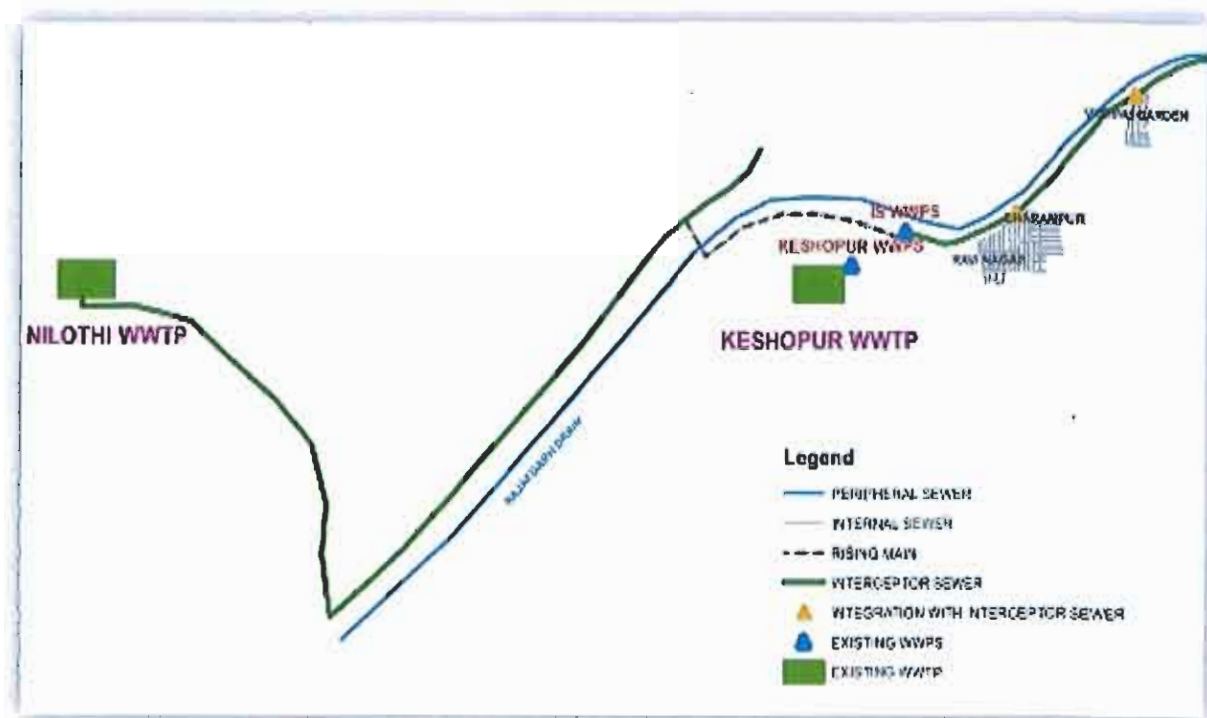


Figure 10: Proposed Sewerage Infrastructure of Keshopur Drainage Zone (KSP)

Waste Water Pumping Requirements

No additional Pumping Stations have been proposed for unsewered pockets of the Drainage Zone.

Waste Water Treatment Requirements

No additional WWTP have been proposed for unsewered pockets of the Drainage Zone.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the Table 3.

Table 3: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Kapashera	(SD-KH)	8	-	-	-

Line Diagram for Existing WWPS and WWTP of Keshopur is shown in **Figure 11**:

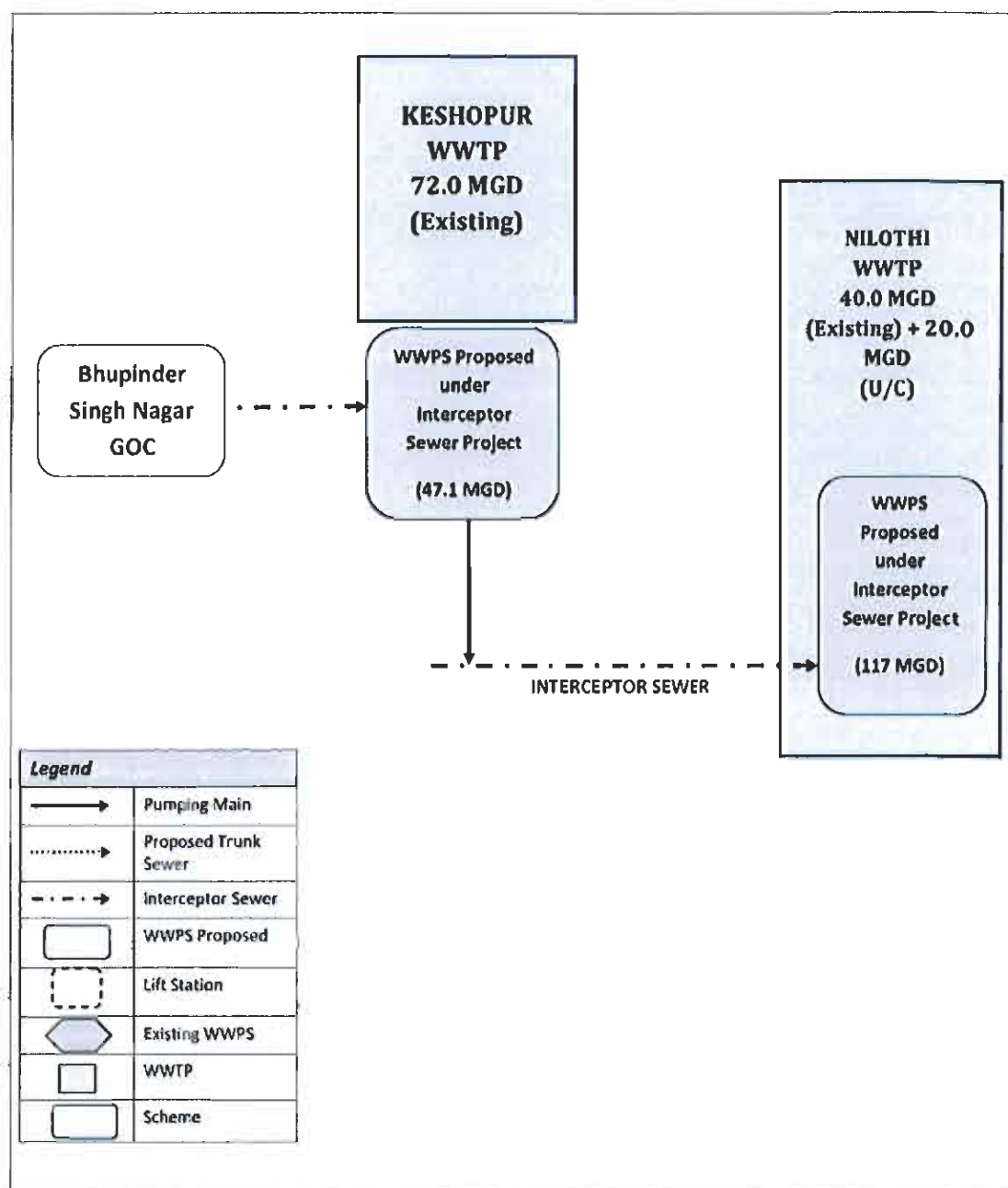


Figure 11: Flow Chart of Existing Sewerage Infrastructure in the Drainage Zone

Disposal of Treated Effluent

Current practice of disposal is to discharge it to Irrigation Canal and Najafgarh Drain. Likely users of Treated Effluent are Flood Irrigation Deptt., DTC, DDA, MCD for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Keshopur Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in the **Figure 12**.

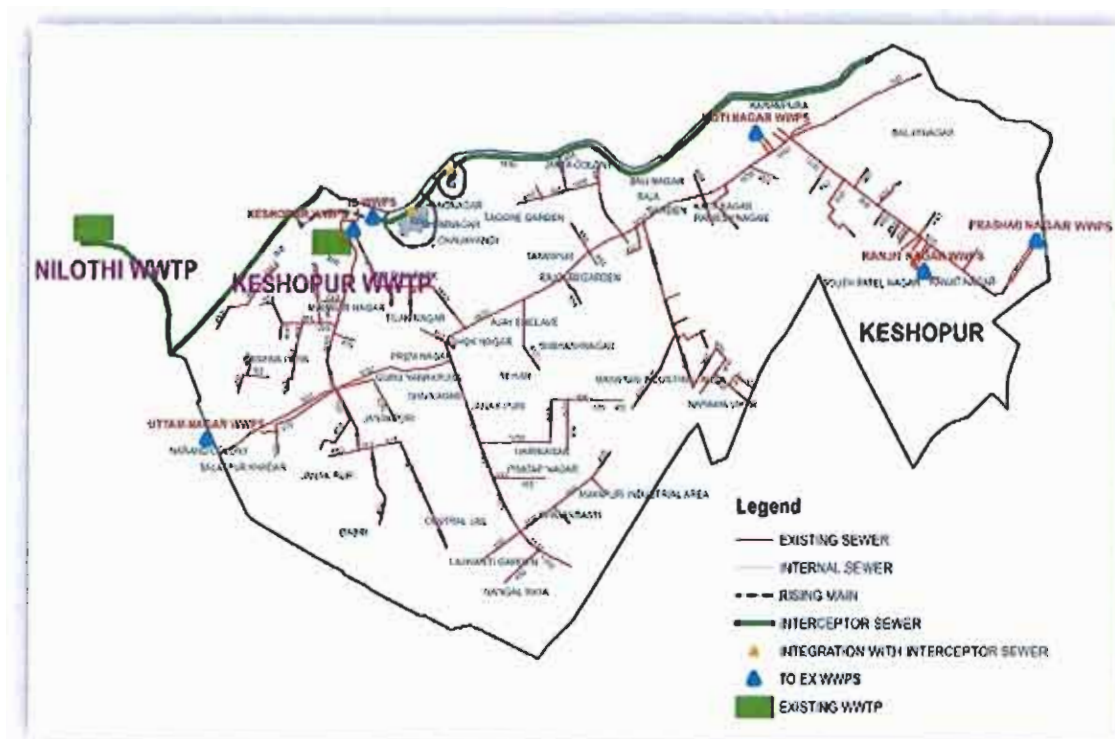


Figure 12: Proposed Sewerage Scheme for Keshopur Drainage Zone

Various Group of Colonies (GOCs) - wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 13**.

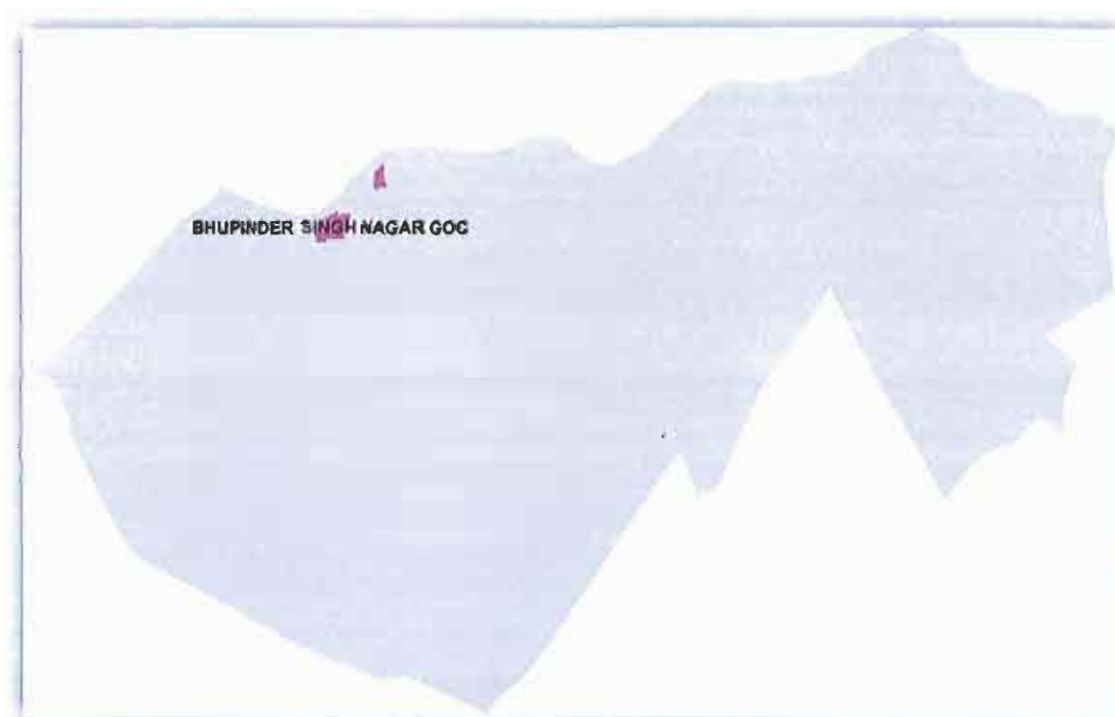


Figure 13: GOC-wise Sewerage Schemes – Keshopur Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 4: Implementation Schedule

Scheme Details					Implementation Schedule			
Sl. No.	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Keshopur	KP2	KSP-KP2-BN	Bhupinder Singh Nagar Group of Colonies				

Table 5: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Bhupinder Singh Nagar GOC	Ravi Nagar Dharampur Vishnu Garden

ANNEXURE - 7

NILOTHI DRAINAGE ZONE (NLT)

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NILOTHI DRAINAGE ZONE (NLT)

1. INTRODUCTION

Nilothi Drainage Zone is bounded by Delhi-Rohtak railway line along its Northern boundary, Najafgarh Drainage Zone along western boundary, whereas along Southern boundary runs Shivaji road separating Dwarka sub city and Najafgarh Drain in eastern side. The area comprises of Residential high density development on east side, unauthorized colonies and Industrial establishments, towards west side of the Zone. Location of Nilothi Drainage Zone is shown in the *Figure 1*.

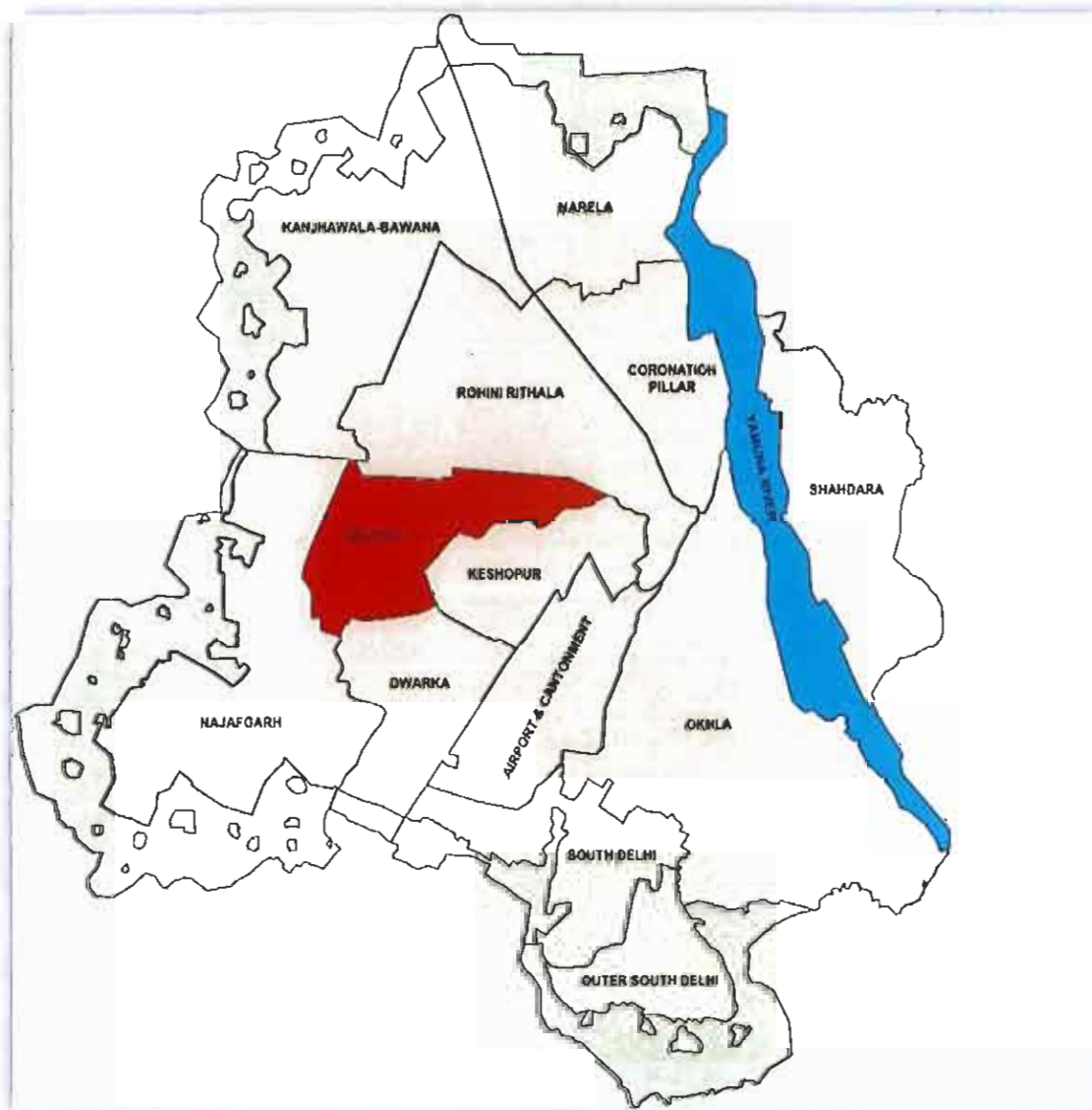


Figure 1: Nilothi Drainage Zone

Nilothi Drainage Zone consists of major areas like Punjabi Bagh, Pashchim Vihar, Nangloi, Nihal Vihar, Swarna Park, Uday Vihar, Shiv Enclave, Ranhola, Mohan Garden, Vikaspuri etc. Nilothi Zone falls under DDA Zone K1 and G as shown in the *Figure 2*.

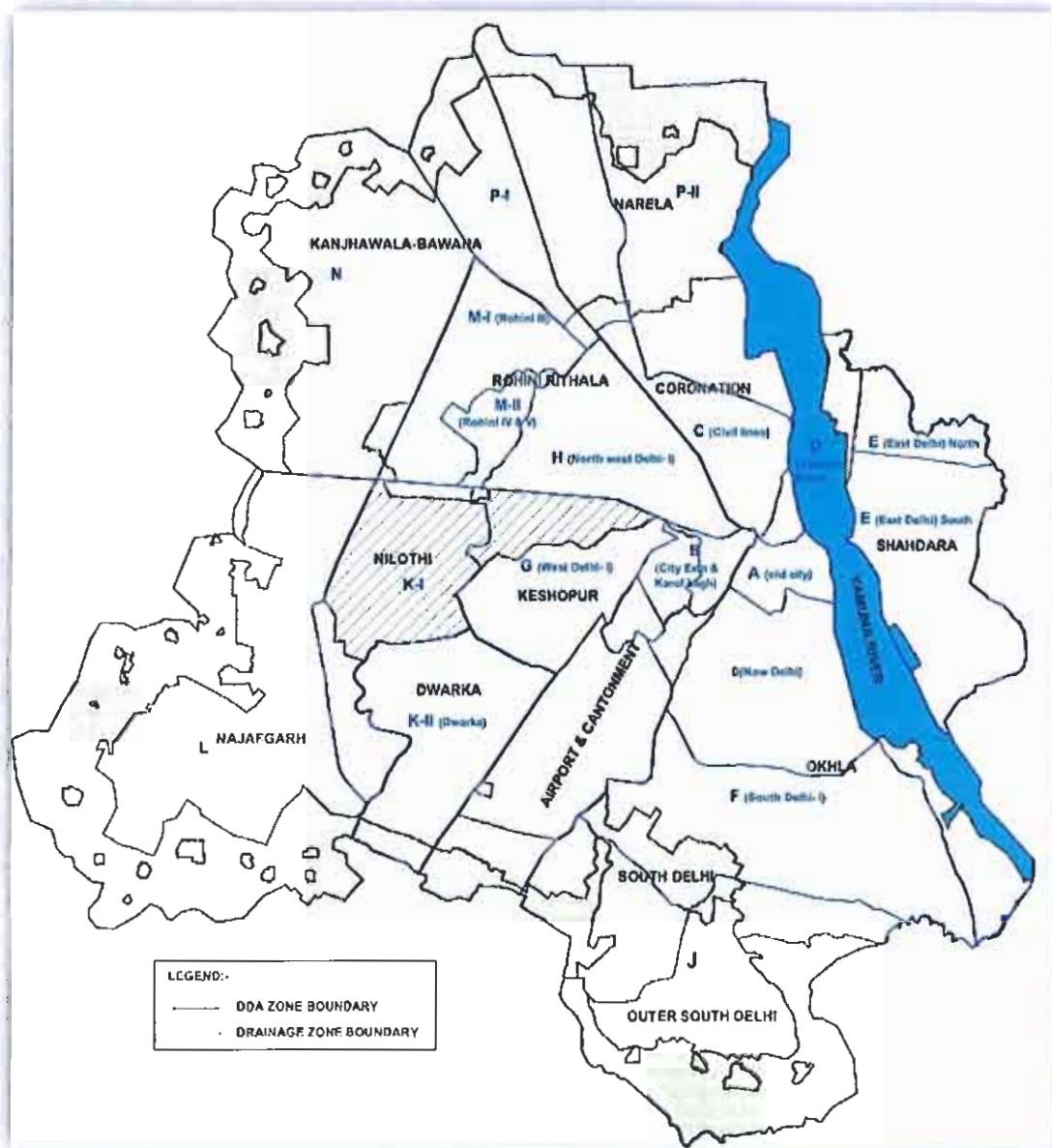


Figure 2: DDA Zones and Niloti Drainage Zone

Soil Description in Niloti

This zone is fully covered with older alluvium deposits. Niloti zone is under Moderate hazard due to High Amplification & Liquefaction. This is due to South Najafgarh sedimentary fill (Dabar). This zone is having water depth ranging from 2- 10m. The major areas under these zones are Chandan Vihar, Shiv Vihar, Mohan Garden, Mundka, Paschim Vihar, Shivali Park, Shodya Park, TikriKalan, Nangloi extension, Udyog Nagar etc. In This zone half of the portion is covered with Bangar soil (Mundka, Nongoli extension, Paschim Vihar etc.) & rest of the portion with Dabar soil (Shiv Vihar, Mohan garden, Chandan Vihar, etc.).

2. MASTER PLANNING FOR NILOTHI DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSS, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The Drainage Zone is partially sewered. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

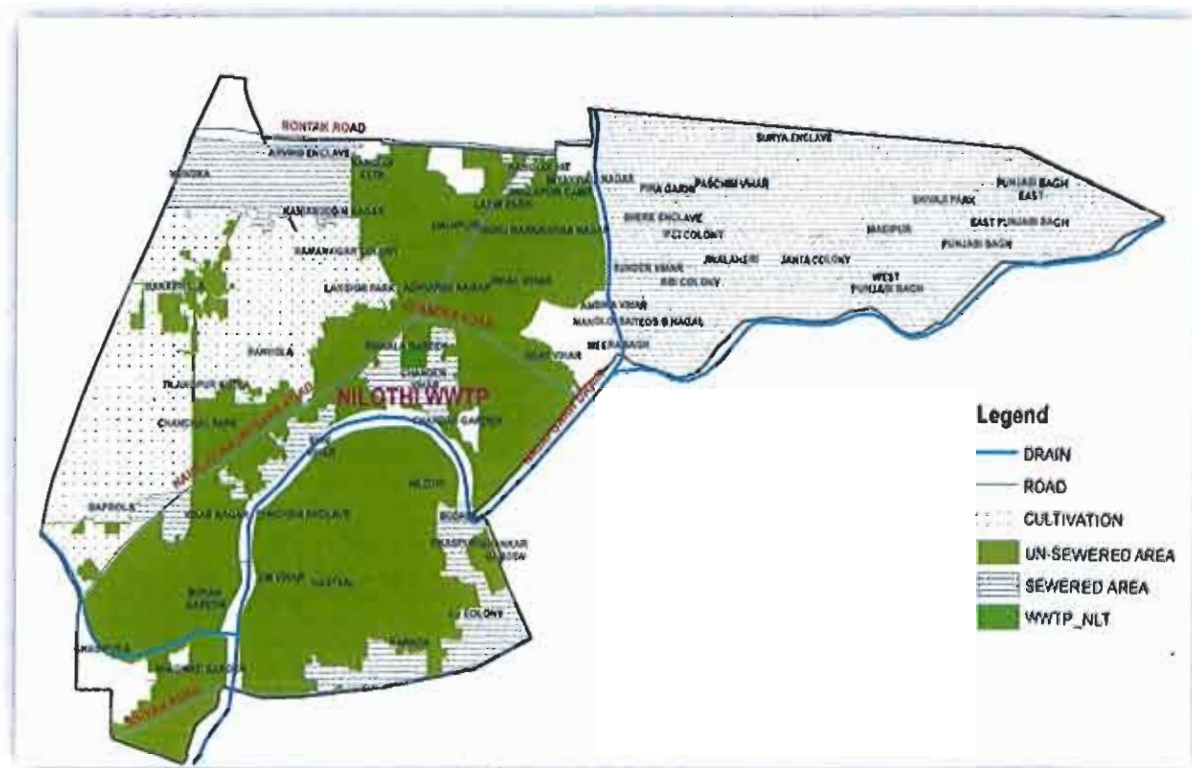


Figure 3: Sewerage Status of Nilothe Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works for capacity enhancements.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Nilothi Drainage Zone has been divided into 2 Sub Drainage Zones as below:

- Nilothi (NLT-NT1)
- Nilothi (NLT-NT2)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

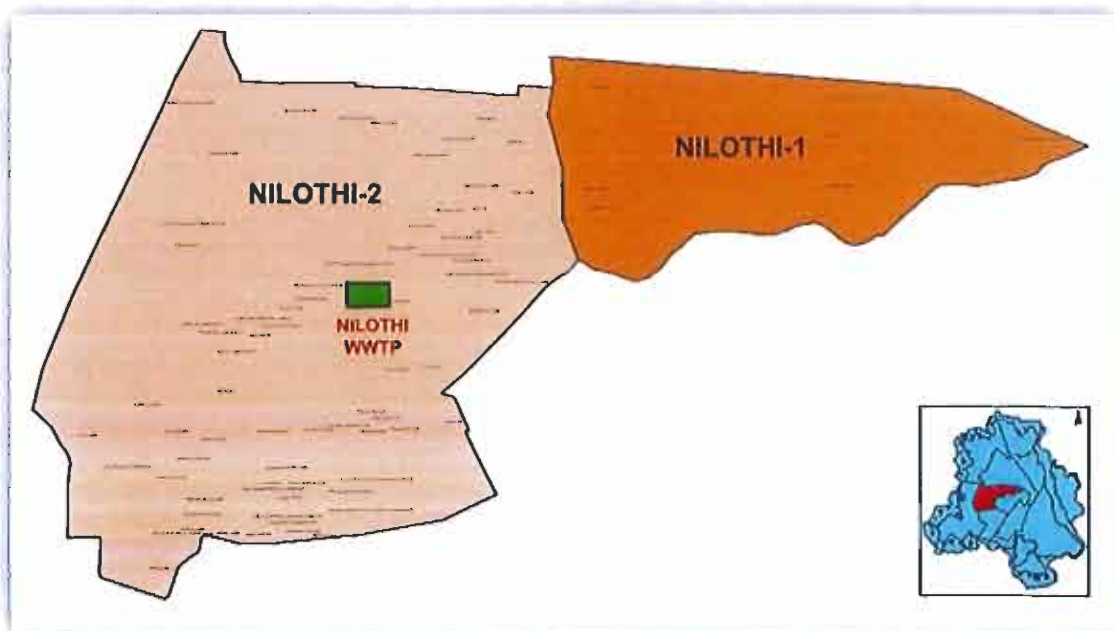


Figure 4: Sub Drainage Zone Map of Nilothi Drainage Zone (NLT)

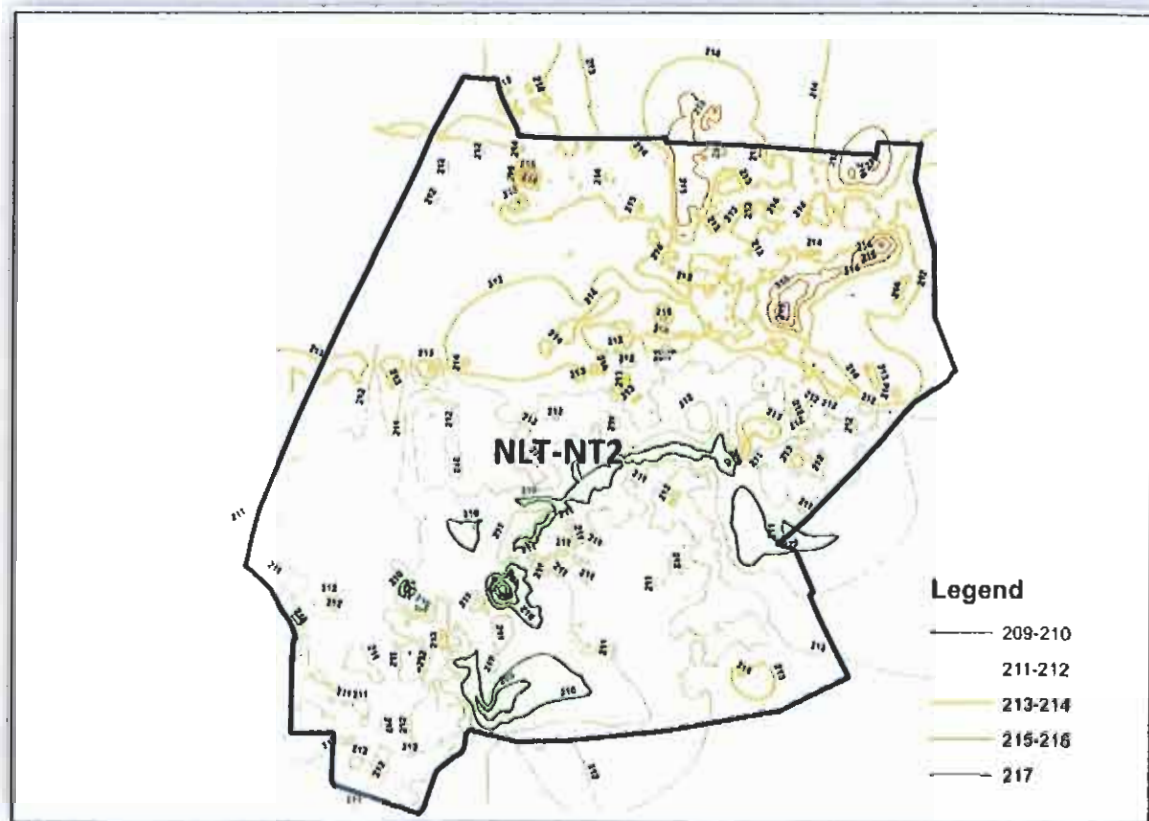


Figure 5: Contour Map of unsewered area of Nilothi Drainage Zone (NLT)

Based on population projections (Main Report), estimated sewage generation for the zone is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Nilothi Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
NLT-NT1	77.13	90.55	103.97	17.00	19.90	22.90
NLT-NT2	127.31	149.46	171.61	28.00	32.90	37.80
Total	204.43	240.01	275.58	45.00	52.90	60.70

3.1 Sub Drainage Zone: Nilothi (NLT-NT1)

This Sub Drainage Zone spread across Punjabi Bagh, Madipur, Pashchim Vihar, Pira Garhi, Jwalipuri Camp, Ambika Vihar, Nangloi Saiyed. The area is completely sewerage, contributing towards existing Nilothi WWTP of 40 MGD capacity.

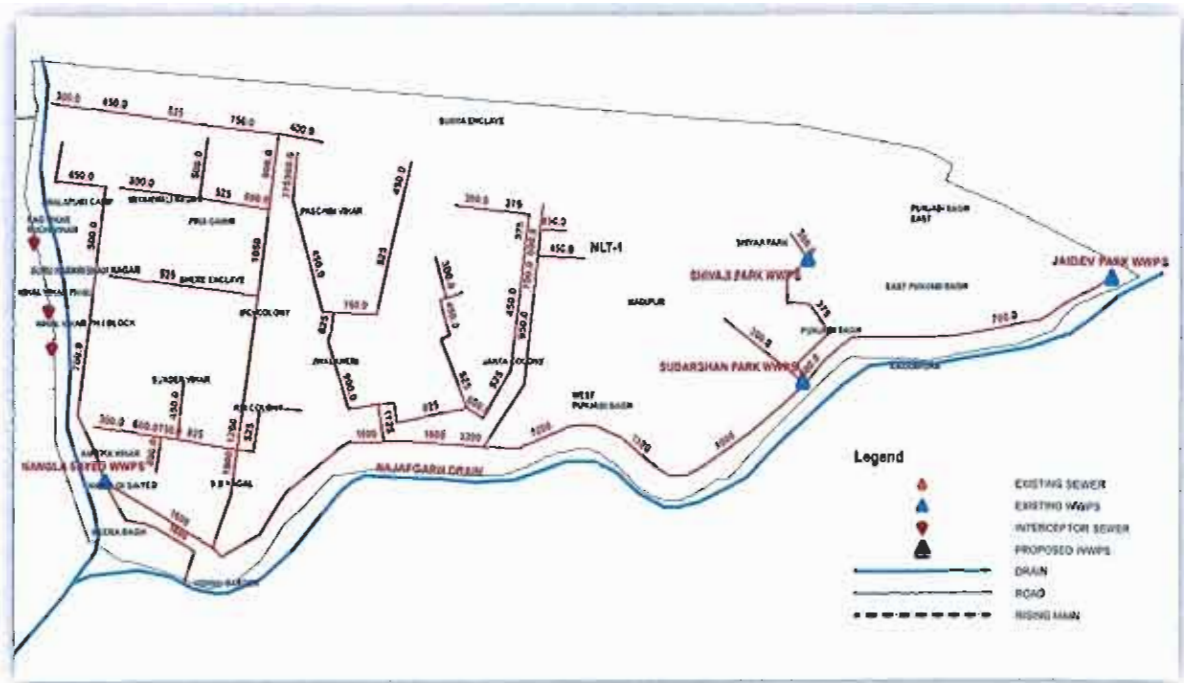


Figure 6: Land Use Map of Nilothi Sub Drainage Zone (NLT-NT1)

Existing Sewerage Infrastructure

Sewerage Network already exists in the Sub Drainage Zone. Trunk Mains in this zone have already been laid along the main roads. Sewage from this area is pumped to Niloti WWTP via Existing Nangloi Saiyed WWPS.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 7:**

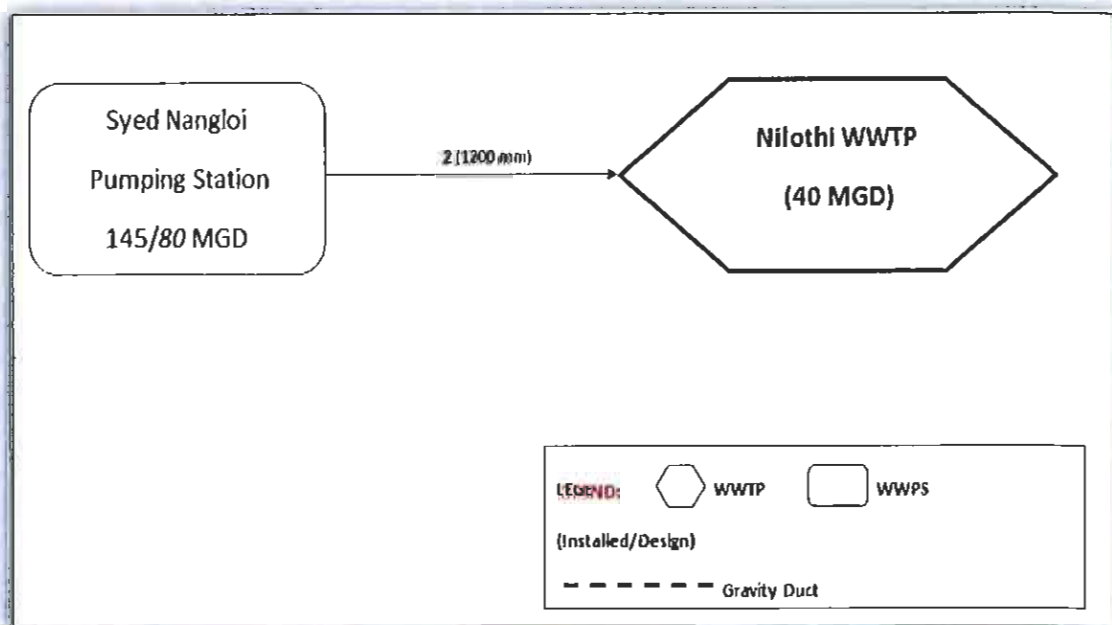


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage

3.2 Sub Drainage Zone: Nilothi (NLT-NT2)

This Sub Drainage Zone spread across Mundka, Bakkarwala, Kamruddin Nagar, Nilothi, Ranhola, Baprola, Amar Colony, Swarna Park, Nangloi Extension, Yadav Park, Mohan Garden, Siddhatri Enclave, Vipin Garden, Vikas Nagar, Vikas Vihar, Press Enclave, Vikas Enclave, Deepak Vihar, Uday Vihar, Nihal Vihar, Shiv Enclave etc. This sub drainage zone is mostly unsewered. Land use map is as shown in the **Figure 8**.

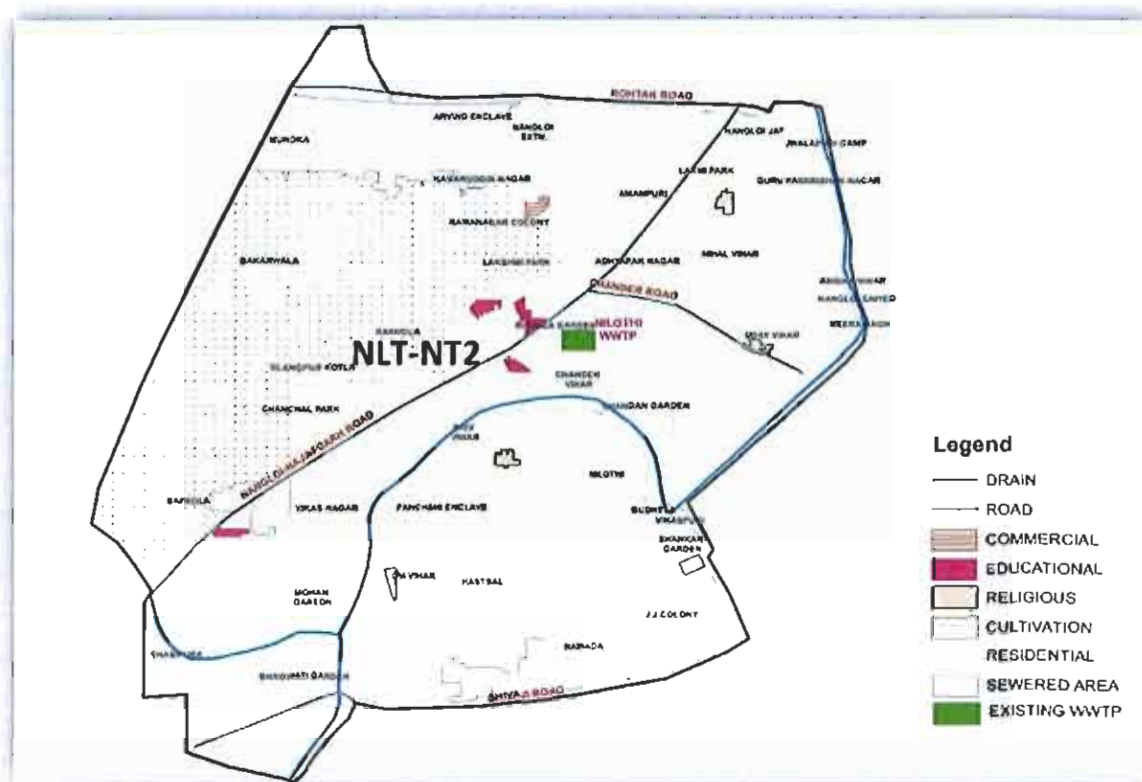


Figure 8: Land Use Map of Nilothi Sub Drainage Zone (NLT-NT2)

Existing Sewerage Infrastructure

Sewerage Network already exists in few colonies like Kamruddin Nagar, Mundka, Tyagi Colony etc. Trunk Sewer has been laid along Nangloi Najafgarh Road outfalling into existing WWPS at Nilothi. There is an existing WWTP known as **Nilothi WWTP** of 40 MGD capacity with additional proposed capacity of 20 MGD.

DJB has proposed Interceptor Sewer in this sub drainage zone. At initial stage, all sub drains outfalling into Najafgarh drain will be intercepted by this sewer, however, as the catchment of most of the drains falls within the Sub Zone, it is proposed to utilize Interceptor Sewer as trunk sewer for the sub drainage zone.

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Trunk Sewer on Nangloi Najafgarh Road is utilized to carry partial load from proposed internal sewers. However, as the capacity of existing trunk was insufficient to cater complete load of the area, one new trunk sewer has been proposed on Nangloi Najafgarh Road.

Proposed Interceptor Sewer is being utilized as trunk sewer for the Sub Drainage Zone. The hydraulic analysis shows that the capacity of Interceptor Sewer will be sufficient to cater 2031 sewage load from this sub zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 9** as below.

- The area is mostly unsewered with few isolated stretches sewerage and routed through Existing Nangloi Najafgarh Road Trunk Sewer.
- There is an existing WWTP of 40 MGD capacity with additional proposed capacity of 20 MGD.
- Sewage from part of Nangloi Extn., Shiv Ram Park, Adhyapak Nagar and nearby area is routed to Proposed Nangloi Najafgarh Road Trunk Sewer towards Existing Niloti WWPS.
- Sewage from part of Swarna Park, Kamruddin Nagar and nearby area is routed to Proposed WWPS at Kamruddin Nagar and then via rising main to proposed gravity sewer towards Proposed Niloti WWPS.
- Sewage from part of Nihal Vihar, Laxmi Park, Ram Park, Uday Vihar, Shiv Enclave, Mohan Garden, Siddharthi Enclave, Vipin Garden, Vikas Nagar, Vikas Vihar, Press Enclave, Vikas Enclave and nearby area is routed to already proposed/under construction Interceptor Sewer along Najafgarh Drain.
- Sewage from part of Jay Vihar, Baprola, Chanchal Park and nearby area is routed to Proposed Baprola WWPS and then via rising main to Niloti WWTP.

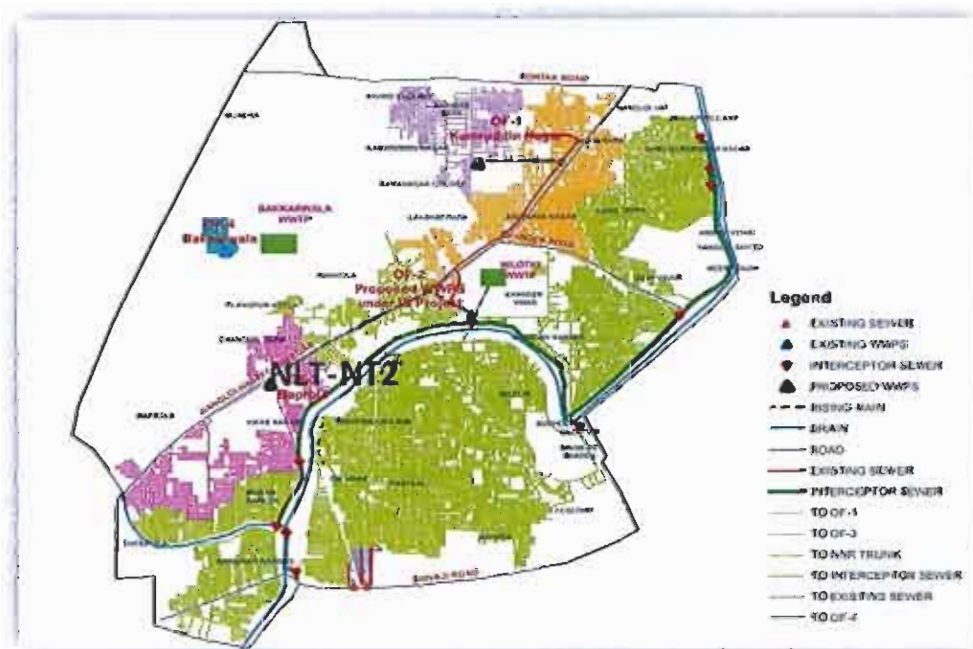


Figure 9: Scheme Map of Niloti Sub Drainage Zone (NLT-NT2)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Niloti Sub Drainage zone is shown in the **Figure 9**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	1084157
300	HDPE/DWC	11543
350	HDPE/DWC	5691
400	HDPE/DWC	15881
500	HDPE/DWC	16136
563.6	HDPE/DWC	5372
635.2	HDPE/DWC	4077
700	RCC NP3/NP4	5270
800	RCC NP3/NP4	2465
900	RCC NP3/NP4	1738
1000	RCC NP3/NP4	1336
1100	RCC NP3/NP4	2334
Total		1156000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 10**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

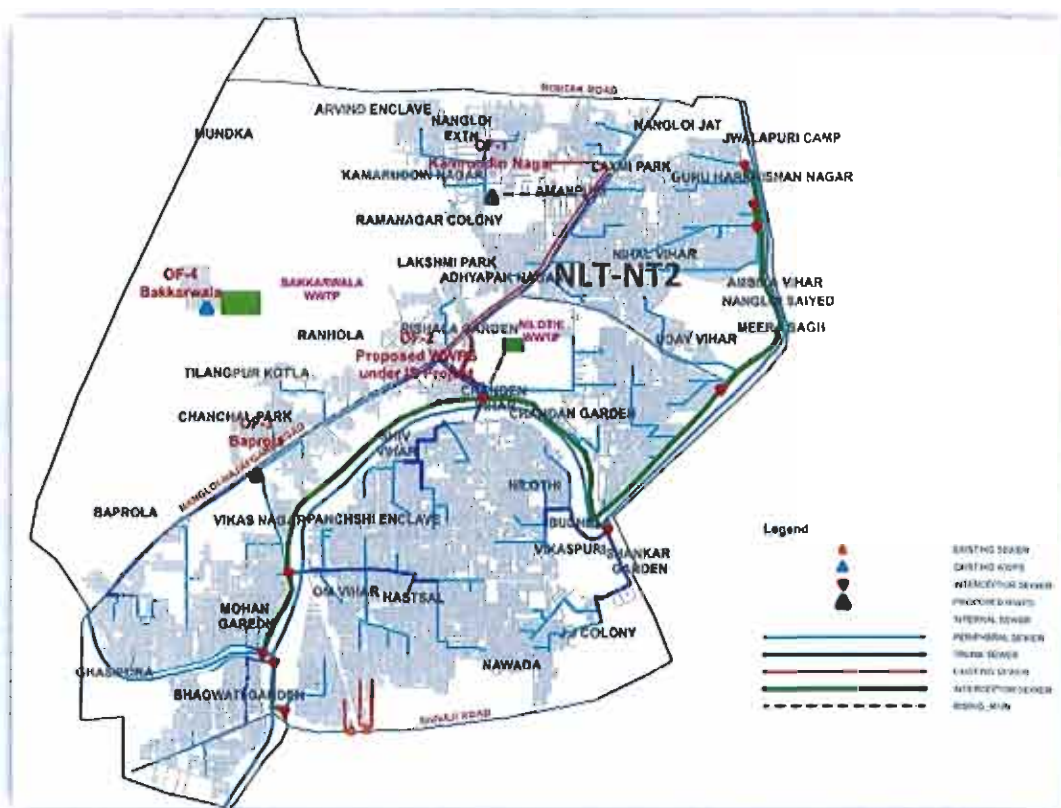


Figure 10: Proposed Sewerage Infrastructure of Nilothi Sub Drainage Zone (NLT-NT2)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Kamruddin Nagar	WWPS	5.50	600	1	1200	NNR Trunk
2	Baprola	WWPS	10.00	800	1	3600	Nilothi WWTP

Waste Water Treatment Requirements

The existing 40 MGD WWTP with additional proposed capacity of 20 MGD was found to be sufficient to cater anticipated sewage load for design year 2031 from the sub drainage zone. No additional treatment capacity has been proposed for this Sub Drainage Zone.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 4**.

Table 4: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Nilothi	NLT-NT1	-	-	-	-
Nilothi	NLT-NT2	922	2	-	-

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 5**.

Table 5: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Nilothi	Nilothi	-	-	Kamruddin Nagar	WWPS	5.5	2500.0
				Baprola	WWPS	10.0	2814.0

Line Diagram for Proposed WWPS and WWTP for Nilothi is shown in **Figure 11**:

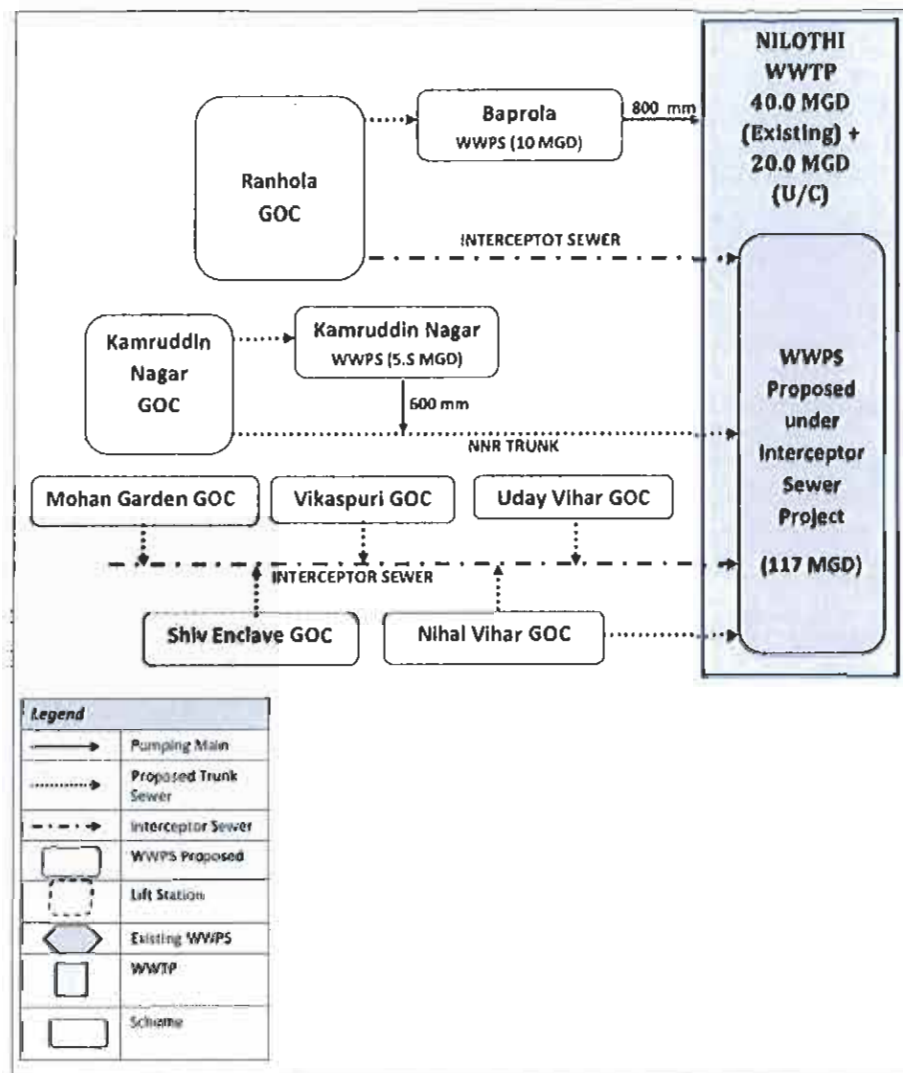


Figure 11: Line Diagram for Proposed WWPS and WWTP for Nilothi Drainage Zone

Line Diagram for Proposed WWPS and WWTP for Bakkarwala is shown in **Figure 12**:

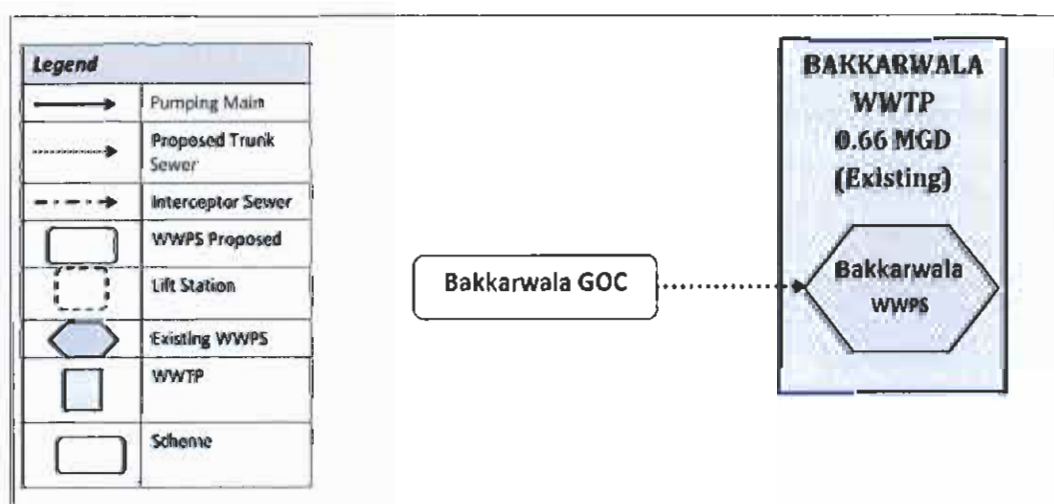


Figure 12: Proposed Sewerage Scheme for Nilothi Sub-Drainage Zone (Bakkarwala WWTP)

Disposal of Treated Effluent

Current practice of disposal is to discharge it to Irrigation Canal and Najafgarh drain.

Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be MCD, DMRC, and DDA. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Nilothi Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 13 & 14**.

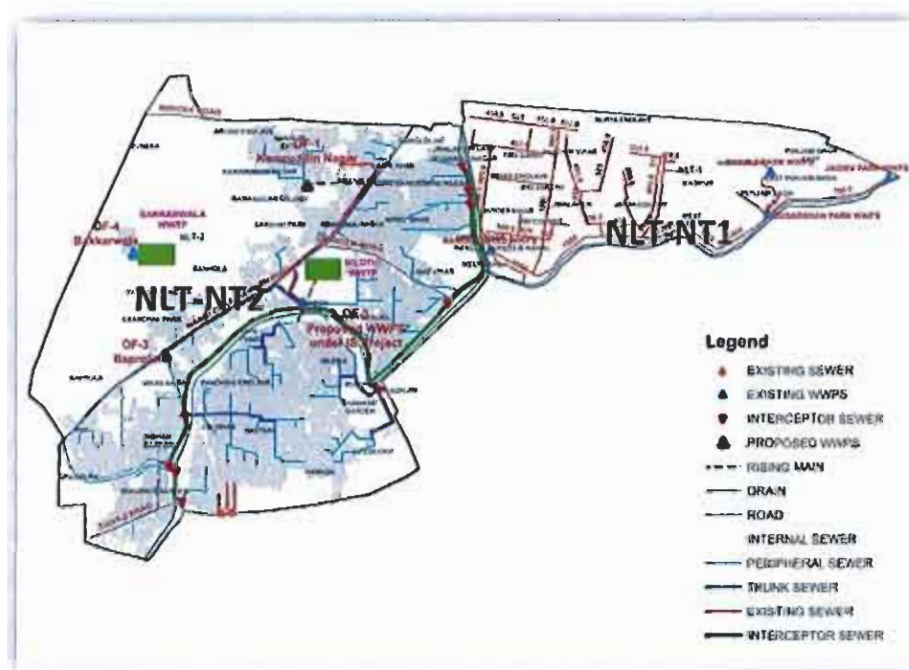


Figure 13: Proposed Sewerage Scheme for Nilothi Drainage Zone

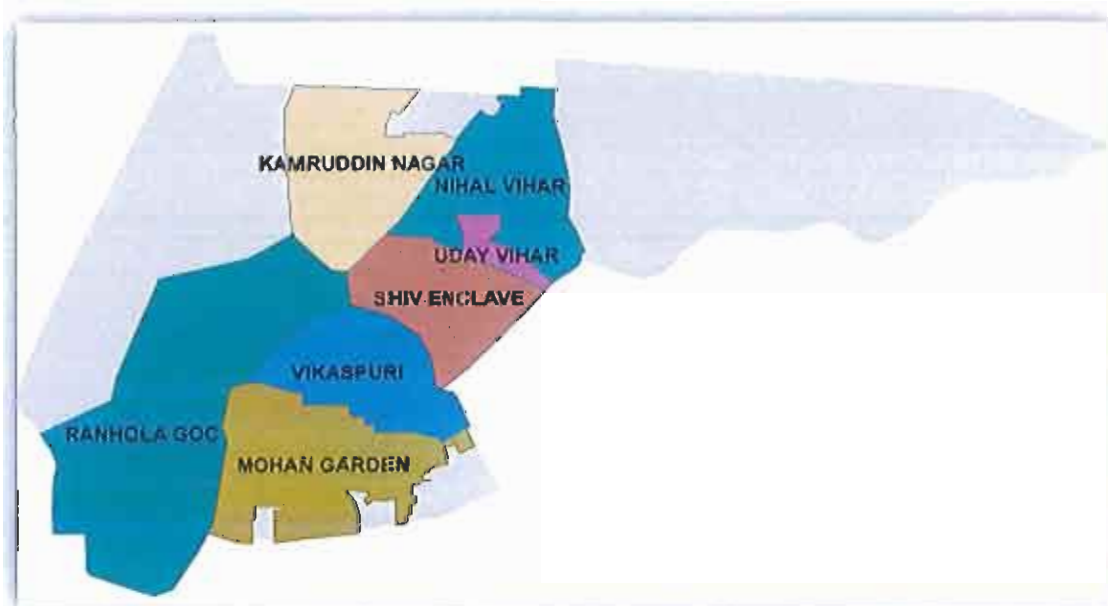


Figure 14: GOC-wise Sewerage Schemes – Nilothi Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 6: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-2031
1	Nilothi	NT2	NLT-NT2-KMR	Kamruddin Nagar				
2	Nilothi	NT2	NLT-NT2-MG	Mohan Garden				
3	Nilothi	NT2	NLT-NT2-VP	Vikaspuri				
4	Nilothi	NT2	NLT-NT2-UV	Uday Vihar				
5	Nilothi	NT2	NLT-NT2-SE	Shiv Enclave, Nilothi				
6	Nilothi	NT2	NLT-NT2-NNR	NNR Trunk Sewer				
7	Nilothi	NT2	NLT-NT2-NV	Nihal Vihar				
8	Nilothi	NT2	NLT-NT2-RN	Ranhola GOC				

Table 7: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Ranhola GOC	Partap Vihar, Safipur Ranhaula najafgarh road, Nangloi Meera Enclave, Ranhola Village, New Delhi-41 Akash vihar Ranholla Nangloi Najafgarh Road Delhi-41 Akash Vihar, Baprola, Chanchal Park, Bakkarwala More, New Delhi-43 Ganga Ram Park, Village Ranhola, Nangloi, New Delhi-41 Nathan Vihar, Village Ranhola, New Delhi-41 Ranhaula Vihar, Nangloi, New Dehli-41
2	Kamruddin Nagar	Amar Colony Ph II& III, Rohtak Road, Nangloi, Delhi Amar Colony, C & N Block, Mundka, Nangloi, Delhi-41 Amar Colony Ph-II, Mundka Nangloi, Delhi-41 Amar Colony(C D E & K Block) Rohtak Road Amar Colony, ABC Block, Mundka, Nangloi, Delhi-41 Amar Colony, A-Block, Rohtak Road, Nangloi, Delhi Yadav Park Extn Najafgarh Road Nangloi Delhi-41 Nangloi Extn, II-C, Delhi-41 Nangloi Extn., 1-C, Delhi-41 Nangloi Extn., D-Block West (2-D), Delhi-41 Nangloi Extn., IV Block-ABC, Nangloi, Delhi-41 Nangloi Extn.-1-B, Delhi-41 Nangloi Extn.-2, Block-A, Nangloi, Delhi-41 Nangloi, Extn., 2-B, Nangloi, Delhi-41 Swarn Park & Swarn Park Extn., Part 1&2 Swarn Park Extn.-II, Mundka, Delhi-41 Kamruddin Nagar Kamrudin Nagar, Extn.-III, Najafgarh Road, Delhi-41 Village Kamruddin Nagar Nangloi Delhi 41
3	Nihal Vihar	Adhyapak Nagar Block A B C Nangloi Adhyapak Nagar Block D E F, Najafgarh Road, Delhi Adhyapak Nagar G,H, I, J, K block, Nangloi, Delhi-41 Nihal Vihar Ph-I Block A B C D E F G H Q S K I K2 Nangloi Jat, Delhi-41 Nihal Vihar Ph-III Nangloi Jat Delhi-41 Nihal Vihar, Nangloi Jat, Delhi Hanuman Enclave Nangloi Delhi-41 Vandana Vihar, Nangloi Shiv Park, Jwala Puri Road, Nangloi, Delhi-41 Rao Vihar, Nangloi, Delhi-41 Laxmi Park Ranhola Extn. Ph-I, Nangloi, Delhi-41 Laxmi park Nangloi Delhi-41 Shri Ram Colony, Nilothi Extn., Nangloi, Delhi-41 Shiv Vihar, ABCDE-Block, Nilothi Extn. Nangloi Shiv Ram Park (Kamruddin Nagar) Najafgarh road, Nangloi Shiv Ram Park B-1 Block Nangloi Najafgah Nangloi Road Delhi-41

Sl. No.	Name of GOC	Name of Colonies
		Shiv Ram park Ext.Nangloi Najafgarh Road Delhi-41 Shiv Ram park J- Block Nangloi Delhi-41 Shiv Ram Park, Block E1, E2 Nangloi, Delhi-41 Shiv Ram Park, DEF Block, Najafgarh Road, Nangloi, Delhi -41(LOP) Shiv Ram Park,Nangloi, G H Block, New Delhi-41
4	Uday Vihar	Uday Vihar
5	Shiv Enclave	Vijay Laxmi Park, Nilothi, Ext. Delhi-41 Teck Chand Colony Main Road village Nilothi, Delhi Village Nilothi Nangloi New Delhi 41 Nilothi Extn.Nangloi Delhi-41
6	Vikas Puri	Vikas Kunj Raza Pur Khurd No. -1, Mohan Garden, New Delhi - 59 Hastsal Extn.Vikas Nagar Uttam Nagar Delhi-59 Vidya Vihar, Hastsal, New Delhi-59 C-Block & C-Block Extn., Vikas Nagar, Uttam Nagar Raj Hansh Vihar
7	Mohan Garden	Zaildar Enclave, Mohan Garden, Uttam Nagar, Delhi-57 Laxmi Vihar Block ABC Main Najafgarh Road , Near DTC Bus Depot. Maharani Enclave Uttam Nagar New Delhi-59 Mohan Garden E F G H I J K F1,F2 & W E Block Uttam Nagar,Delhi Mohan Garden Extn.,A-Block Uttam Nagar Mohan Garden 'B' Extn. Village Nawada Majra, Uttam Nagar Mohan Garden Block A-3 Uttam Nagar New Delhi Mohan garden C- Block Uttam Nagar Delhi-59 Mohan Garden D Block Extn.Uttam Nagar Delhi-59 Mohan Garden Defence Enclave Part-II Uttam Nagar, New Delhi. Mohan Garden G-Block Extn.,R.K. Block Extn., Bhagwati Garden Extn. R.K. Block, Mohan Garden, G-Block, Bhagwati Garden Extn., village Nawada Mohan Garden K1 Extn,Uttam Nagar , Delhi Mohan Garden L, L-9, L1-A, Uttam Nagar Mohan Garden L2 A Block Uttam Nagar , Delhi Mohan Garden L-II Block Uttam Nagar Delhi-59 Mohan Garden Block R Extn.K- 5,K-6, Delhi-59 Mohan Garden Block,A-1,Q1 Q J K & Bhagwati Garden Extn Block E Delhi-57 New Sainik Vihar Mohan Garden, Uttam Nagar, New Delhi-59 Sainik Enclave,Vikas Nagar, Uttam Nagar, Hastal, New Delhi-59 Vikas Kunj Sainik Vihar Mohan garden,Delhi Mohan garden R-III, A-2, Block, R-III A2 Extn., (Shankar Vihar R-4), Mohan garden, Uttam Nagar New Delhi Mohan Nagar Pankha Road New Delhi 46 Om Vihar Extn. E, E-I, F Block Uttam Nagar N.D Om Vihar(LOP), Ph-IV, &V Extn., Uttam Nagar New Delhi-59

Sl. No.	Name of GOC	Name of Colonies
		Om Vihar Ph- III, A,B,D Block & Phase III Extn. Uttam Nagar New Delhi 59 Om Vihar Park-IA , Shiv Shankar Road Uttam Nagar New Delhi-59 Om Vihar Ph-IV, Uttam Nagar New Delhi 59 Om vihar Phase-1 to 4 Uttam Nagar New Delhi-59
8	Bakkarwala GOC	Bakkarwala

ANNEXURE - 8

DWARKA DRAINAGE ZONE (DWK)

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DWARKA DRAINAGE ZONE (DWK)

1. INTRODUCTION

Dwarka Drainage Zone is bounded by Najafgarh Drain towards west, Shivaji Marg towards North, Railway line and boundary of Airport and Cantonment towards East and Delhi/Haryana Border in South. The Zone is mainly residential in nature, consists of neatly planned DDA Sectors towards South and mostly unauthorized colonies towards North of the Zone. Location of Dwarka Drainage Zone is shown in the *Figure 1*.

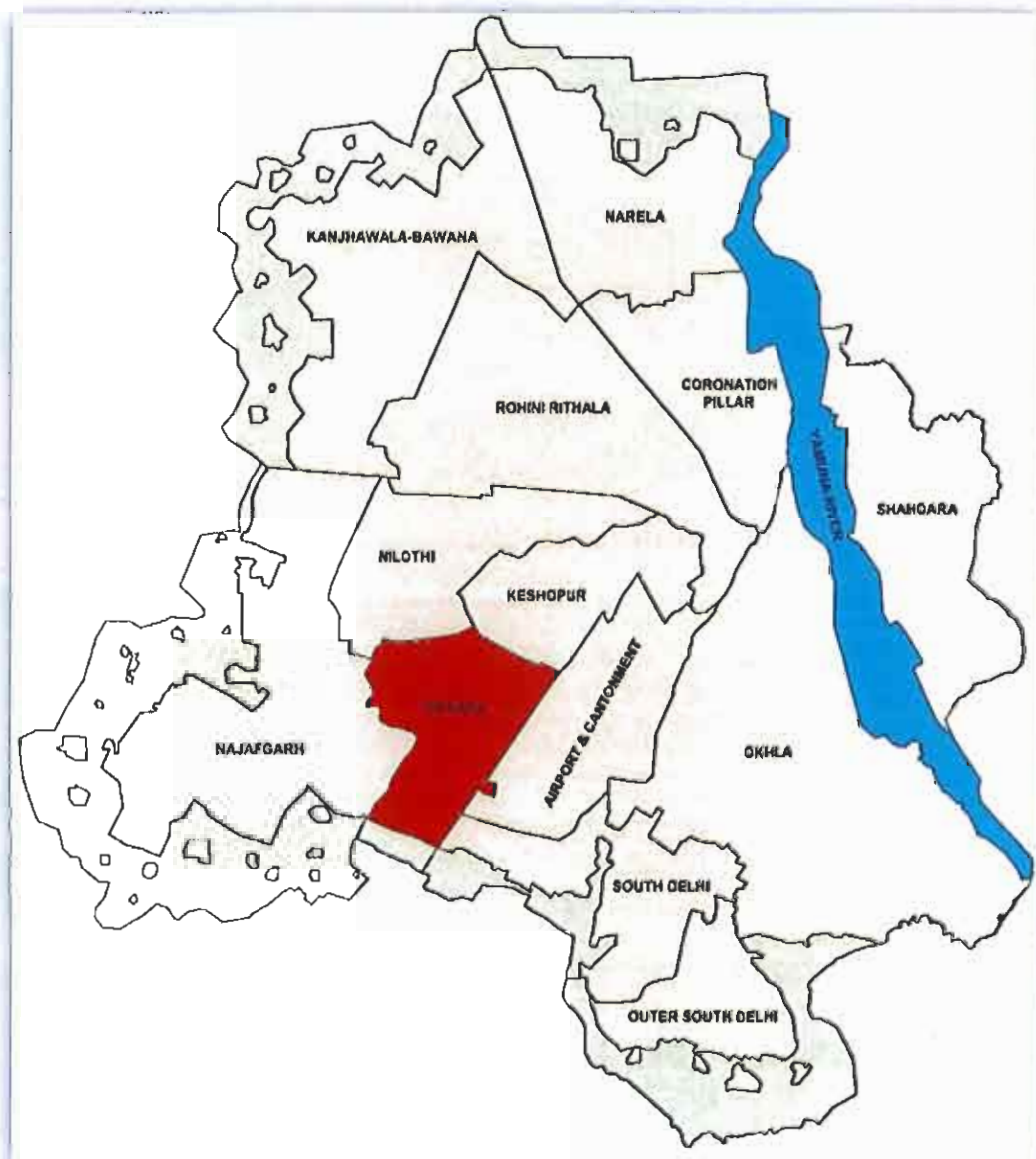


Figure 1: Dwarka Drainage Zone

DDA has developed a township extending over an area of 5600 Ha. The Zone consists of DDA planned sectors in most of the area, with few unauthorized colonies like Bindapur, Mahaveer Enclave, Sagarpur, Vijay Enclave, Raj Nagar, Madhu Vihar etc. This Drainage Zone falls under DDA Zone K-II and G as shown in the *Figure 2*.

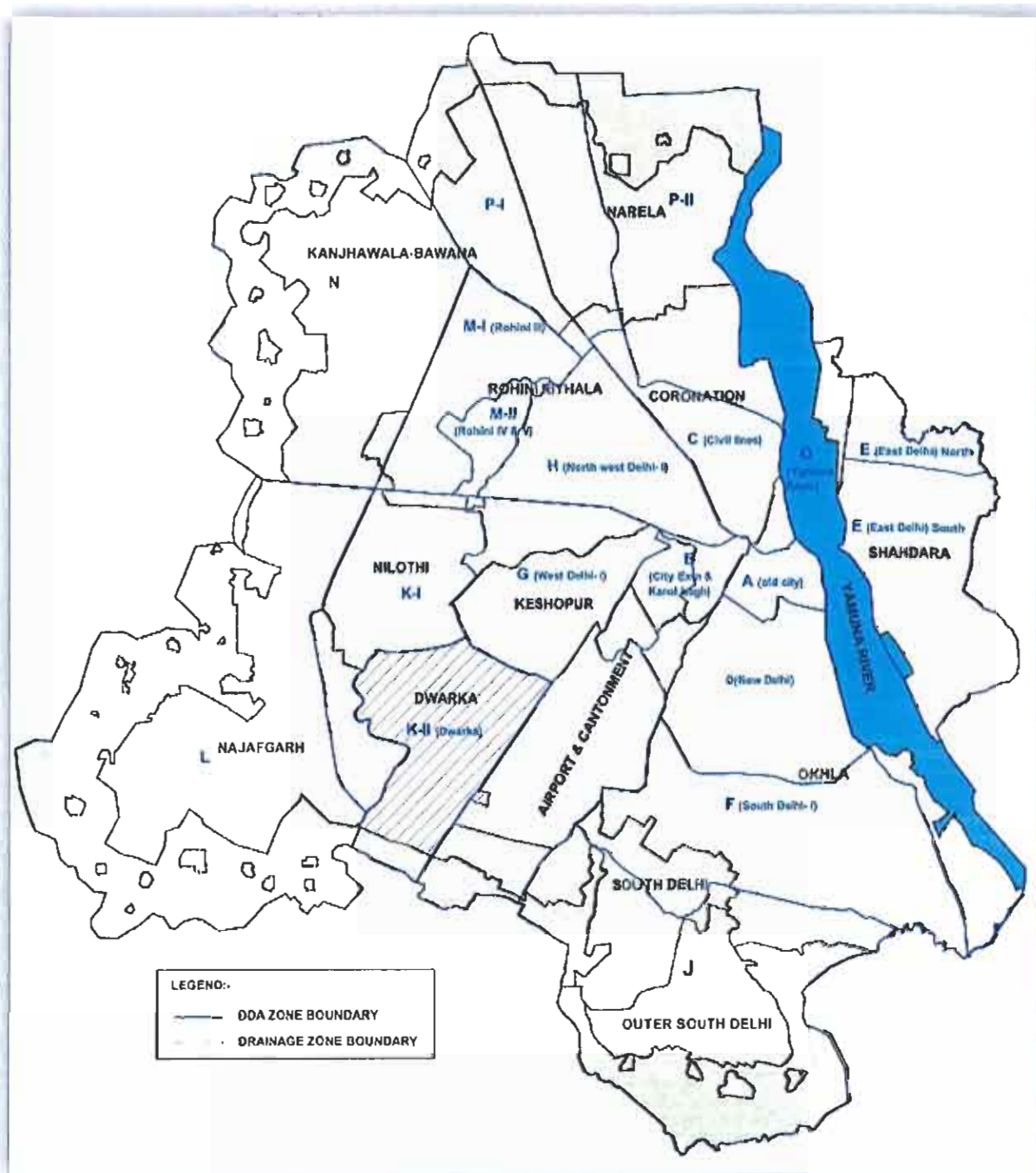


Figure 2: DDA Zones and Dwarka Drainage Zone

Soil Description of Dwarka

In This zone is fully covered with older alluvium deposits. Dwarka zone is having Moderate hazard due to High Amplification & Liquefaction and this factor is due to South Najafgarh sedimentary fill (Dabar). 80% of this area is covered with water depth of 10-20m. The major areas under this portion are Uttam Nagar, Sanjay Enclave, Dwarka sector 11, Dwarka sector 25, Dwarka sector 14 etc. Whereas 20% of this area is having water depth ranging from 20-40m. Those areas are Palam, Raj Nagar, Bhartal, ManglaPuri, Sagar Pur, Sector 26 etc. In This zone 60 % of the portion is covered with Bangar soil (Palam, Mahavir enclave, Durga colony, Uttam Nagar, Sanjay Enclave etc.) & 20 % of the portion with Dabar soil (Dawarka sector 14, 15, Pappankala, Dhul Siras only).

2. MASTER PLANNING FOR DWARKA DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The Drainage Zone is partially sewered. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

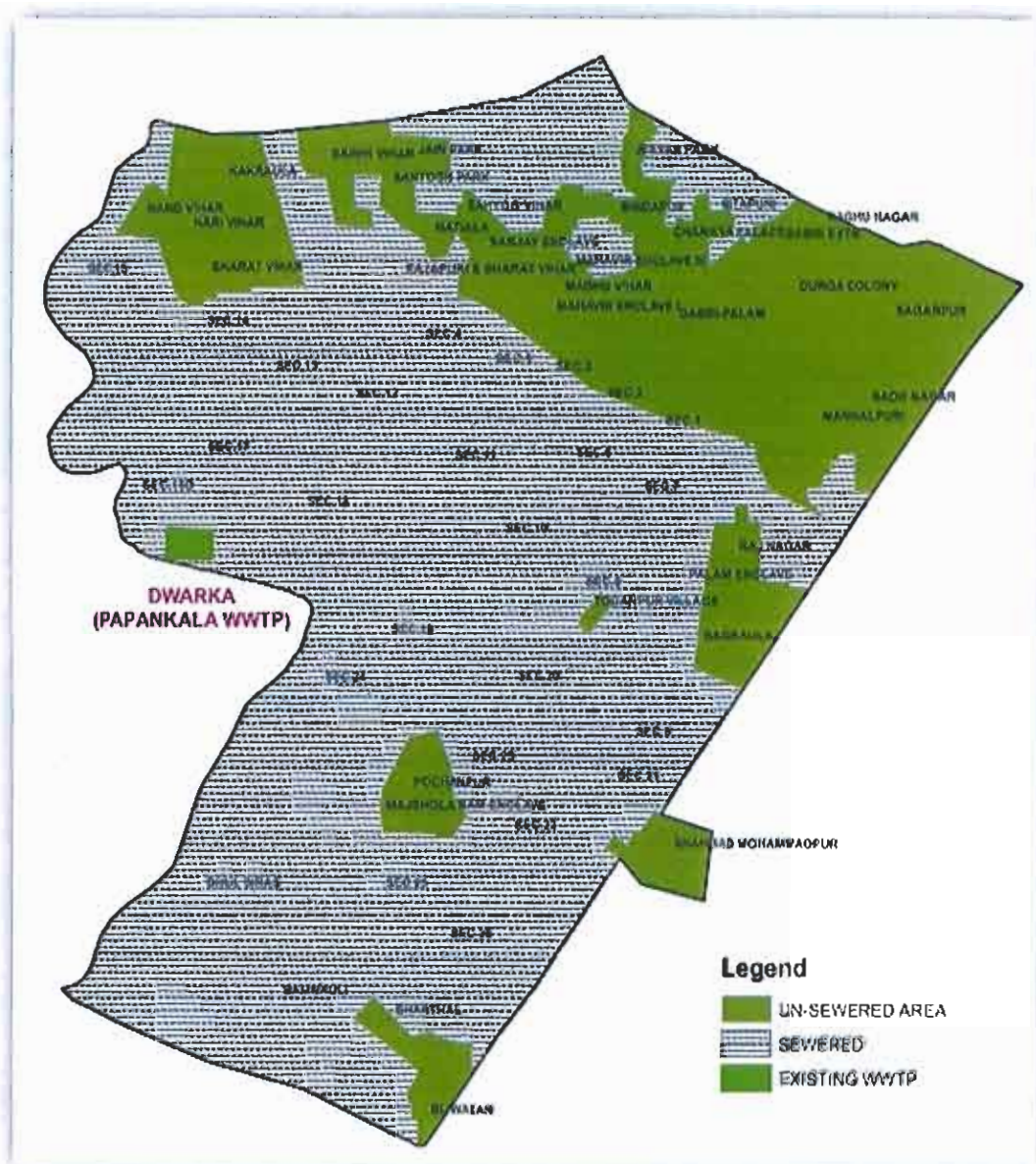


Figure 3: Sewerage Status of Dwarka Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load

- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Dwarka Drainage Zone has been divided into 2 Sub Drainage Zones as below:

- Dwarka 1 (DWK-DK1)
- Dwarka 2 (DWK-DK2)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

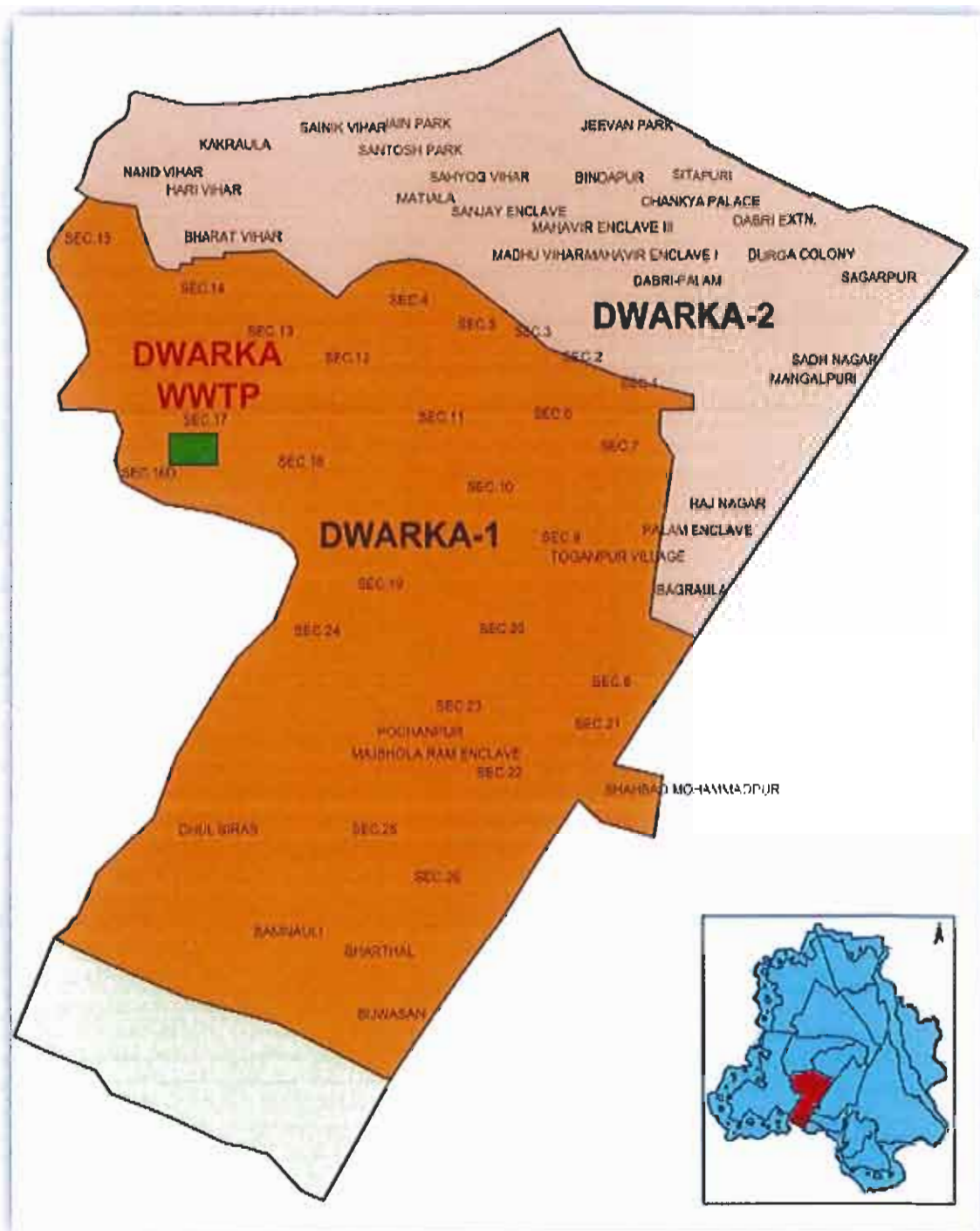


Figure 4: Sub Drainage Zone Map of Dwarka Drainage Zone (DWK)

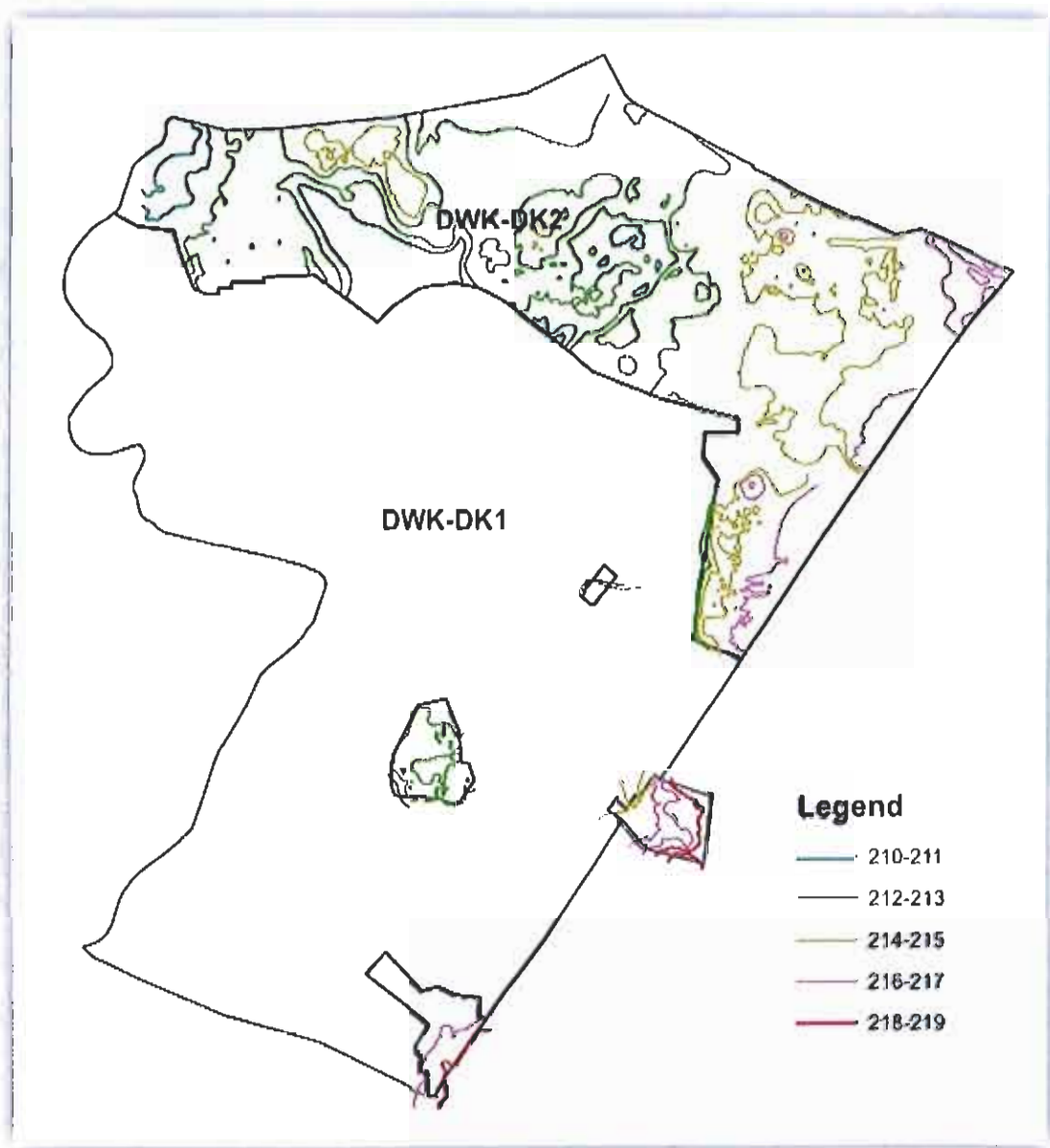


Figure 5: Contour Map of Dwarka Drainage Zone (DWK)

Based on population projections Sub-Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Dwarka Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
DWK-DK1	124.91	160.04	195.17	27.50	35.30	43.00
DWK-DK2	49.45	63.35	77.26	10.90	14.00	17.00
Total	174.35	223.39	272.43	38.40	49.20	60.00

3.1 Sub Drainage Zone: Dwarka 1 (DWK-DK1)

This Sub Drainage Zone spread across Planned Sectors of DDA with few unsewered pockets in between. Major portion of Dwarka sub drainage zone is sewered and there is an existing WWTP. Land use map is as shown in the **Figure 6**.

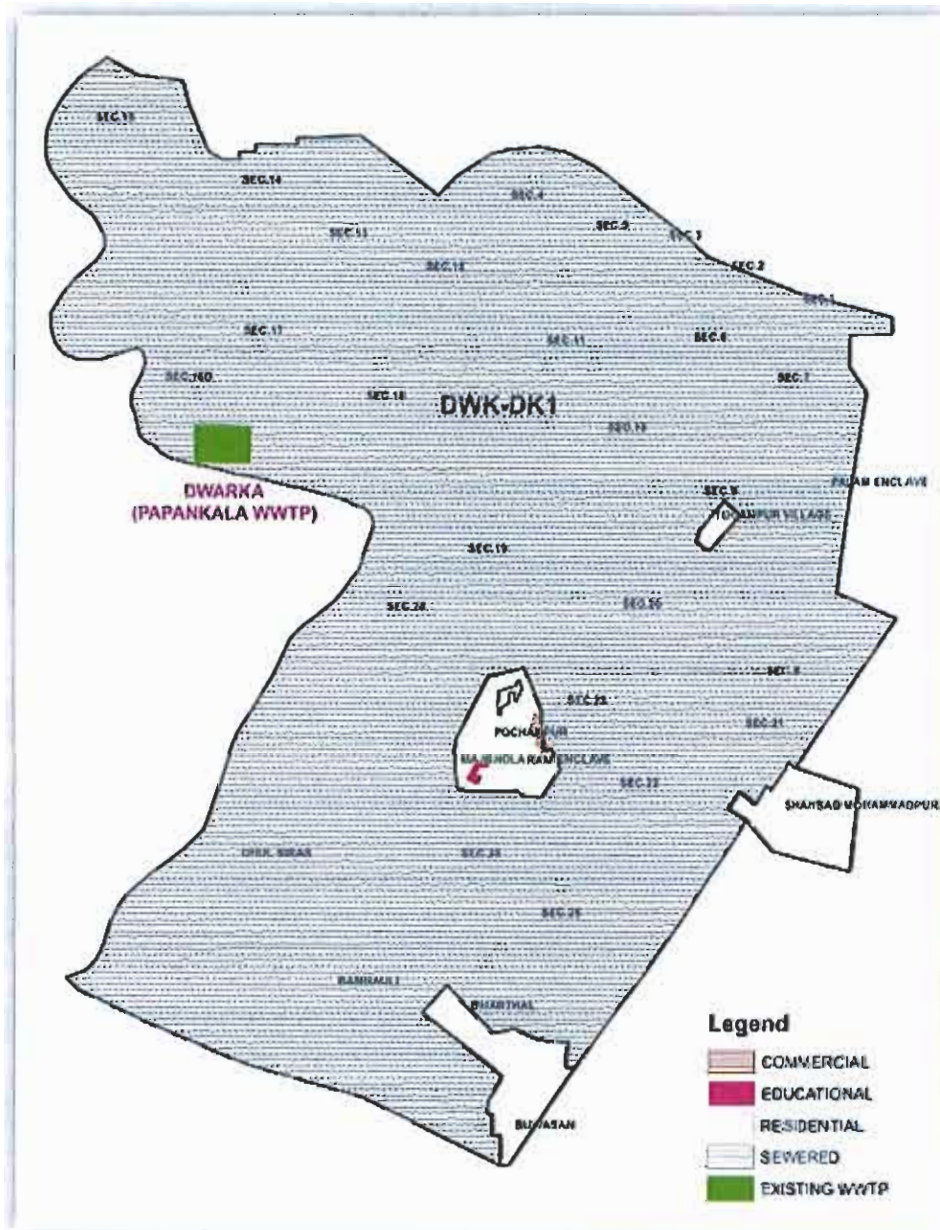


Figure 6: Land Use Map of Dwarka Sub Drainage Zone (DWK-DK-1)

Existing Sewerage Infrastructure

Most of the area in the Sub-Drainage Zone is sewered. The sub drainage zone has existing WWTP with 20 MGD capacity. Another WWTP of 20 MGD capacity is under construction and is likely to be commissioned June / July, 2014.

The details of existing WWPS and their integration arrangement have been shown in the line diagram as **Figure 7**.

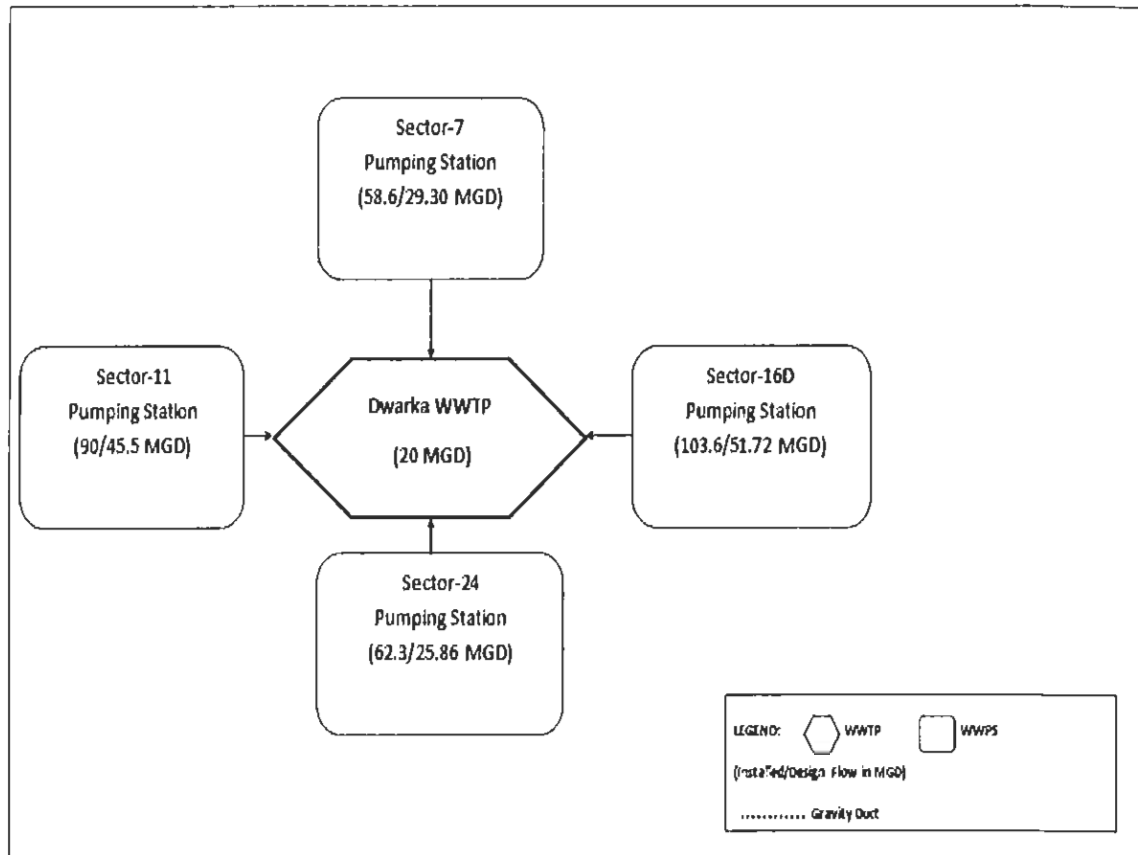


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned in such way that ultimate utilization of existing assets is considered while planning the scheme for sub-drainage zone. Sewerage network for unsewered colonies are planned considering integration with existing sewerage assets along with optimum utilization of the same.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 8**.

- Major portion of Dwarka sub drainage zone is sewerage.
- Sewage from Toganpur is routed to existing Sector 11 WWPS.
- Sewage from Pochanpur, Bijwasan and Shahbad Mohdpur is routed to existing Sector 24 WWPS.

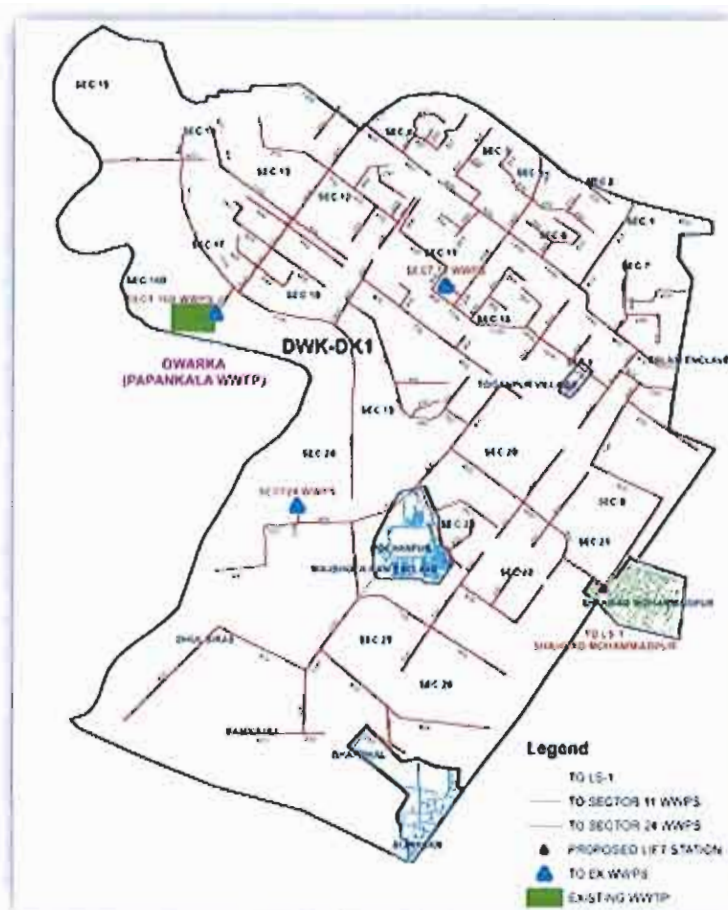


Figure 8: Scheme Map of Dwarka Sub Drainage Zone (DWK-DK1)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Dwarka Sub Drainage zone is shown in the **Figure 9**.

Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	33503
300	HDPE/DWC	1114
400	HDPE/DWC	1210
500	HDPE/DWC	1173
Total		37000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 9** below. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

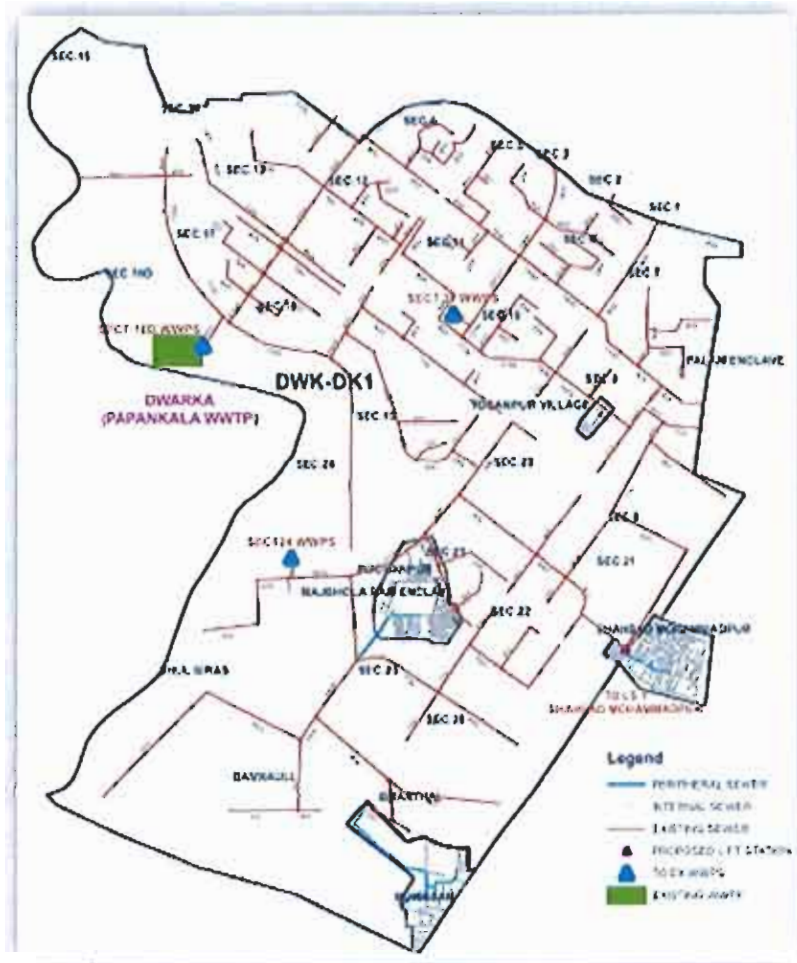


Figure 9: Proposed Sewerage Infrastructure of Dwarka Sub Drainage Zone (DWK-DK1)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Shahbad Mohd Pur	LS	2.00	400	1	30	Nearest Manhole

Waste Water Treatment Requirements

The combined capacity of 40 MGD will be sufficient to cater the sewage generated from entire Drainage Zone for Phase I. Additional Capacity of 20 MGD is proposed for Phase 2. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Dwarka 2 (DWK-DK2)

This Sub Drainage Zone spread across Kakrola, Sainik Vihar, Rajapuri, Bindapur, Madhu Vihar, Mahaveer Enclave, Durga Colony, Sadh Nagar, Sagarpur, Dabri Palam etc. Area is partially sewered and sewered portion is discharging sewage to Dwarka WWTP (DWK-DK1). Land use map is as shown in the **Figure 10**.

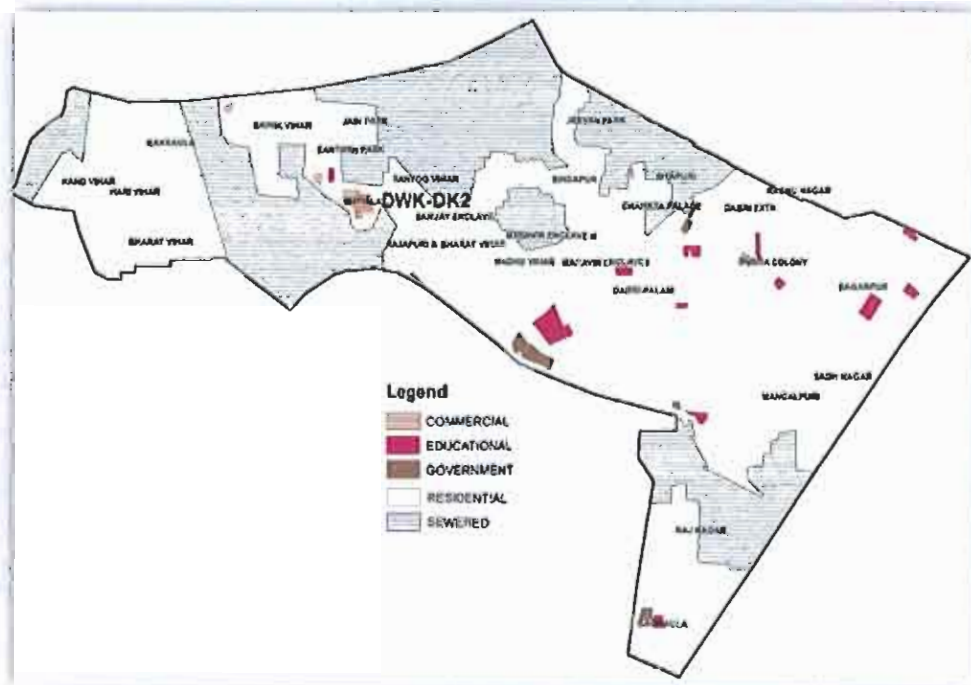


Figure 10: Land Use Map of Dwarka Sub Drainage Zone (DWK-DK2)

Existing Sewerage Infrastructure

The Sub Drainage Zone is partly sewered. Trunk Sewer from Durga Colony, Dabri Palam and Sagarpur is routed to Existing Palam WWPS. Trunk Sewer from Chanakya Place, Mahaveer Enclave is routed to recently commissioned Jeevanpark WWPS. West portion of the Sub Zone have trunk sewers routed towards Existing WWPS at Sector 11 and 16D. All WWPS's ultimately discharge into Dwarka WWTP under Sub Drainage Zone DWK-DK1.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 11**:

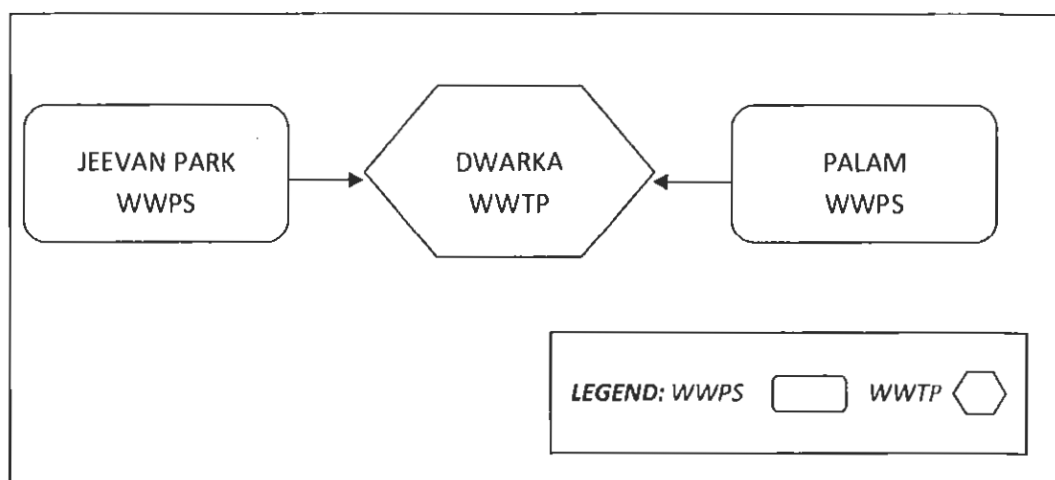


Figure 11: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 12**.

- Area is partially sewered and sewered portion is discharging sewage to Dwarka WWTP (DWK-DK1)
- Sewage from Kakrola, Sainik Vihar, Rajapuri and nearby area is routed to Existing Trunk Sewer towards Sector 16D WWPS.
- Sewage from Madhu Vihar, Raj Nagar, Bagraula and nearby area is routed to Existing Trunk Sewer towards Sector 11 WWPS.
- Sewage from Bindapur, Sitapuri, Chanakya Place and nearby area is routed to Existing Jeevanpark WWPS.
- Sewage from Dabri Palam, Durga Colony, Sagarpur, Sadhnagar and nearby area is routed to Existing Trunk Sewer towards Palam WWPS.

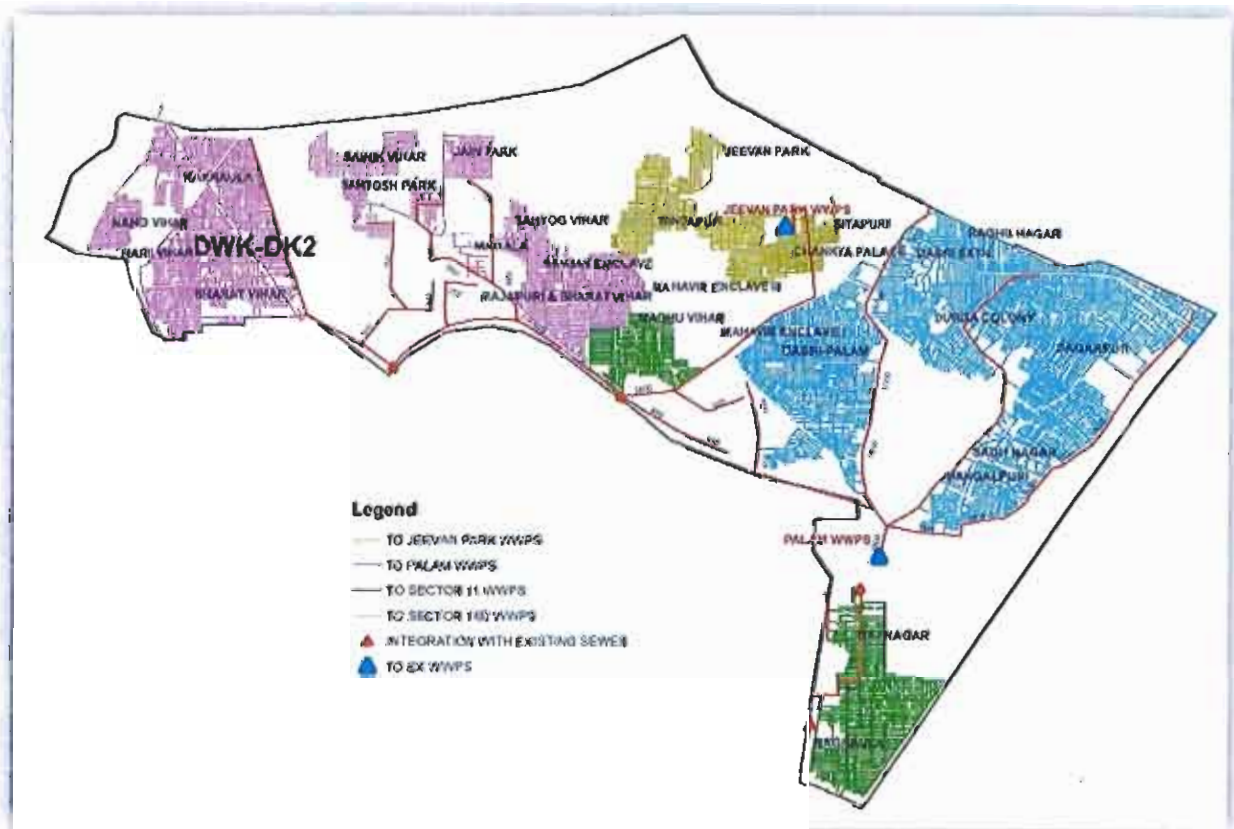


Figure 12: Scheme Map of Dwarka Sub Drainage Zone (DWK-DK2)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Dwarka Sub Drainage zone is shown in the **Figure 12**.

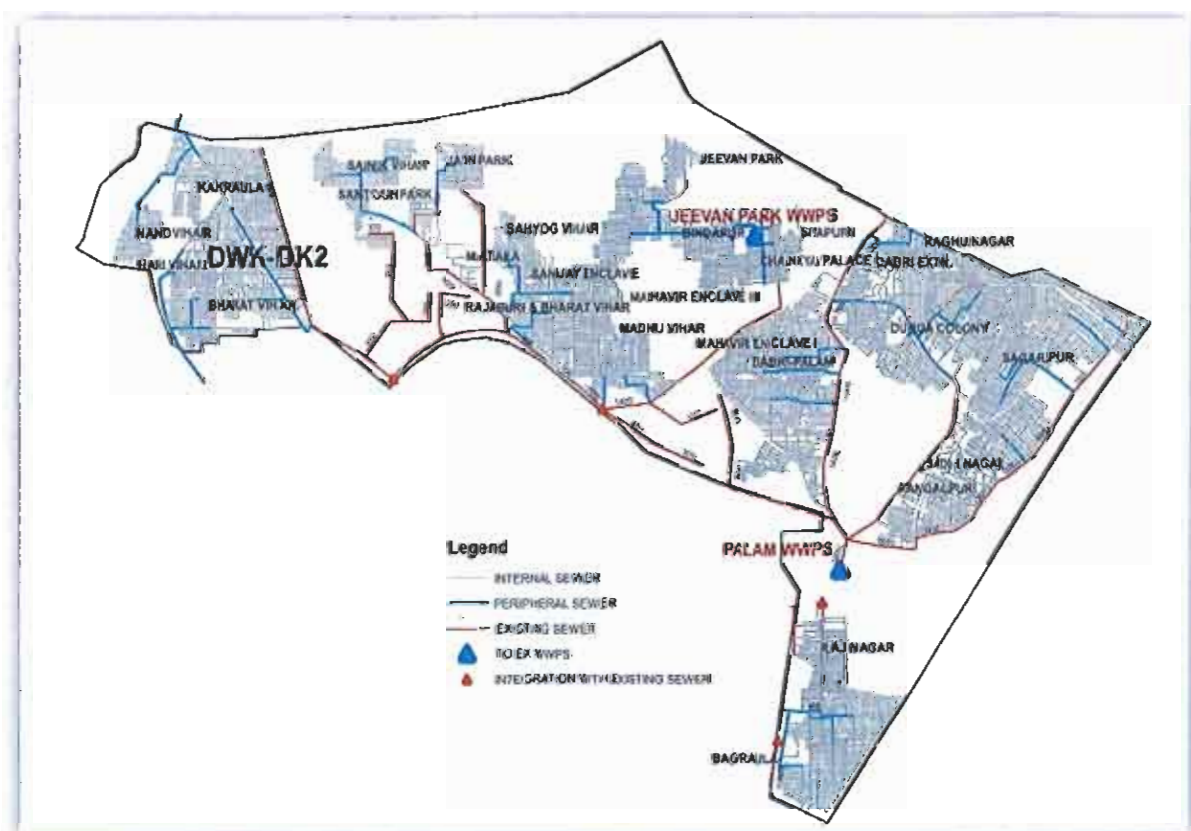
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Table 4: Proposed Gravity Sewerage Network - Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	613480
300	HDPE/DWC	7232
350	HDPE/DWC	1314
400	HDPE/DWC	4741
500	HDPE/DWC	4261
563.6	HDPE	2007
635.2	HDPE	1965
Total		635000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 13**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

**Figure 13: Proposed Sewerage Infrastructure of Dwarka Sub Drainage Zone (DWK-DK2)**

Waste Water Pumping Requirements

No additional Pumping Stations have been proposed for unsewered pockets of Sub Drainage Zone.

Waste Water Treatment Requirements

The combined capacity of 40 MGD will be sufficient to cater the sewage generated from entire Drainage Zone for Phase I. Additional Capacity of 20 MGD is proposed for Phase 2. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 5** below:

Table 5: Summary of Proposed Sewerage Infrastructure

Sub Zone	Proposed Infrastructure			
	Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Dwarka 1 (DWK-DK1)	37	-	1	1
Dwarka 2 (DWK-DK2)	635	-	-	-
Total	672	-	1	1

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 6**.

Table 6: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Dwarka	Dwarka	20	11.3 - 14.6	Shahbad Mohdpur	LS	2.0	60

Line Diagram for Proposed WWPS and WWTP for Dwarka is shown in **Figure 14**:

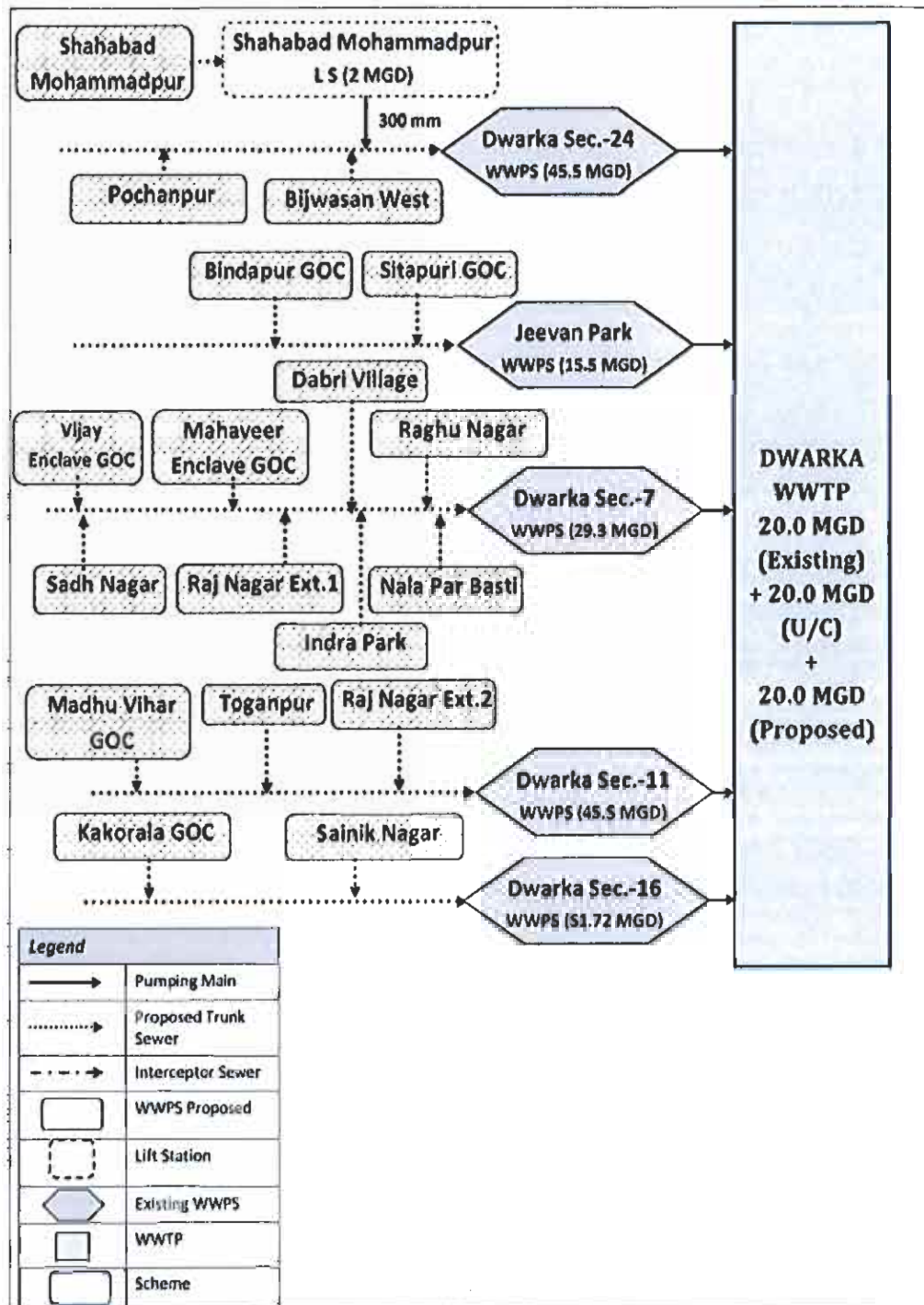


Figure 14: Line Diagram for Proposed WWPS and WWTP

Disposal of Treated Effluent

Treated effluent is being discharged to Najafgarh Drain which ultimately discharges to Yamuna River. Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be DDA. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Dwarka Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in the **Figure 15**.

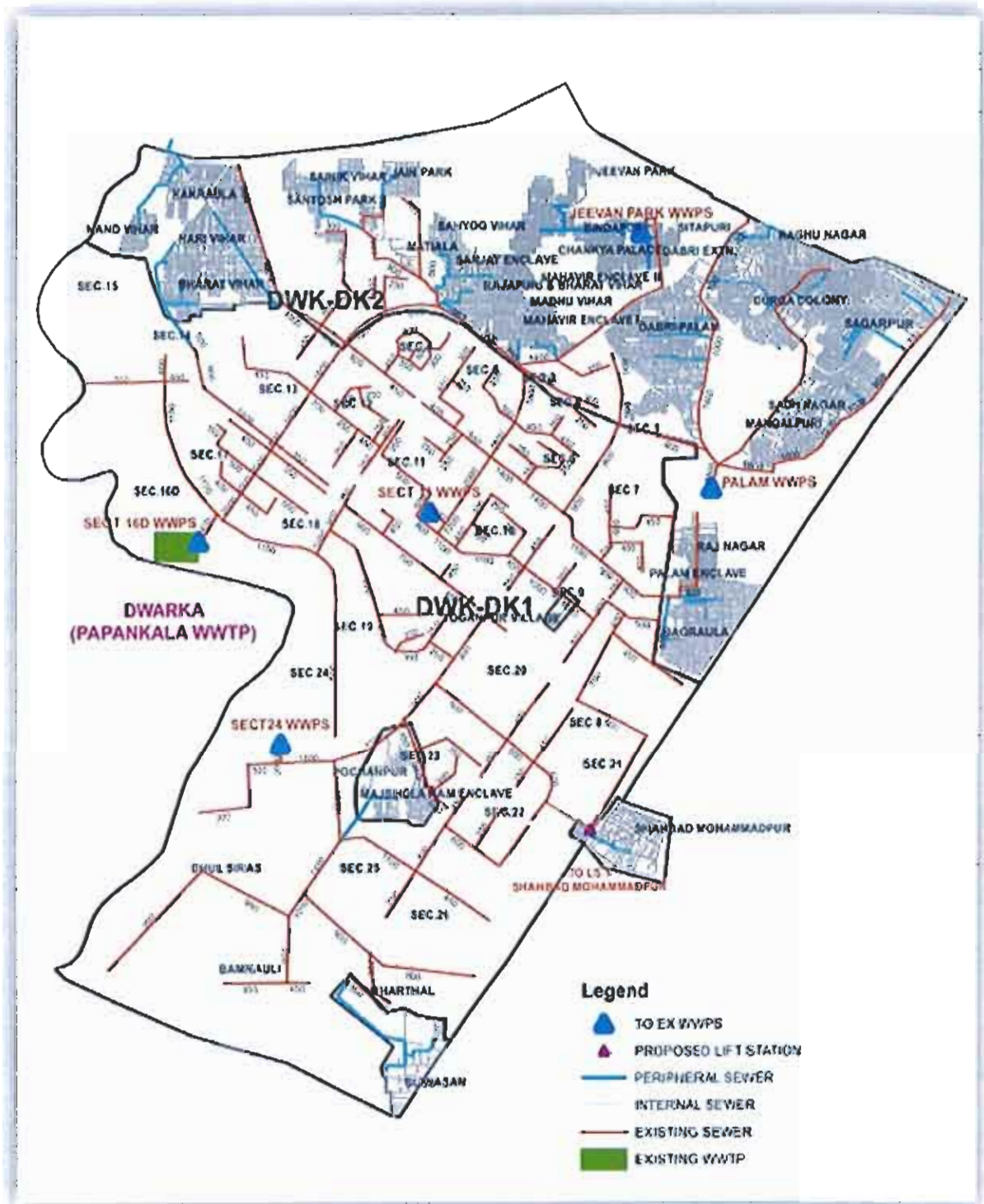


Figure 15: Proposed Sewerage Scheme for Dwarka Drainage Zone

Various Group of Colonies (GOCs) - wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 16**.

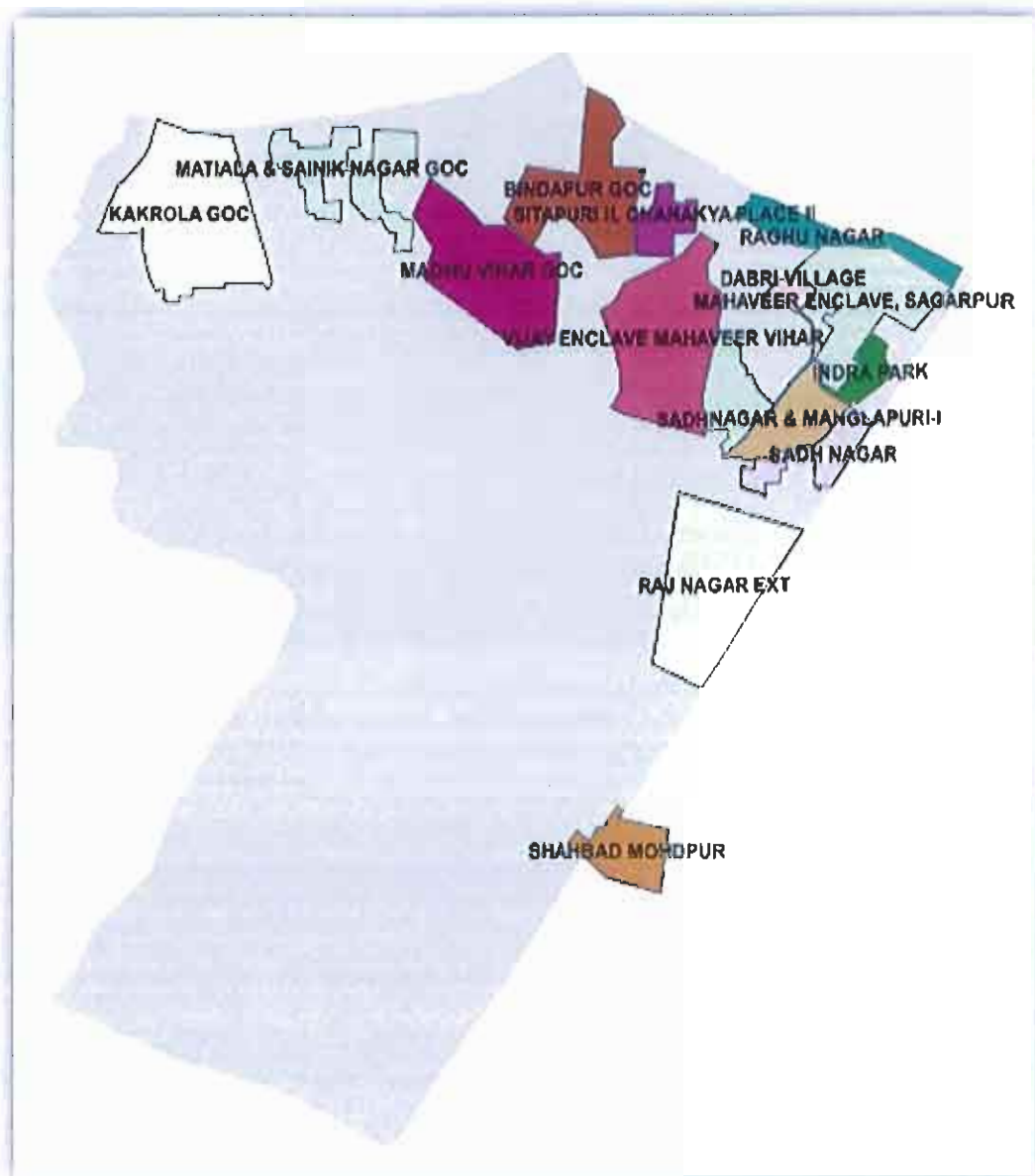


Figure 16: Schemes – Dwarka

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 7: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	Sub Zone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Dwarka	DK2	DWK-DK2-ME	Mahaveer Enclave GOC				
2	Dwarka	DK2	DWK-DK2-VM	Vijay Enclave Mahaveer Vihar				
3	Dwarka	DK2	DWK-DK2-KGC	Kakrola GOC				
4	Dwarka	DK2	DWK-DK2-SC	Sitapuri II, Chanakya Place II				
5	Dwarka	DK2	DWK-DK2-BP	Bindapur GOC				
6	Dwarka	DK2	DWK-DK2-MV	Madhu Vihar GOC				
7	Dwarka	DK2	DWK-DK2-SAD	Sadh Nagar				
8	Dwarka	DK2	DWK-DK2-IP	Indra Park				
9	Dwarka	DK2	DWK-DK2-DV	Dabri Village				
10	Dwarka	DK2	DWK-DK2-SM	Shahbad Mohdpur				
11	Dwarka	DK2	DWK-DK2-RN	Raj Nagar Ext				
12	Dwarka	DK2	DWK-DK2-BWW	Bijwasan West				
13	Dwarka	DK2	DWK-DK2-SN	Sainik Nagar GOC				
14	Dwarka	DK2	DWK-DK2-NPB	Nala Par Basti				
15	Dwarka	DK2	DWK-DK2-PP	Pochanpur				
16	Dwarka	DK2	DWK-DK2-RGN	Raghu Nagar				
17	Dwarka	DK2	DWK-DK2-TP	Toganpur				

Table 8: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Matiala & Sainik Nagar GOC	Matiala & Sainik Nagar
2	Kakrola GOC	Patel Garden Extn., Najafgarh Road, Kakrola More, Delhi Raju Extn., Old Palam Road, Kakrola, New Delhi-43 Shivani Enclave Ph-I, II, III, Kakrola, New Delhi-43 Tara Nagar, Old Palam Road, kakrola, New Delhi Kakrola Extn., Village, New Delhi-78 Vikas Vihar near Kakrola Kakrola Bajaj Enclave Old Palam Road Kakrola More, N.D Hari Vihar Main Najafgarh Road, Kakrola, New Delhi-43 Nishat Park, Kakrola Mor, Najafgarh Road, New Delhi Kakrola Housing Complex Nand Vihar Kakrola, New Delhi-43 Raju Enclave Old Palam Road Kakrola, New Delhi Shyam Vihar, Kakrola
3	Bindapur GOC	Anoop Nagar (Block C & D) Uttam Nagar, Delhi Bhagawati Vihar V-Block Uttam Nagar, Delhi Sitapuri Extn. Part-I, Dabri Sitapuri Part-II (G & H Block) Dabri Delhi-45 Sitapuri Extn. Pt-II G-1 Block New Delhi-45 Sitapuri Extn. Pt-II (Block A B F & G) Near Dabri New Delhi-45 Mahavir Enclave Pt II & III, Uttam Nagar, Delhi Nand Ram Park, F-Block, Mahavir Enclave-3, New Delhi Sitapuri, Pankah Road, New Delhi Indra Park Extn. Pt-I, Uttam Nagar, New Delhi-59 Janki puri, Uttam Nagar, Hastal Mahindra Park (Pankha Road) Uttam Nagar Jeevan Park, Pankha road, New Delhi, D-1, D-2, D-3 Block Jeevan park F- Block Uttam Nagar, Delhi-59 Jivan park E- Block Pankha Road Delhi-59 Adarsh Nagar Near Jeevan park Uttam Nagar, Delhi Chanakya Place Part-II, Uttam Nagar, New Delhi Chanakya Place Pt-II Uttam Nagar, Delhi Chankaya Place Pt-I Pankha Road, Uttam Nagar, Delhi Jain Enclave Old Jankipuri Uttam Nagar, Delhi Rohtash Nagar, Dabri, Delhi Pratap Garden Uttam Nagar Delhi--59 Mahindra Park D-Block, , Uttam Nagar, Pankha Road, Delhi Uttam Nagar U- Block Bindapur Matiyala Road New Delhi-59 Vishu Vihar V-Block Sect-A Uttam Nagar Rajapuri (GKLMS Block) Som Bazar road, Madhu Vihar, Palam, New Delhi-59 Raja Puri Colony, Uttam Nagar, New Delhi

Sl. No.	Name of GOC	Name of Colonies
		Rajpuri Viswas Park Extn. Uttam Nagar Delhi (LOP) Madhu Vihar Near Dwarka Sector-III, Delhi Bharat Vihar Raja puri Uttam Nagar New Delhi-43 Vishnu Vihar Uttam Nagar,Block V & Sect-B Near Village Bindapur, Delhi Binda pur Extn.Uttam Nagar,Delhi Bindapur Extended, Abadi, Uttam Nagar, New Delhi-59 Binda Pur, Pocket-IV Bindapur Uttam Vihar Rotash
4	Madhu Vihar	Madhu Vihar
5	Sitapur – II	Sitapur – II
6	Chankaya Place – II	Chankaya Place – II
7	Raghu Nagar	Raghu Nagar
8	Dabri Village	Dabri Village
9	Mahavir Enclave	Mahavir Enclave
10	Sagarpur	Sagarpur
11	Vijay Enclave	Vijay Enclave
12	Mahavir Vihar	Mahavir Vihar
13	Indra Park	Indra Park
14	Sadh Nagar & Manglapuri – I	Sadh Nagar & Manglapuri – I
15	Sadh Nagar	Sadh Nagar
16	Raj Nagar Extn.	Raj Nagar Extn.
17	Shahbad Mohdpur	Shahbad Mohdpur

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS (MoEF)

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

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JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
JUNE 2014

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ANNEXURE - 9

NAJAFGARH DRAINAGE ZONE (NJF)

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NAJAFGARH DRAINAGE ZONE (NJF)

1. INTRODUCTION

The Najafgarh Drainage Zone is bounded by Rohtak Road in North, Dwarka sub city in East and NCT boundary on its Southern and Western sides. The zone is primarily rural in character, with scattered habitations and villages in entire zone excluding urban town of Najafgarh. The old and longest Najafgarh drain originates from Najafgarh Jheel traverses along southern and eastern periphery of the zone. The zone comprises two protected forests and three major institutional campuses related to police and para-military forces. Location of Najafgarh Drainage Zone is shown in the **Figure 1**.

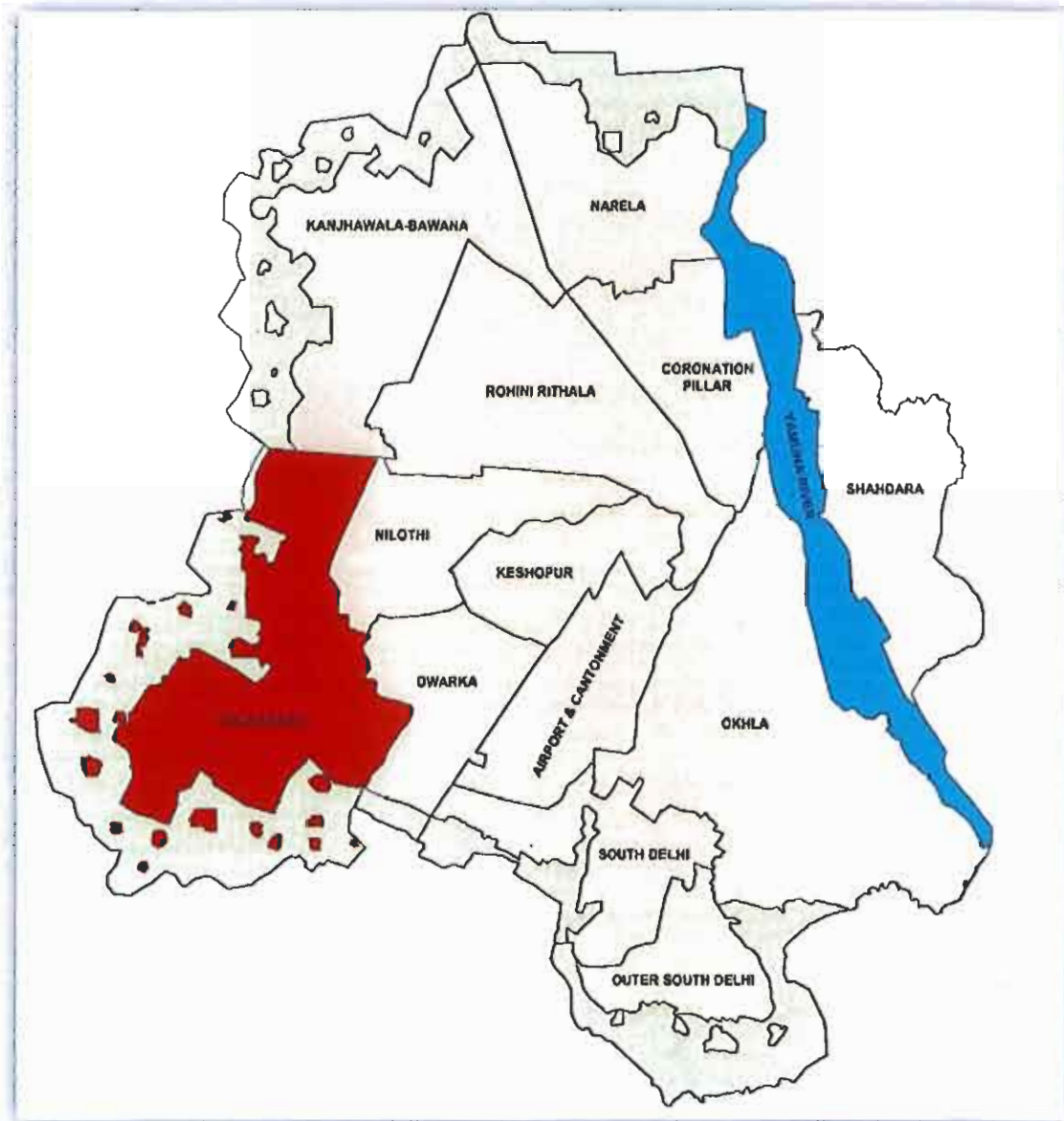


Figure 1: Najafgarh Drainage Zone

Density of population in Najafgarh area is only concentrated to Najafgarh town where as most part of this area is either agricultural land or open plots with so many isolated villages in between. This drainage zone falls partly under the DDA Zone K-I and L as shown in the **Figure 2**.

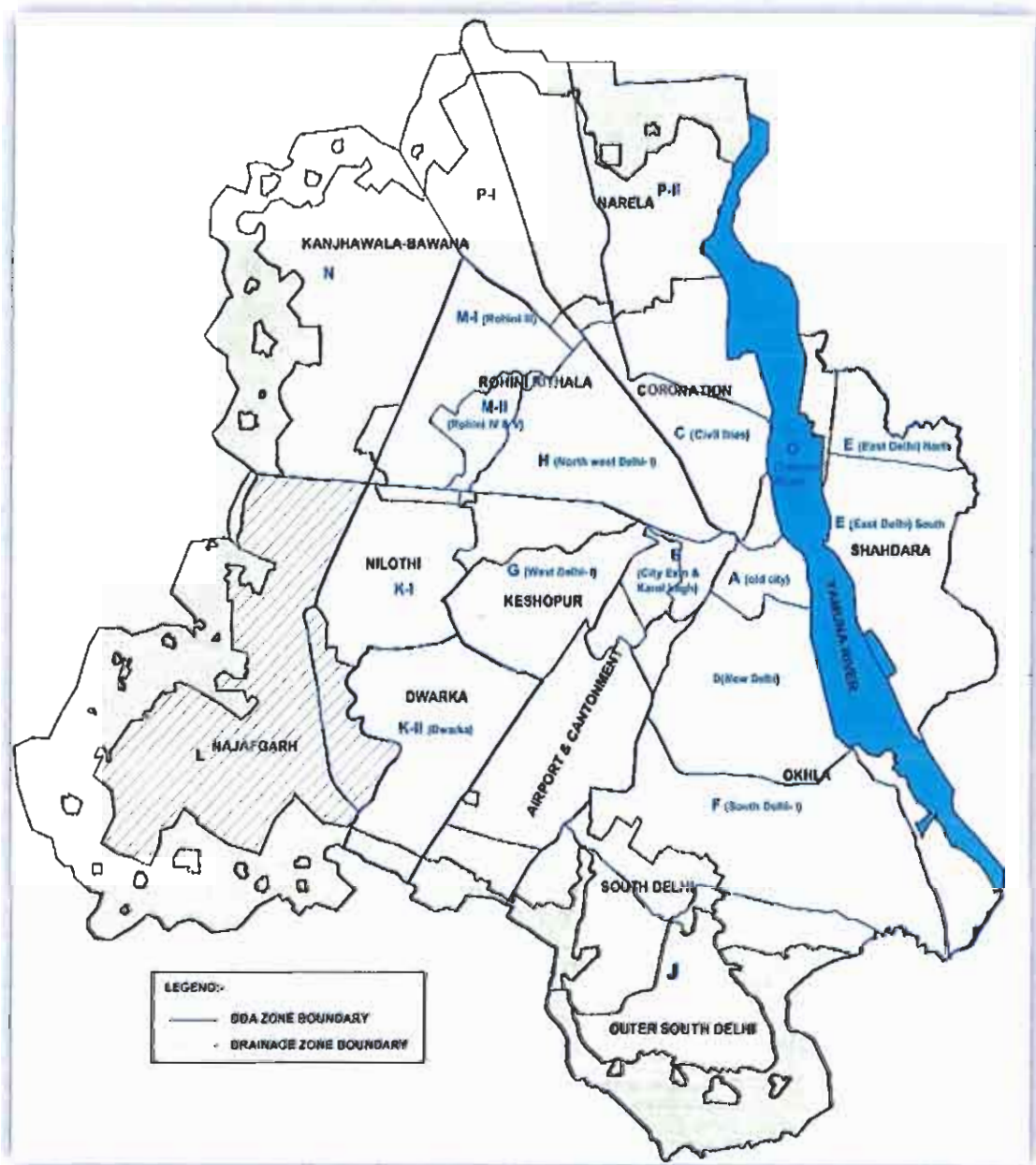


Figure 2: DDA Zones and Najafgarh Drainage Zone

Soil Description of Najafgarh

This zone is fully covered with older alluvium deposits.

Najafgarh drain zone is having sedimentary fill (Dabar) with Moderate Hazard due to high amplification and liquefaction. Only the areas like DichainKalan, Laxmi Vihar, Vijay Park etc. is having Moderate Hazard due to thick soft sediments.

The central portion covering Durga Vihar, DindarPur, Paprawat etc. is having water at deeper levels i.e. 20-40m. The peripheral portion covering Dichain Kalan, Laxmi Vihar, Baba Hari Das Nagar, DaulatPur, Reola Khanpur, Pind Wala Kalan etc. is having water at shallower depths of 10-20m only.

Most of this drainage zone is covered by Dabar soil.

2. MASTER PLANNING FOR NAJAFGARH DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The zone is conspicuously devoid of sewerage facilities barring urban town of Najafgarh. The present mode of excreta disposal is that of septic tanks, besides open air defecation is also prevalent in rural remote areas. Topographical Survey & GIS integration has been carried out for unsewered portions of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

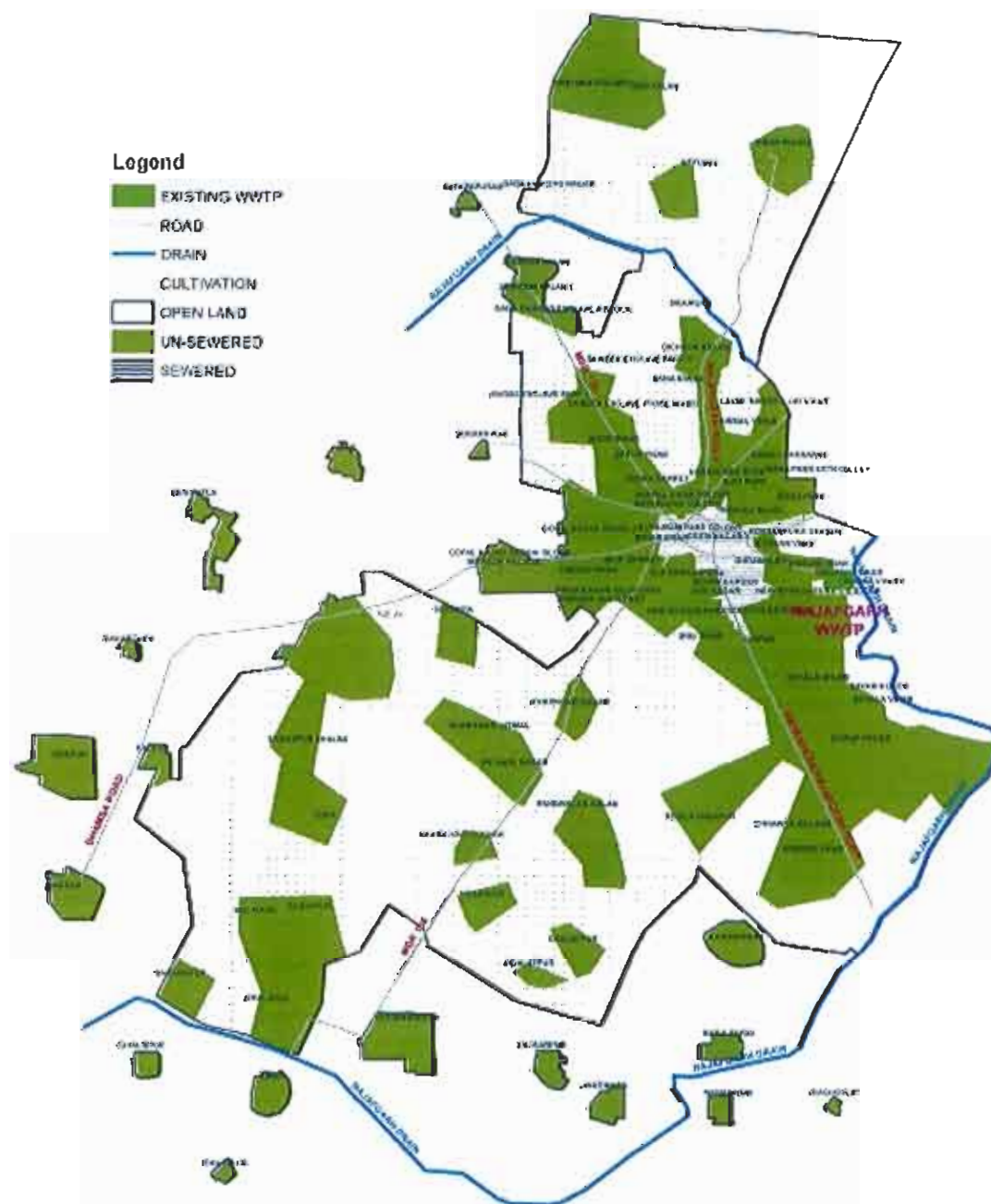


Figure 3: Sewerage Status of Najafgarh Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Najafgarh Drainage Zone has been divided into 4 Sub Drainage Zones as below:

- Najafgarh (NJF-NJ)
- Jhuljhuli (NJF-JH)
- Somesh Vihar (NJF-SV)
- Dichaon Kalan (NJF-DK)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

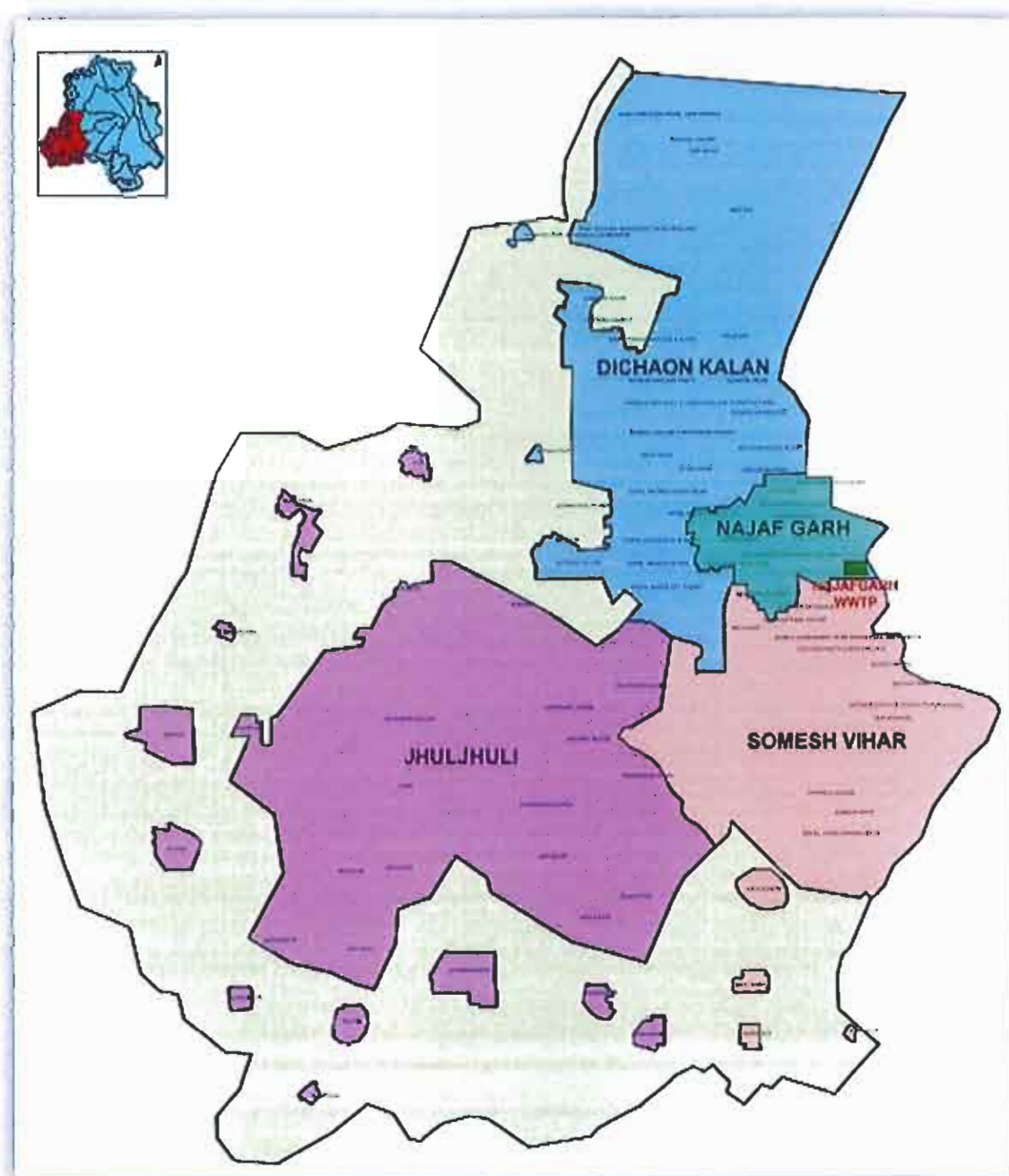


Figure 4: Sub Drainage Zone Map of Najafgarh Drainage Zone (NJF)

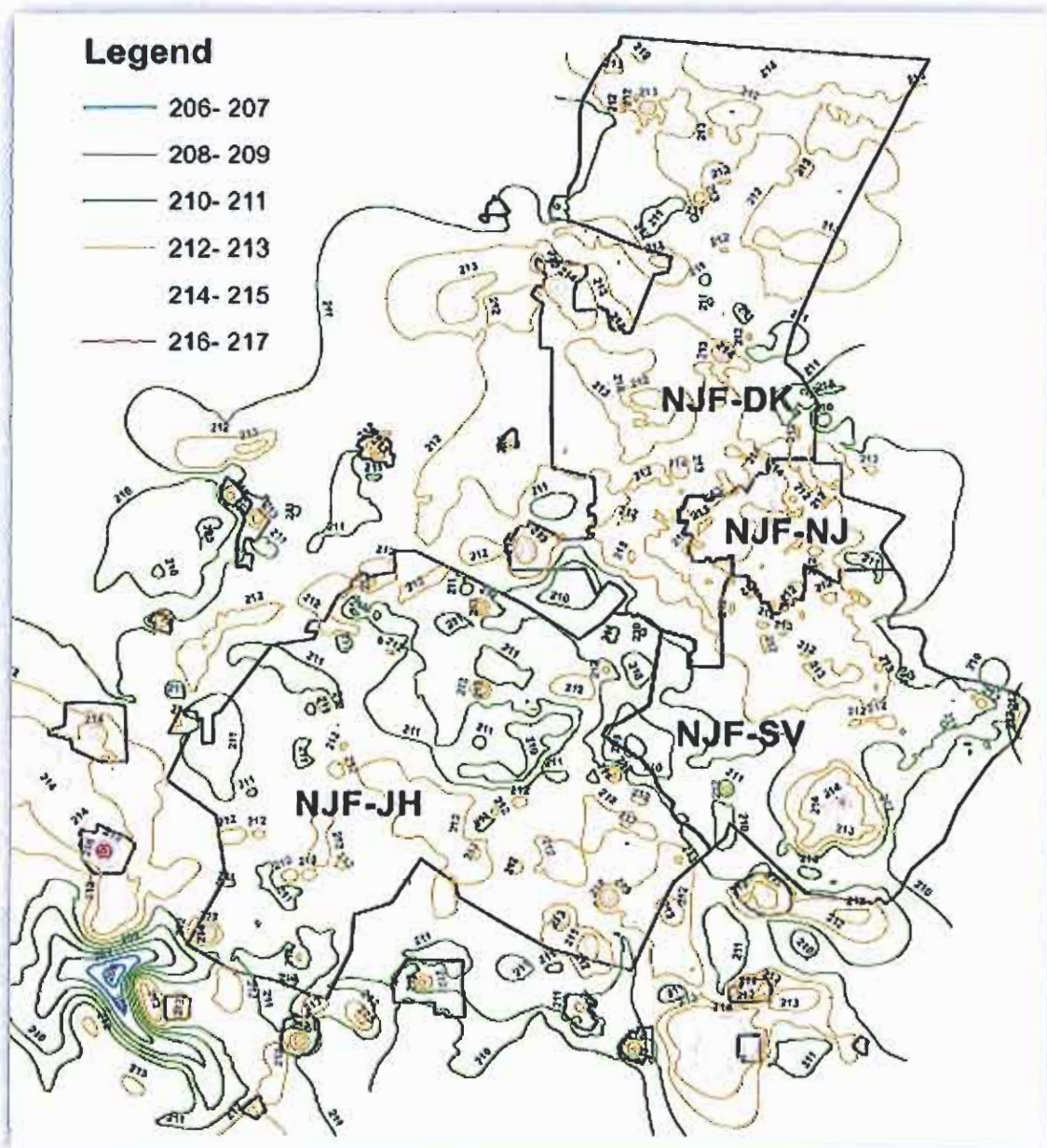


Figure 5: Contour Map of Najafgarh Drainage Zone (NJF)

Based on population projections, Sub-Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Najafgarh Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
NJF-DK	62.47	94.80	127.12	13.80	20.90	28.00
NJF-JH	59.12	89.72	120.31	13.00	19.80	26.50
NJF-NJ	17.85	27.08	36.32	3.90	6.00	8.00
NJF-SV	55.78	84.64	113.50	12.30	18.60	25.00
Total	195.22	296.24	397.25	43.00	65.30	87.50

3.1 Sub Drainage Zone: Najafgarh (NJ)

This Sub Drainage Zone spread across Roshanpura, Dharampura, Prem Nagar, Indra Park, Roshan Mandi, Nehru Garden etc. This zone consist of sewerred portions of Najafgarh Drainage Zone contributing towards existing Najafgarh WWTP of 5 MGD capacity and few unsewered colonies. Land use map is as shown in the *Figure 6*.

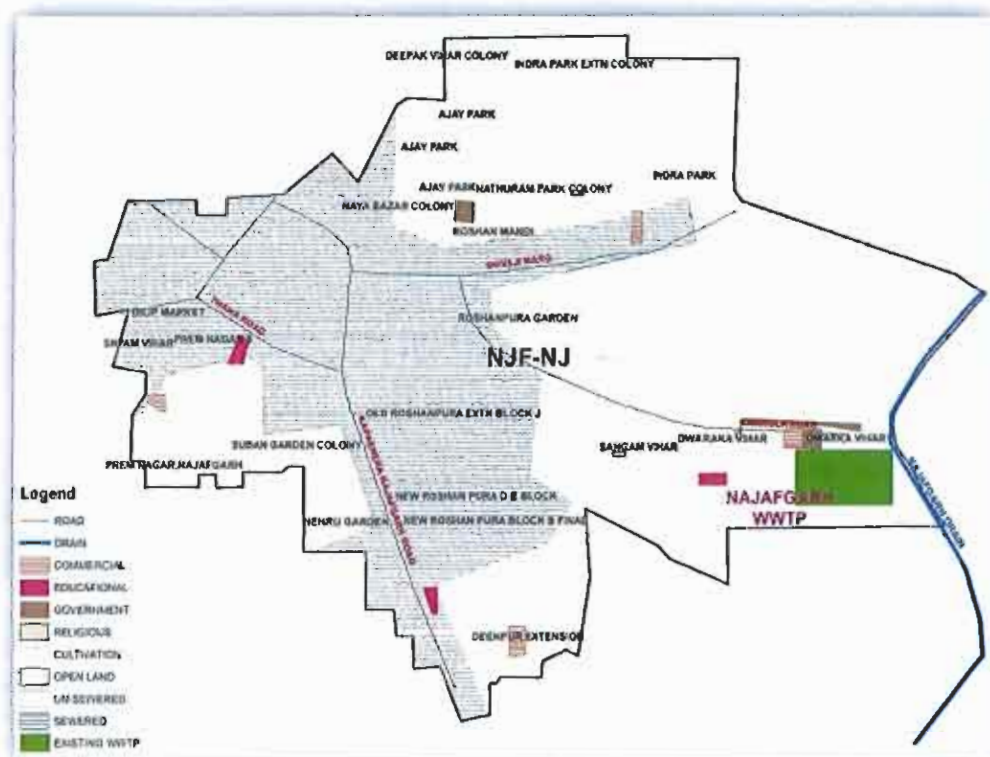


Figure 6: Land Use Map of Najafgarh Sub Drainage Zone (NJF-NJ)

Existing Sewerage Infrastructure

One 5 MGD capacity WWTP exists which is fed by 25 MGD (installed) capacity pumping station to cater the sewage flow generated from the sub drainage zone. The Trunk Mains in this zone have already been laid along the main roads as shown in the **Figure 5**. But the space availability and capacity of existing WWTP of 5 MGD limits any further extension of catchment area.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 7:**

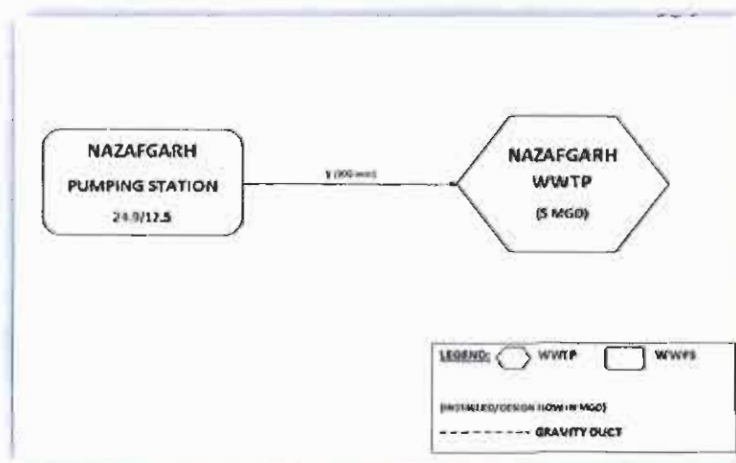


Figure 7: Flow Chart of Existing Sewerage Infrastructure In the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 8**.

- Area is partially sewerage. Existing Trunk Sewer (as shown in the map below) outfalls into existing Najafgarh WWPS and pumping flow to existing Najafgarh WWTP.
- Sewage from unsewered part of Deenpur Extension, Nehru Garden, Prem Nagar, Dwarka Vihar, Roshanpura, Roshan Mandi, Ajay Park, Indra Park and nearby area is routed to existing trunk sewer towards Najafgarh WWPS.

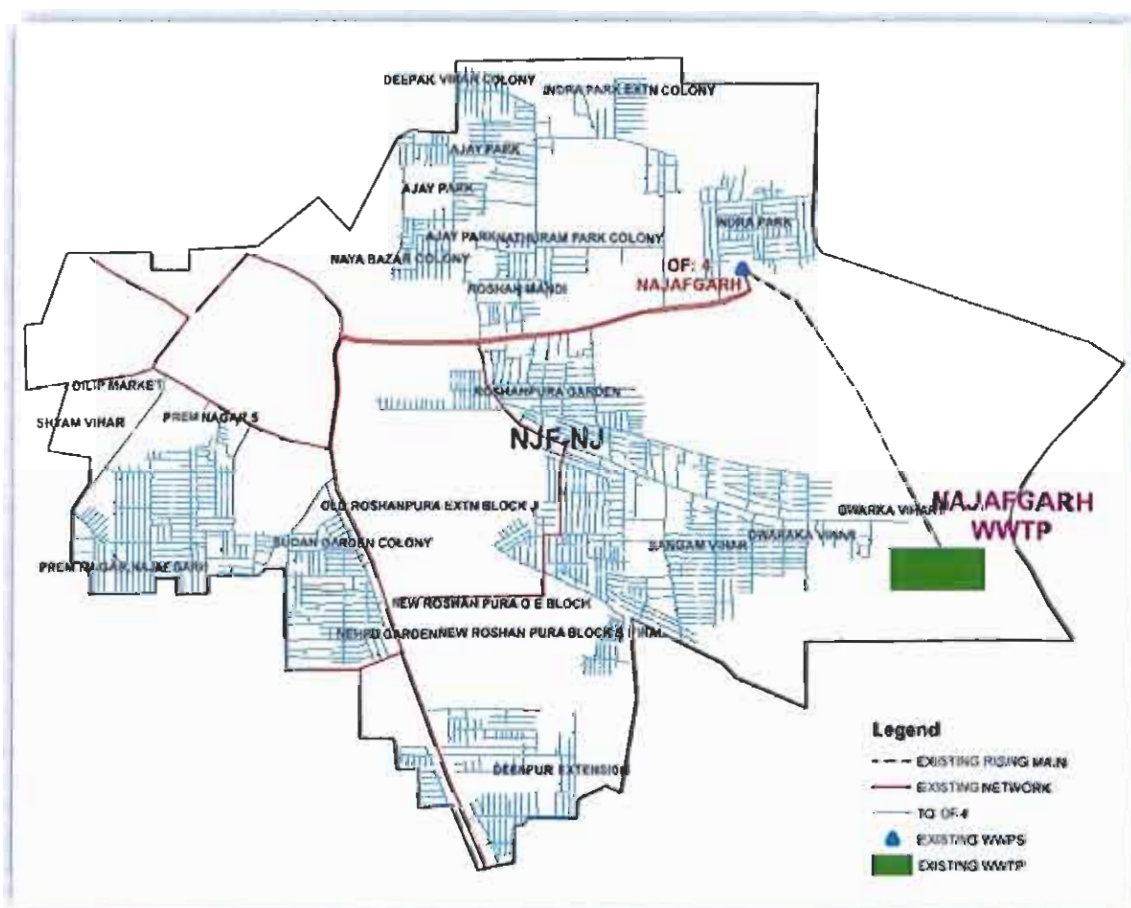


Figure 8: Scheme Map of Najafgarh Sub Drainage Zone (NJF-NJ)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map of Najafgarh Sub Drainage Zone is shown in the **Figure 9**.

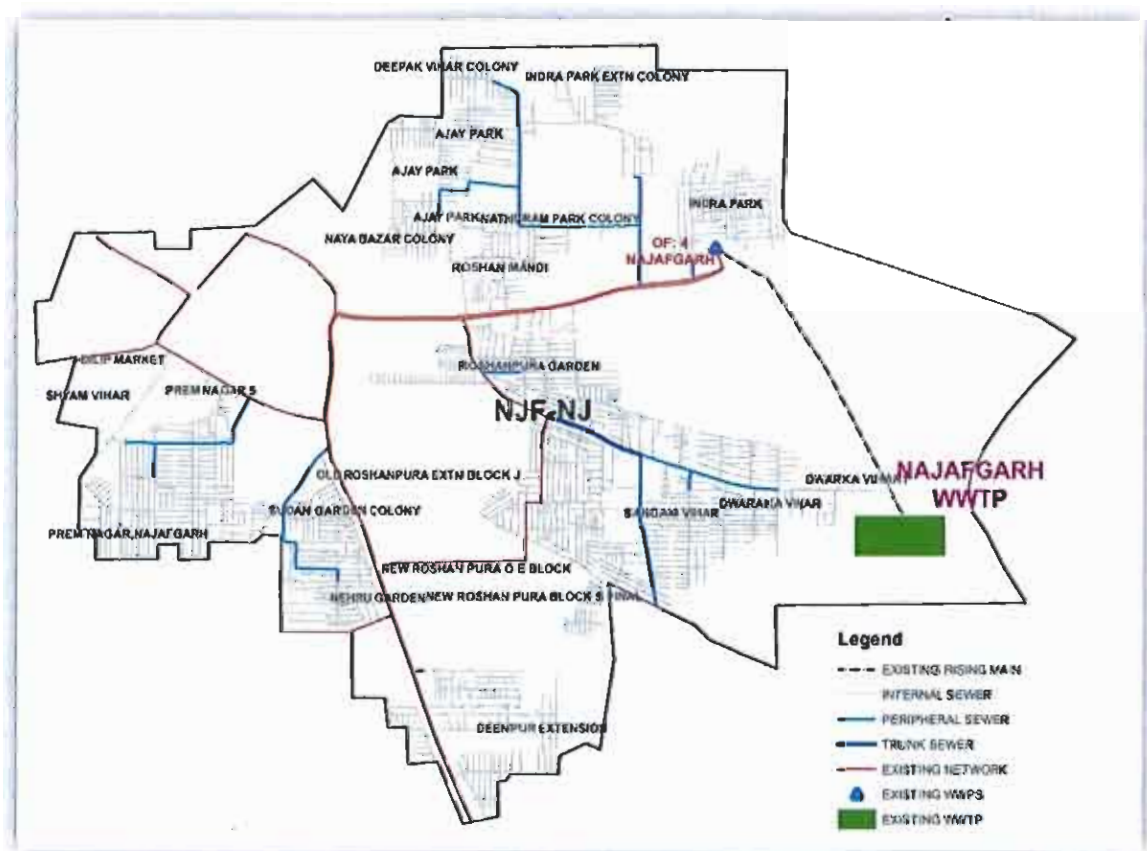
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network – Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	129343
300	HDPE/DWC	940
400	HDPE/DWC	1433
500	HDPE/DWC	2350
563.6	HDPE/DWC	538
635.2	HDPE/DWC	216
700	RCC NP3/NP4	180
Total		135000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in *Figure 9*. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on the as built drawings.

**Figure 9: Proposed Sewerage Infrastructure of Najafgarh Sub Drainage Zone (NJF-NJ)**

Waste Water Pumping Requirements

No additional Pumping Stations have been proposed for unsewered pockets of Sub Drainage Zone.

Waste Water Treatment Requirements

The existing 5 MGD WWTP will be sufficient to cater the sewage generation for Phase I. Additional Capacity of 3 MGD is proposed for Phase 2. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Alternatively, excess flow of 3 MGD can be

pumped to Dichaon Kalan for treatment. For master planning purposes pumping of additional 3 MGD flow to Dichaon Kalan has been considered. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Jhuljhuli (NJF-JH)

This Sub Drainage Zone spread across villages Surhera, Kharkhari Nahar, Sri Hans Nagar, Pandwala Kalan, Samaspur Khalsa, Ujwa, Hasanpur, Daulatpur, Kazipur, Issapur, Dhansa, Sarangpur, Malikpur, Daryapur, Jhuljhuli and various scattered habitations in green area at South West boundary of NCT Delhi. The area is unsewered and no sewage treatment facility exists. Land use map is as shown in the **Figure 10**.

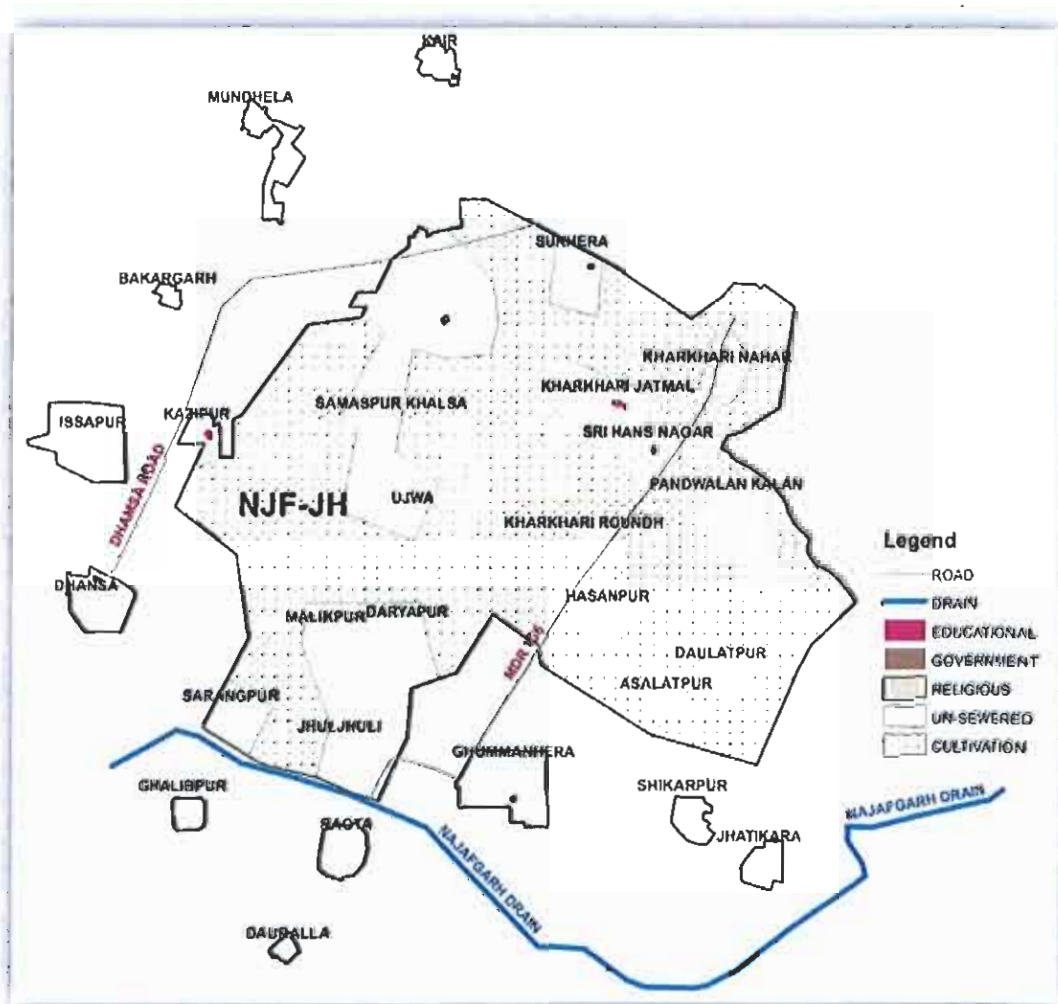


Figure 10: Land Use Map of Jhuljhuli Sub Drainage Zone (NJF-JH)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 11**.

- Eight (8) nos. of WWTPs are proposed for Jhuljhuli Sub-Drainage Zone.
- Sewage from Ghalibpur, Daurala and Raota is routed to Proposed WWTP at Raota via terminal WWPS.

- Sewage from Dhansa, Sarangpur, Jhuljhuli, Malikpur, Daryapur, Ghummanhera, etc. is routed to Proposed WWTP at Jhuljhuli via terminal WWPS.
- Sewage from Asalatpur, daulatpur, Hasanpur, Kharkhari, Sri Hans Nagar and Pandwalan Kalan is routed to Proposed WWTP at Pandwalan Kalan via terminal WWPS.
- Sewage from Surhera, Khera Dabar etc is routed to Proposed WWTP at Khera Dabar via terminal WWPS.
- Sewage from Ujwa, Samaspur Khalsa and nearby area is routed to Proposed WWTP at Samaspur Khalsa via terminal WWPS.
- Sewage from Issapur, Kazipur, Bakargarh is routed to Proposed WWTP at Kazipur via terminal WWPS.
- Sewage from Mundhela, Kair and nearby area is routed to proposed WWTP at Zafarpur via terminal WWPS.
- Sewage from Shikarpur, Jhatikara is routed to Proposed WWTP at Shikarpur via terminal WWPS.

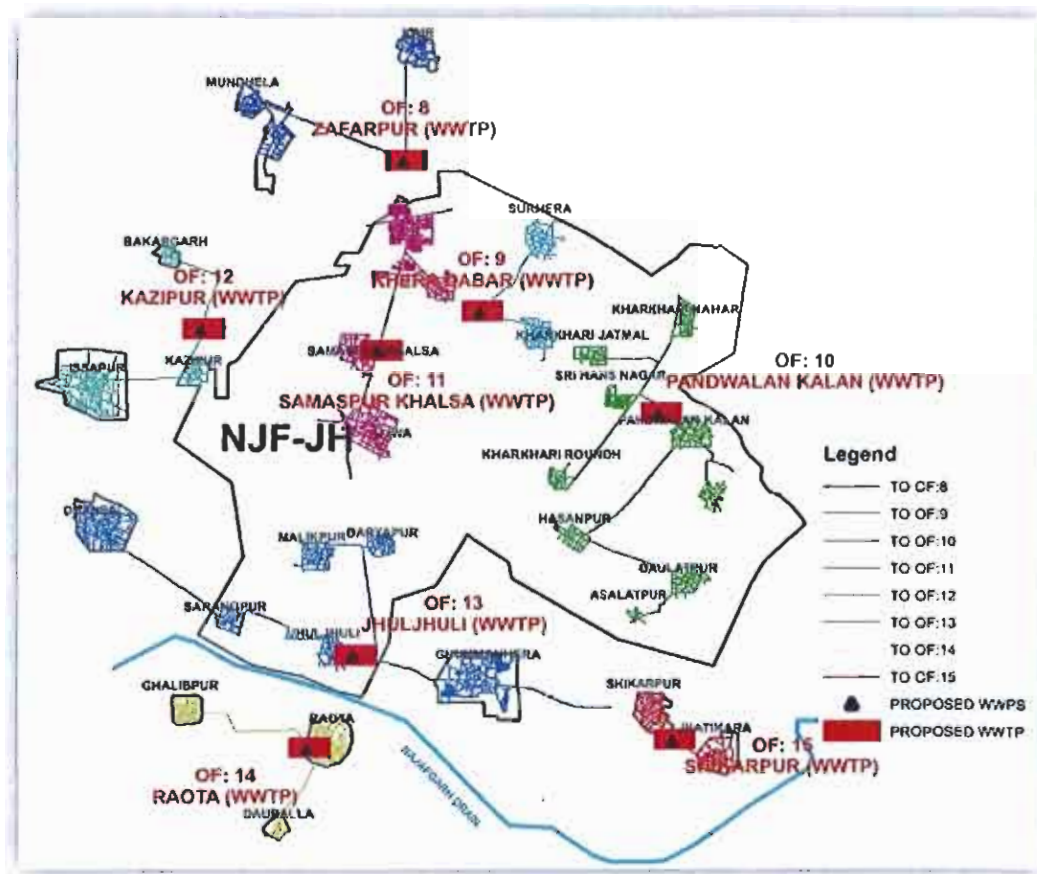


Figure 11: Scheme Map of Jhuljhuli Sub Drainage Zone (NJF-JH)

Proposed Gravity Sewerage Network

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map of Jhuljhuli Sub Drainage Zone is shown in the **Figure 11**.

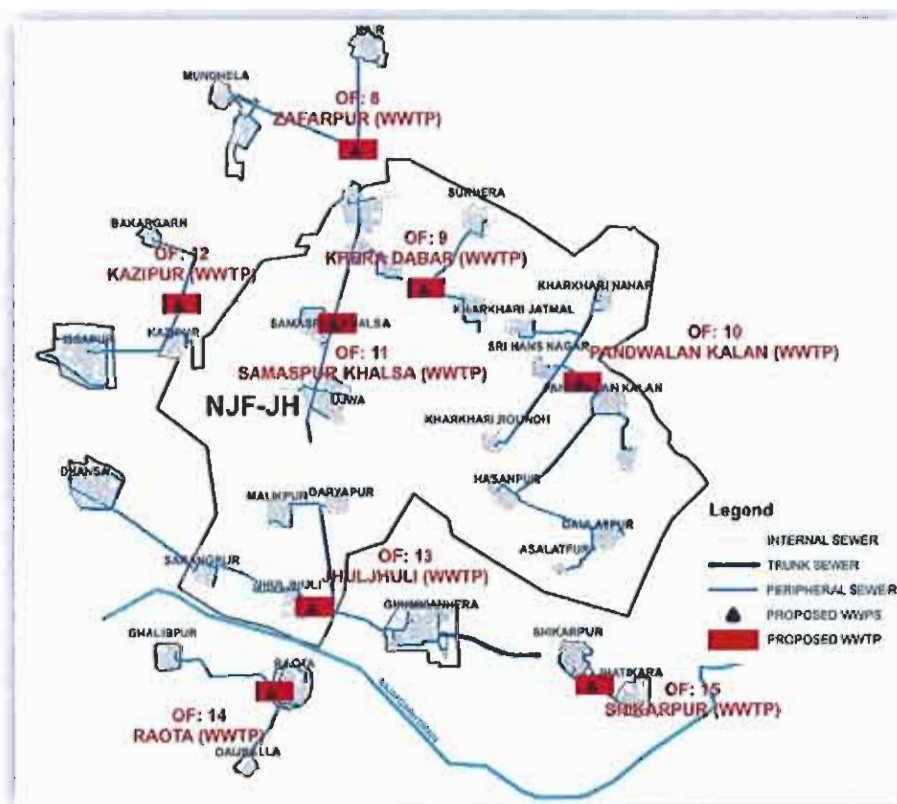
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 3**.

Table 3: Proposed Gravity Sewerage Network – Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	214326
300	HDPE/DWC	10201
400	HDPE/DWC	20755
500	HDPE/DWC	15809
563.6	HDPE/DWC	3182
635.2	HDPE/DWC	3617
700	RCC NP3/NP4	7162
800	RCC NP3/NP4	4695
900	RCC NP3/NP4	960
Total		484000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 12** below. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

**Figure 12: Proposed Sewerage Infrastructure of Jhuljhuli Sub Drainage Zone (NJF-JH)**

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 4**.

Table 4: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Kazipur	Terminal WWPS	5.00	-	-	-	-
2	Khera Dabar Extn	Terminal WWPS	5.00	-	-	-	-
3	Shikarpur	Terminal WWPS	3.00	-	-	-	-
4	Zafarpur	Terminal WWPS	5.00	-	-	-	-
5	Samaspur Khalsa	Terminal WWPS	7.00	-	-	-	-
6	Pandwala Kalan	Terminal WWPS	7.00	-	-	-	-
7	Jhul Jhuli	Terminal WWPS	8.00	-	-	-	-
8	Raota Village	Terminal WWPS	4.00	-	-	-	-

Waste Water Treatment Requirements

Eight (8) nos. of WWTPs are proposed to cater the sewage flow generated from Jhuljhuli Sub-Drainage Zone in phased manner as shown in **Table 5**.

Table 5: Proposed Waste Water Treatment Plants

Sl. No.	Location	WWTP Capacity (MGD) Phase I	WWTP Capacity (MGD) Phase II
1.	Kazipur	1.1	1.0
2.	Khera Dabar Extn	0.9	1.0
3.	Shikarpur	0.6	0.5
4.	Zafarpur	1.1	1.0
5.	Samaspur Khalsa	2.2	1.0
6.	Pandwala Kalan	2.2	1.0
7.	Jhul Jhuli	2.8	1.0
8.	Raota Village	0.8	1.0
Sub Total (MGD)		11.7	7.5

The overall sewage generation from the sub drainage zone is 26.5 MGD. The capacities are proposed in phase-wise manner, for phase I & II as shown above in Table 6. Remaining capacity of 7.3 MGD has been proposed in phase III. Locations and capacities may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.3 Sub Drainage Zone: Somesh Vihar (NJF-SV)

This Sub Drainage Zone spread across villages Somesh Vihar, Chhawla Village, Tajpur Khurd, Shyam Vihar, Goyala Vihar, Shyam Kunch, Rewla Khanpur etc. The area is unsewered and no sewage treatment facility exists. Land use map is shown in the **Figure 13**.

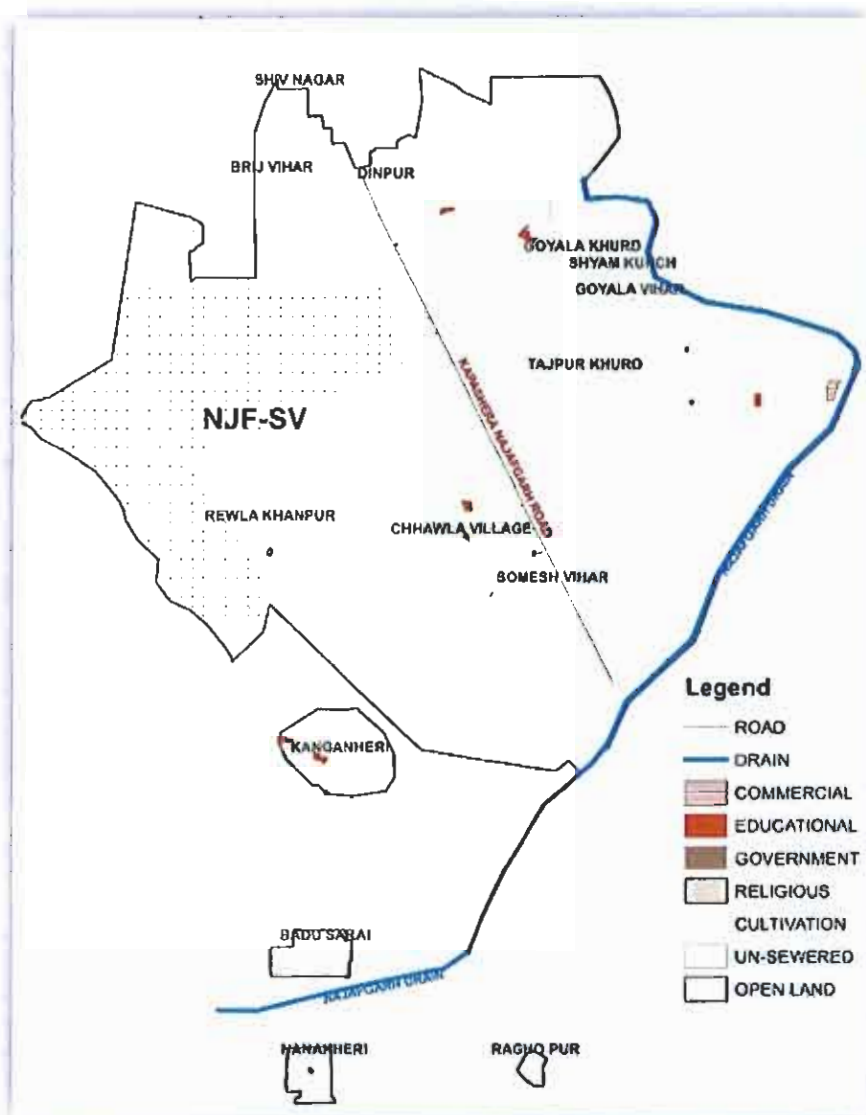


Figure 13: Land Use Map of Somesh Vihar Sub Drainage Zone (NJF-SV)

Existing Sewerage Infrastructure

The area is completely unsewered and no sewage treatment facility exists in the drainage zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 14**.

- Three (3) nos. of WWTPs are proposed for Somesh Vihar Sub Drainage Zone.
- Sewage from Shiv Nagar, Brij vihar, Dinpur, Goyala Khurd, Tajpur Khurd, Rewla Khanpur, Chawala Village, Somesh vihar etc is routed to Proposed WWTP at Tajpur Khurd via terminal WWPS.
- Sewage from Goyala Vihar and nearby area is routed to Proposed WWTP at Goyala Vihar via terminal WWPS.
- Sewage from Kanganheri, Badusarai, Manakheri, Ragho pur is routed to Proposed WWTP at Badu Sarai via terminal WWPS.

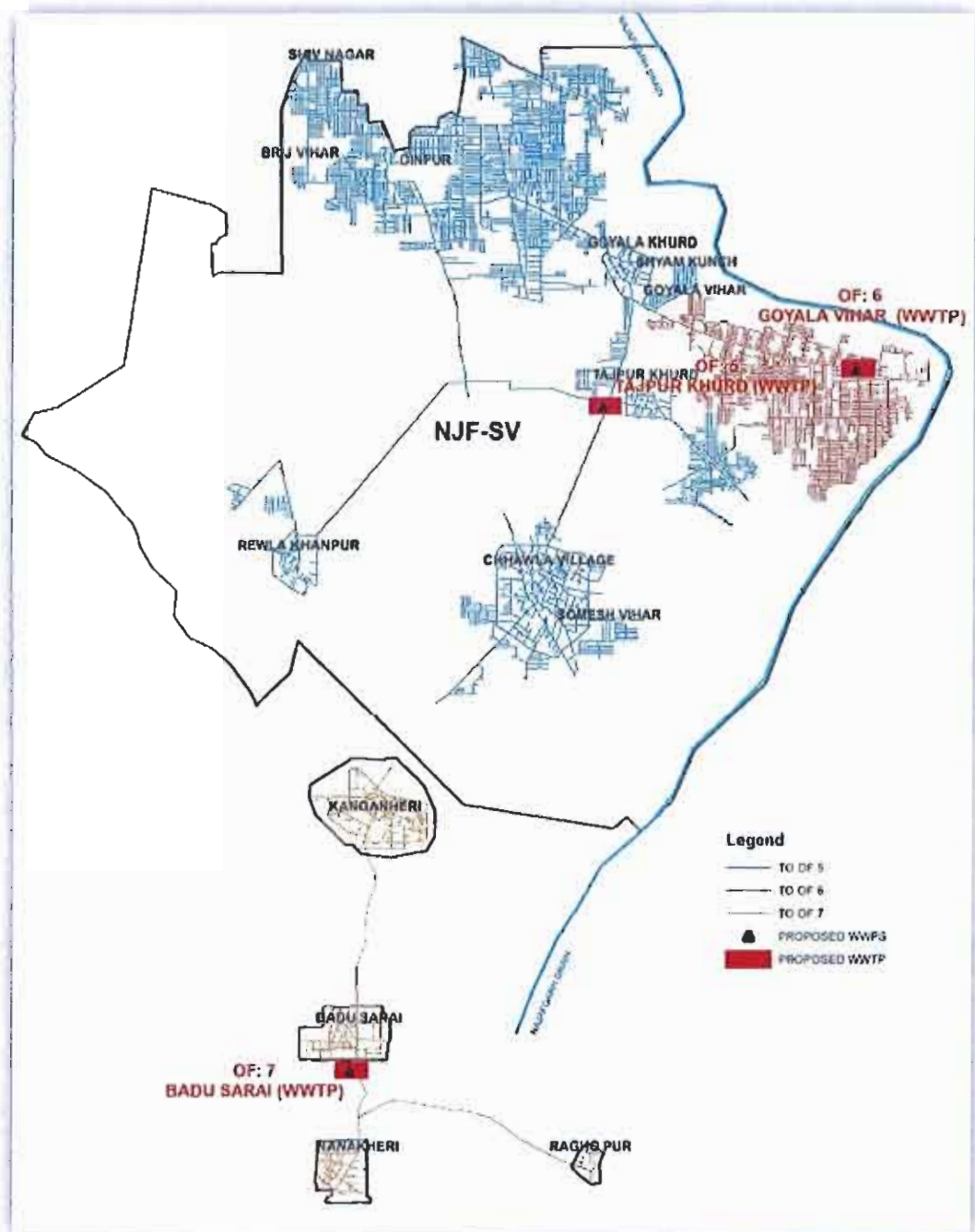


Figure 14: Scheme Map of Somesh Vihar Sub Drainage Zone (NJF-SV)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Somesh Vihar Sub Drainage zone is shown in the **Figure 14**.

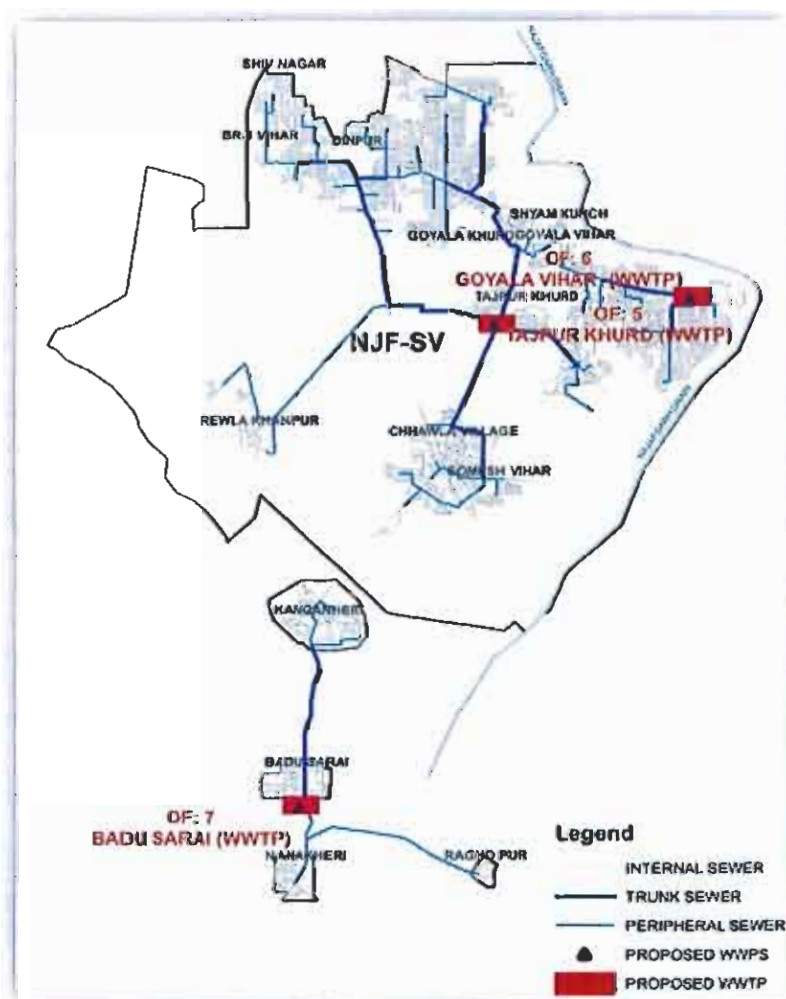
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. . The proposed sewer network details are shown in **Table 6**

Table 6: Proposed Gravity Sewerage Network – Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	344057
300	HDPE/DWC	3813
400	HDPE/DWC	10918
500	HDPE/DWC	8327
563.6	HDPE/DWC	1073
635.2	HDPE/DWC	3904
700	RCC NP3/NP4	1860
800	RCC NP3/NP4	2138
900	RCC NP3/NP4	1313
1000	RCC NP3/NP4	1754
1100	RCC NP3/NP4	2843
Total		382000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 15**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

**Figure 15: Proposed Sewerage Infrastructure of Somesh Vihar Sub Drainage Zone (NJF-SV)**

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 7**.

Table 7: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Tajpur Khurd	Terminal WWPS	24.00	-	-	-	-
2	Goyala Vihar	Terminal WWPS	9.00	-	-	-	-
3	Badu Sarai	Terminal WWPS	7.00	-	-	-	-

Waste Water Treatment Requirements

Three (3) WWTPs are proposed to cater the sewage load from Somesh Vihar Sub-Drainage Zone in phased manner as shown in **Table 8**.

Table 8: Proposed Waste Water Treatment Plants

Sl. No.	Location	WWTP Capacity (MGD)	
		Phase I	Phase II
1.	Tajpur Khurd	8.0	4.0
2.	Goyala Vihar	2.5	2.0
3.	Badu Sarai	1.4	2.0
Sub Total (MGD)		11.9	8.0

The overall sewage generation from the sub drainage zone is 25 MGD. The capacities are proposed in phase-wise manner, for phase I & II as shown above in Table 6. Remaining capacity of 5.1 MGD has been proposed in phase III. Locations and capacities may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.4 Sub Drainage Zone: Dichaon Kalan (NJF-DK)

This Sub Drainage Zone spread across Haridas Colony, Neelwal, Hiran Kudna, Jharoda Kalan, Dichaon Kalan, Mitraon, Surakhipur, Gopal Nagar, Janata Vihar, Nirmal Vihar etc. The area is unsewered and no sewage treatment facility exists. Land use map is as shown in the **Figure 16**.

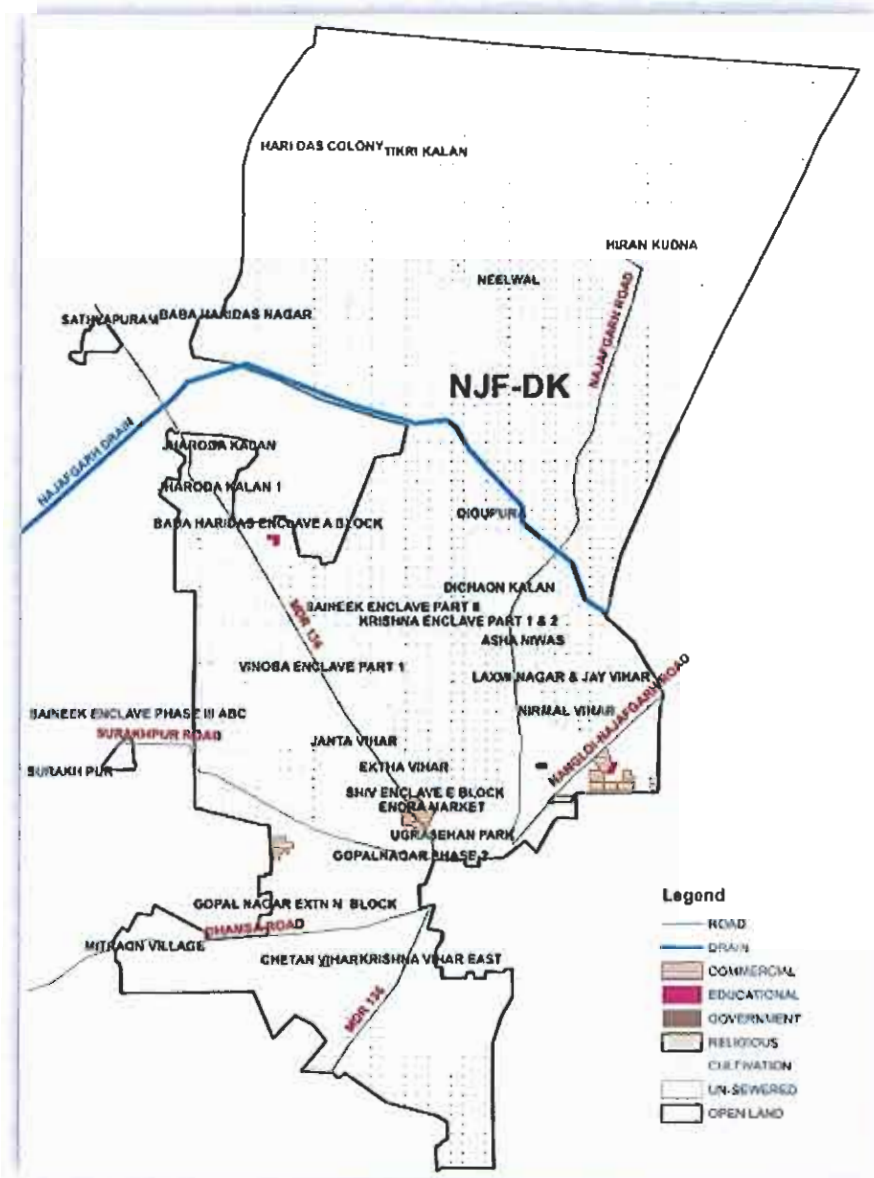


Figure 16: Land Use Map of Dichaon Kalan Sub Drainage Zone (NJF-DK)

Existing Sewerage Infrastructure

The area is completely unsewered and no sewage treatment facility exists in the drainage zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 17**.

- Three (3) WWTPs are proposed for Dichaon Kalan sub drainage zone.
- Sewage from Haridas Colony, Tikri Kalan, Hiran Kudna, Neelwal, Baba Haridas Nagar etc is routed to Proposed WWTP at Tikri Kalan via terminal WWPS. One intermediate Lift Station is proposed at Baba Haridas Nagar.
- Sewage from Surakhpur, Mitraon Village, Gopal Nagar, Chetan Vihar, Krishna Vihar etc is routed to Proposed WWTP at Mitraon via terminal WWPS.

- Sewage from Satyapuram, Jharoda Kalan, Vinoba Enclave, Janata Vihar, Shiv Enclave, Nirmal Vihar, Laxmi Nagar, Asha Niwas, Dichaon Kalan etc is routed to Proposed WWTP at Dichaon Kalan via terminal WWPS. One intermediate Lift Station is proposed at Jharoda Kalan.

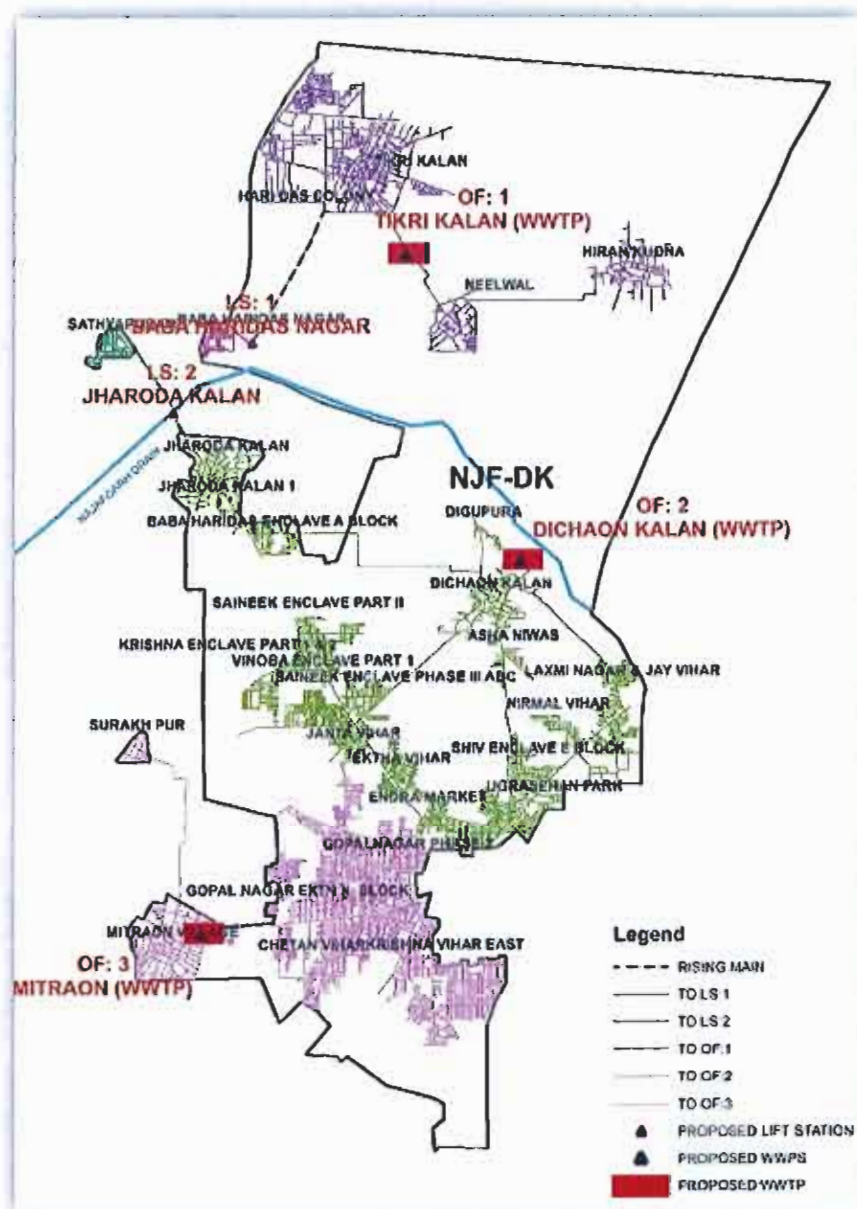


Figure 17: Scheme Map of Dichaon Kalan Sub Drainage Zone (NJF-DK)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Dichaon Kalan Sub Drainage zone is shown in the **Figure 18**.

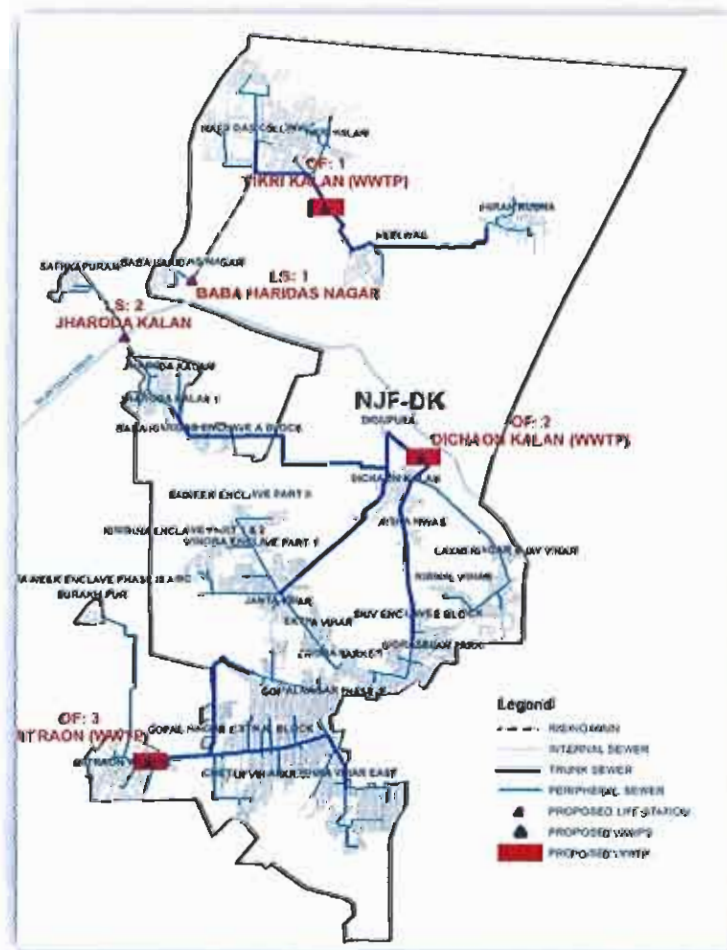
Proposed Gravity Sewer Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 9**.

Table 9: Proposed Gravity Sewerage Network – Diameter wise

Diameter (mm)	Material	Length (m)
upto 250	HDPE/DWC	514985
300	HDPE/DWC	4331
400	HDPE/DWC	14678
500	HDPE/DWC	9044
563.6	HDPE/DWC	2686
635.2	HDPE/DWC	3929
700	RCC NP3/NP4	4740
800	RCC NP3/NP4	6546
900	RCC NP3/NP4	1453
1000	RCC NP3/NP4	3119
1100	RCC NP3/NP4	606
1200	RCC NP3/NP4	1107
1400	RCC NP3/NP4	776
Total		568000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 18** below. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

**Figure 18: Proposed Sewerage Infrastructure of Dichaon Kalan Sub Drainage Zone (NJF-DK)**

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 10**.

Table 10: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Hari das Colony	LS	1.00	250	1	1650	Nearest Manhole
2	Tikri Kalan	Terminal WWPS	10.00	–	–	–	–
3	Mitraon WWPS	Terminal WWPS	18.00	–	–	–	–
4	Dichao Kalan WWPS	Terminal WWPS	19.00	–	–	–	–
5	Jharoda Kalan	LS	1.00	250	1	400	Nearest Manhole

Waste Water Treatment Requirements

Three (3) WWTPs are proposed to cater the sewage flow from Dichaon Kalan Sub Drainage Zone in phased manner as shown in **Table 11**.

Table 11: Proposed Waste Water Treatment Plants

Sl. No.	Location	WWTP Capacity (MGD) Phase I	WWTP Capacity (MGD) Phase II
1.	Tikri Kalan	2.7	2.0
2.	Mitrao	5.6	3.5
3.	Dichao Kalan	5.6	4.0
Sub Total (MGD)		13.9	9.5

The overall estimated sewage generation from the sub drainage zone is 28 MGD. The capacities are proposed in phase-wise manner, for phase I & II as shown above. Remaining capacity of 4.6 MGD has been proposed in phase III. Locations and capacities may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 12**.

Table 12: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Najafgarh	NJF-NJ	135	-	-	1
Jhuljhuli	NJF-JH	484	8	-	8
Dichaon Kalan	NJF-DK	568	3	2	3
Somesh Vihar	NJF-SV	382	3	-	3
Total		1569	14	2	15

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 13**.

Table 13: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Najafgarh	Najafgarh	3	2.0 - 2.4				
Jhuljhuli	Jhuljhuli	2.1	1.4 - 1.7	Kazipur	Terminal WWPS	5.00	-
		1.9	1.2 - 1.5	Khera Dabar Extn	Terminal WWPS	5.00	-
		1.1	0.71 - 0.90	Shikarpur	Terminal WWPS	3.00	-
		2.1	1.4 - 1.7	Zafarpur	Terminal WWPS	5.00	-
		3.2	2.1 - 2.6	Samaspur Khalsa	Terminal WWPS	7.00	-
		3.2	2.1 - 2.6	Pandwala Kalan	Terminal WWPS	7.00	-
		3.8	2.5 - 3.1	Jhul Jhuli	Terminal WWPS	8.00	-
		1.8	1.2 - 1.5	Raota Village	Terminal WWPS	4.00	-
Dichaon Kalan	Dichaon Kalan	4.7	3.0 - 3.8	Hari das Colony	LS	1.0	39.6
				Tikri Kalan	Terminal WWPS	10.0	-
		9.1	5.9 - 7.4	Mitraon WWPS	Terminal WWPS	18.0	-
		9.6	6.2 - 7.8	Dichao Kalan WWPS	Terminal WWPS	19.0	-
				Jharoda Kalan	LS	1.0	36.9
Somesh Vihar	Somesh Vihar	12.0	7.8 - 9.7	Tajpur Khurd	Terminal WWPS	24.0	-
		4.5	2.9 - 3.6	Goyala Vihar	Terminal WWPS	9.0	-
		3.4	2.2 - 2.8	Badu Sarai	Terminal WWPS	7.0	-

Line Diagram for Proposed WWPS and WWTP for Dichaon Kalan is shown in **Figure 19**:

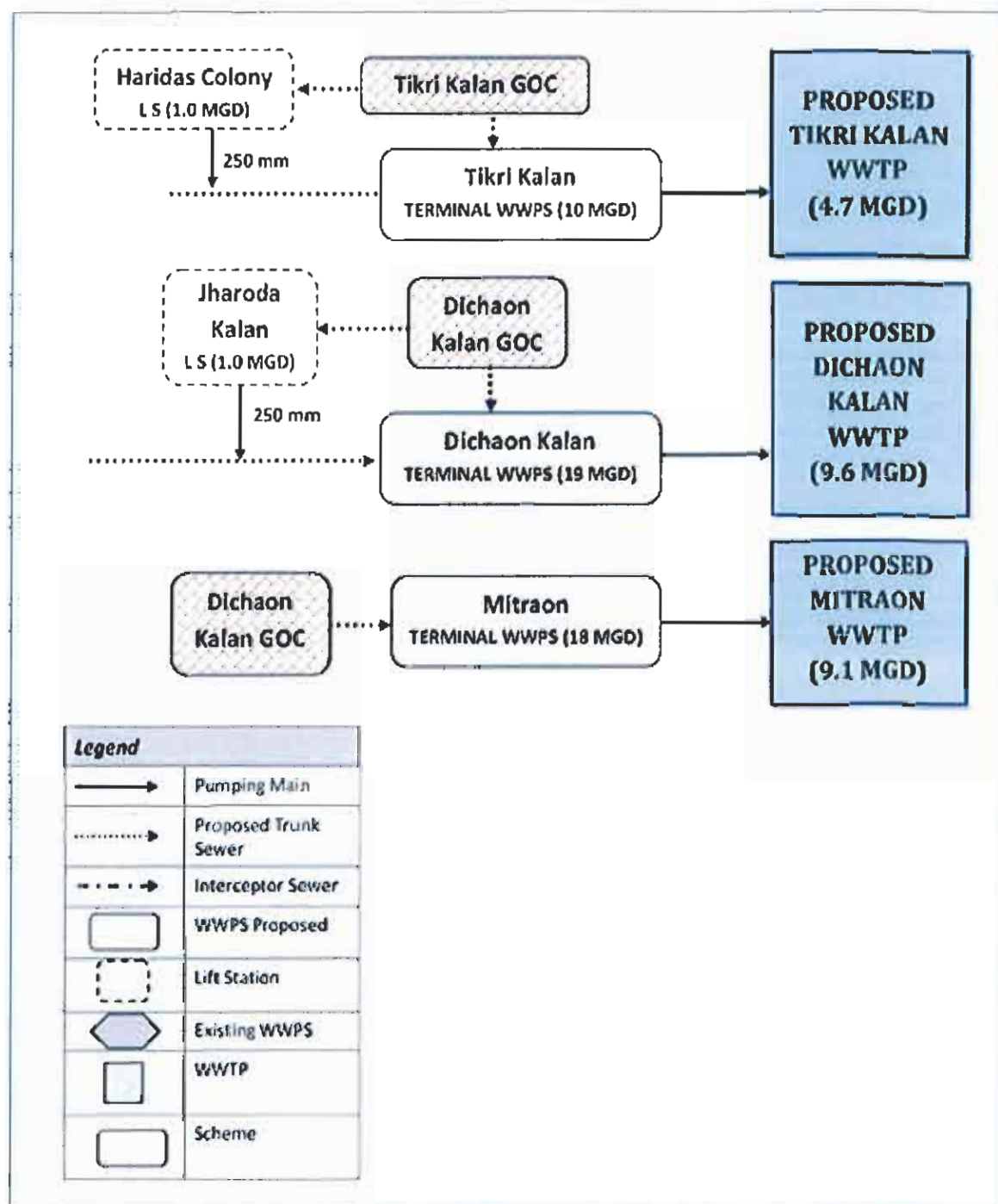


Figure 19: Line Diagram for proposed WWPS and WWTP for Dichaon Kalan (NJF-DK)

Line Diagram for Proposed WWPS and WWTP for Somesh Vihar is shown in **Figure 20**:

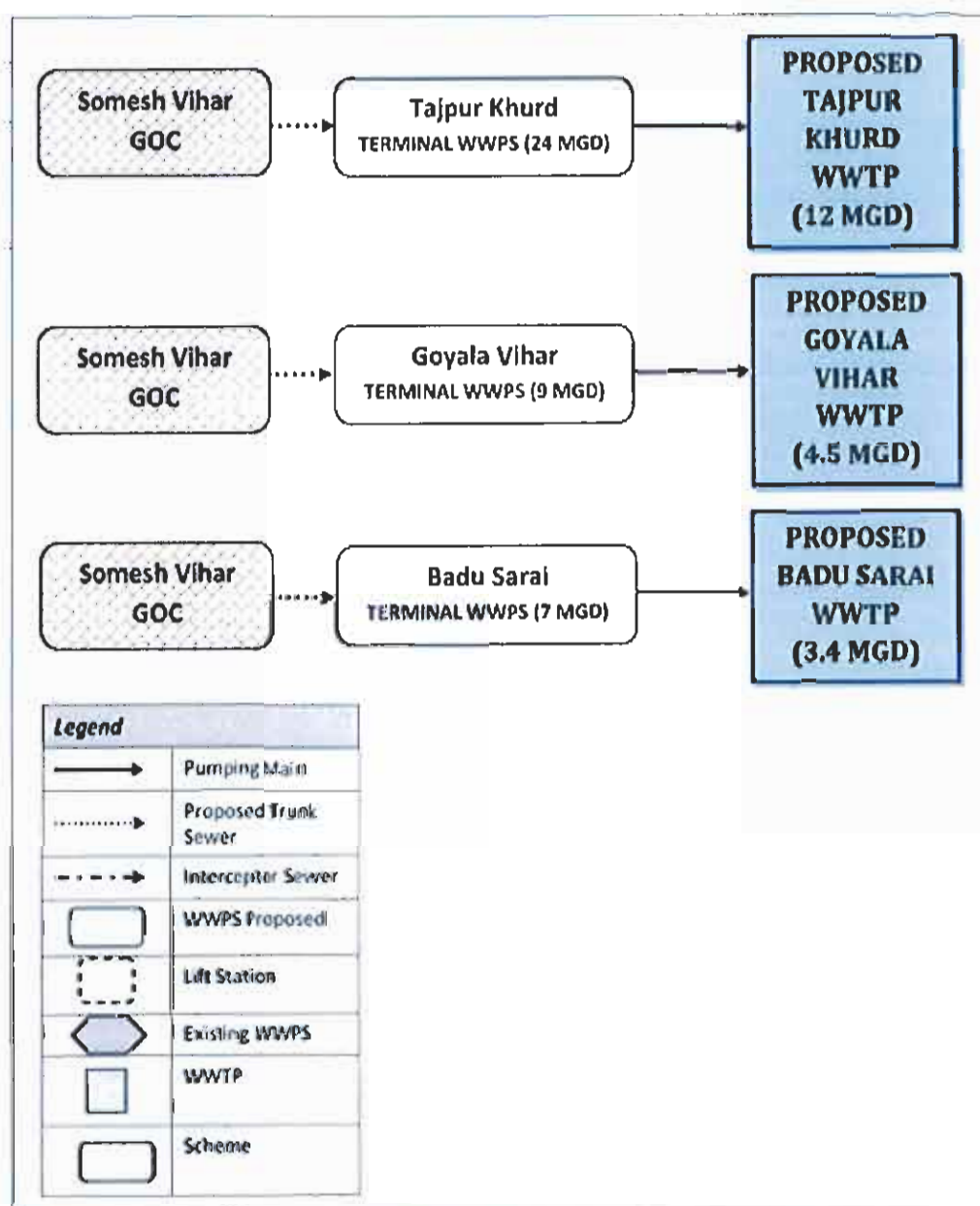


Figure 20: Line Diagram for proposed WWPS and WWTP Somesh Vihar (NJF-SV)

Line Diagram for Proposed WWPS and WWTP for Jhuljhuli is shown in **Figure 21**:

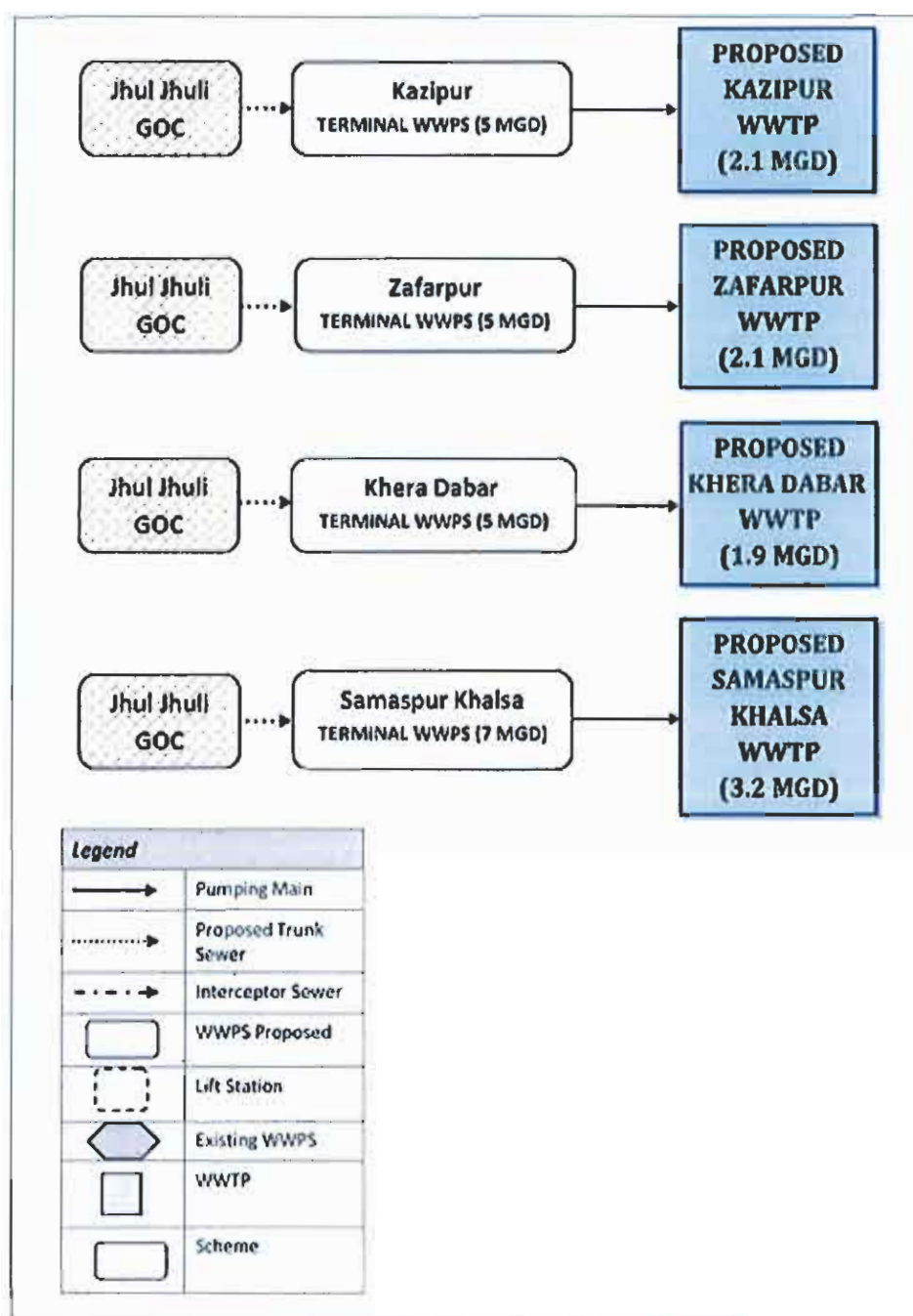


Figure 21: Line Diagram for proposed WWPS and WWTP for Jhul Jhuli (NJF-JH) Contd...

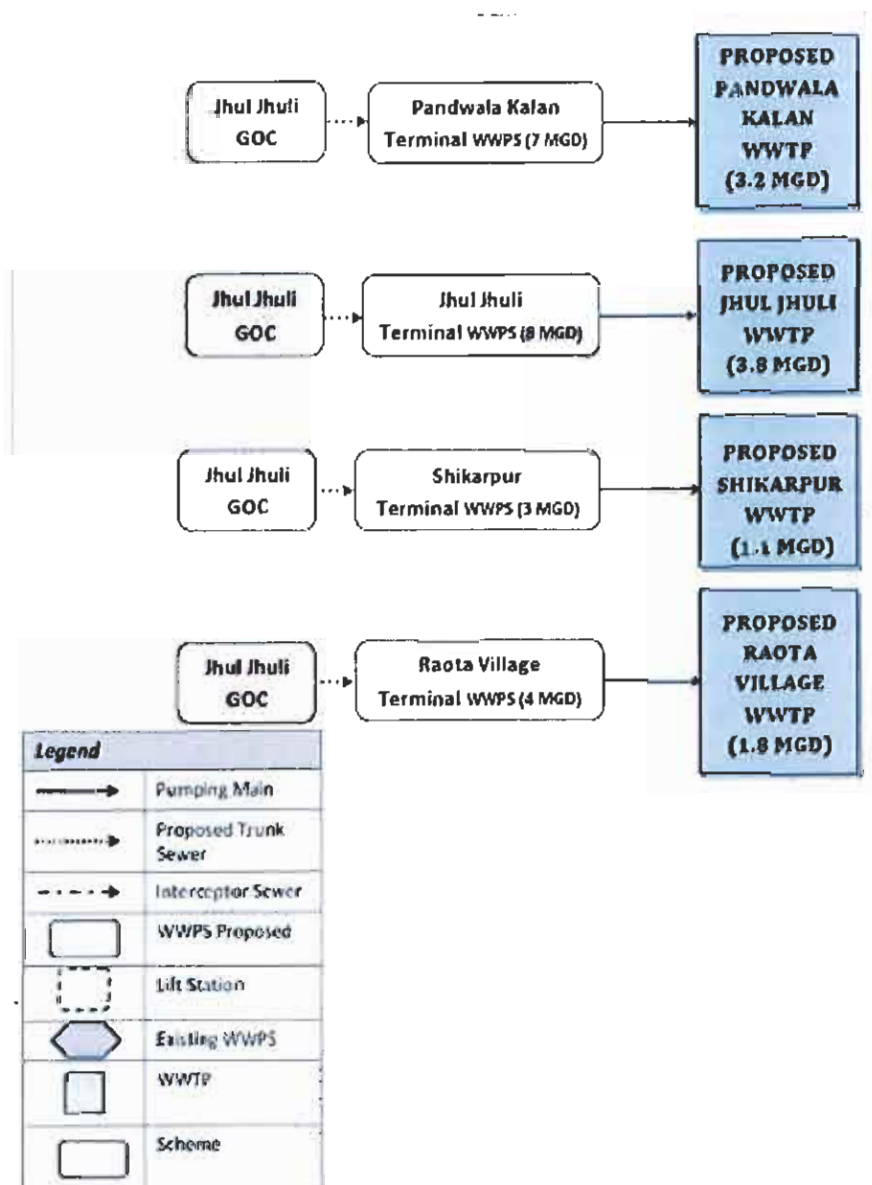


Figure 22: Line Diagram for proposed WWPS and WWTP for Jhul Jhuli (NJF-JH)

Line Diagram for Proposed WWPS and WWTP for Najafgarh is shown in **Figure 23**:

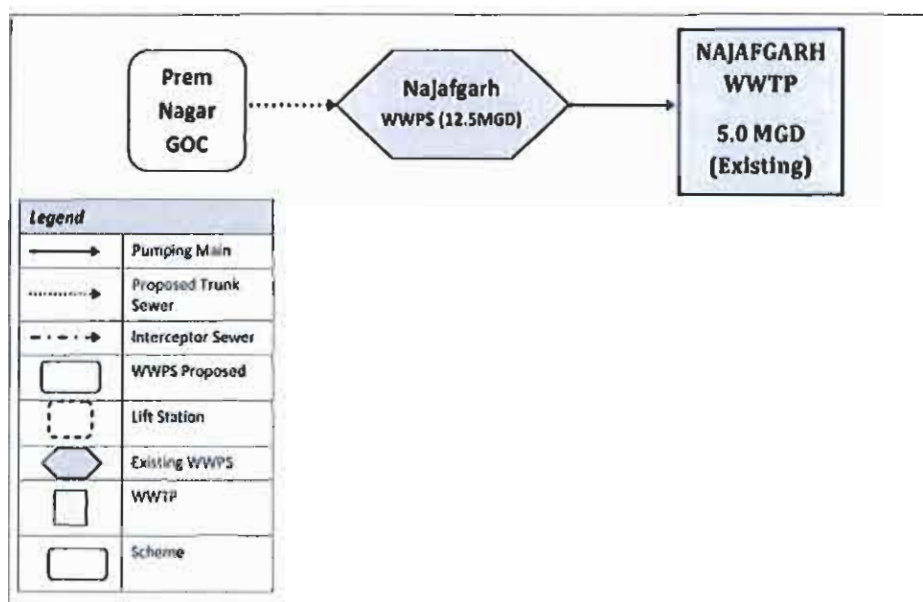


Figure 23: Line Diagram for proposed WWPS and WWTP for Najafgarh (NJF-NJ)

Disposal of Treated Effluent

Likely user of Treated Effluent is DMRC for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area. Remaining treated effluent from proposed WWTP is proposed to be discharged to nearby drains discharging to Najafgarh Drain.

The proposed sewerage scheme for Najafgarh Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in the **Figure 24**.

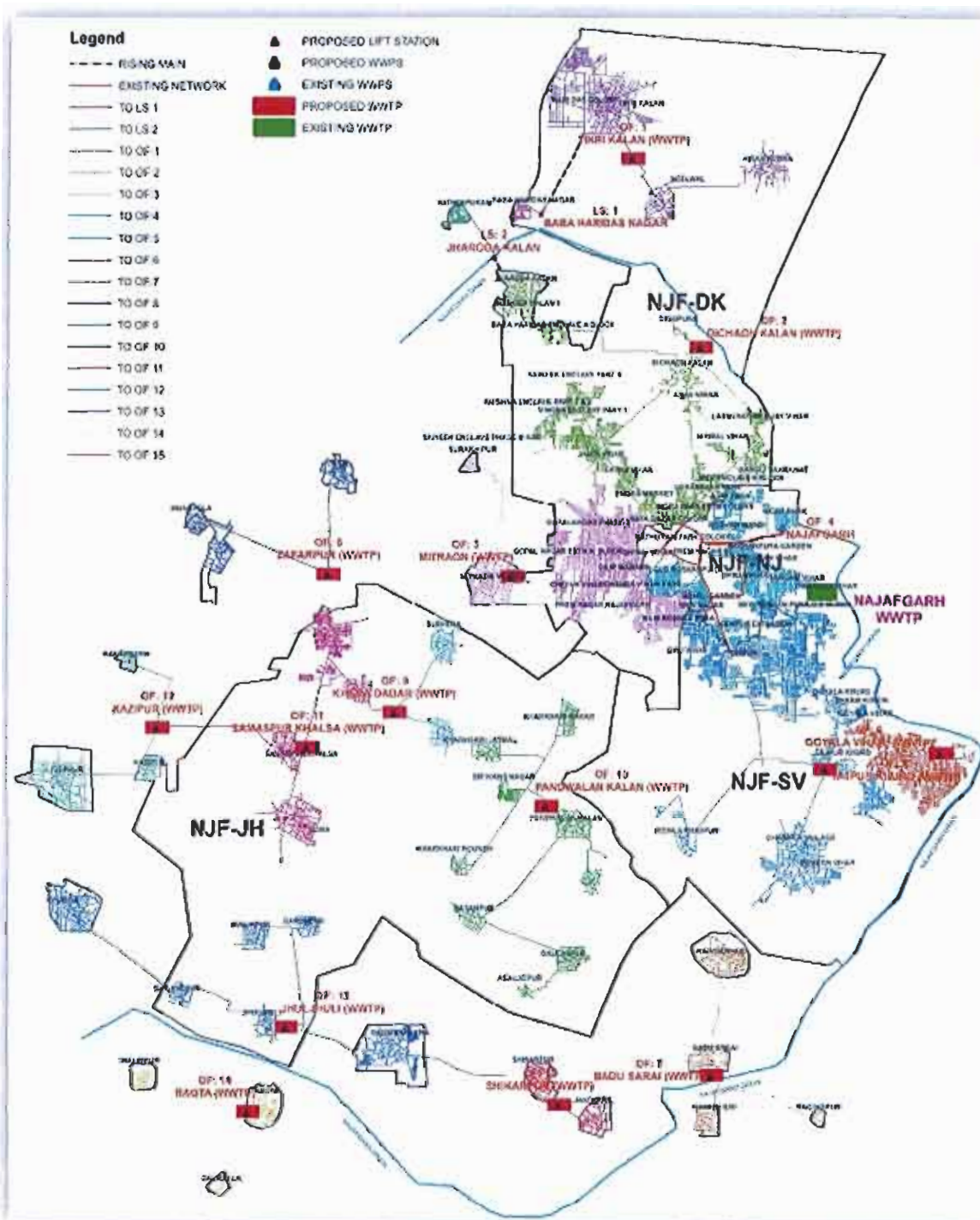


Figure 24: Proposed Sewerage Scheme for Najafgarh Drainage Zone

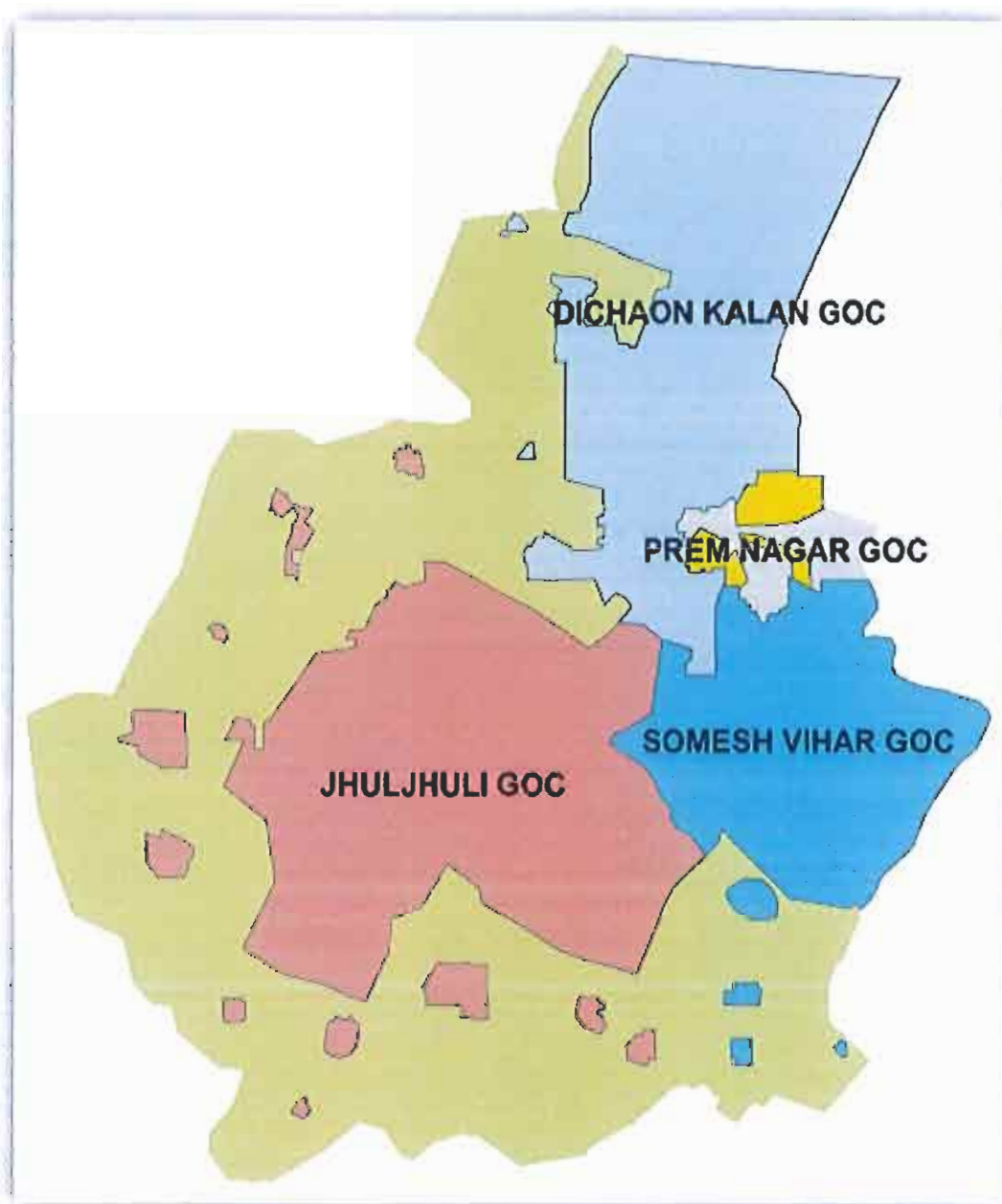


Figure 25: GOC – wise Sewerage Schemes – Najafgarh Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 14: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Najafgarh	NJ	NJF-NJ-IP	Prem Nagar GOC				
2	Jhuljhuli	JH	NJF-JH	Jhuljhuli Village GOC				
3	Dichaon kalan	DK	NJF-DK	Dichaon Kalan GOC				
4	Dichaon kalan	DK	NLT-DK-TK	Tikri Kalan GOC				
5	Somesh Vihar	SV	NJF-SV	Somesh Vihar GOC				

Table 15: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Name of Colonies
1	Dichaon Kalan GOC	Aradhna Enclave Gopal Nagar Extn., Najafgarh New Delhi Bajrang Enclave, Nangloi Road, Najafgarh Chetan Vihar(Gopal Nagar Extn.)Dhansa Road, Najafgarh, Delhi. Chetan Vihar Deepak Vihar, Najafgarh, Delhi- Dichaon kalan Ext. main Dichaon road Ex. (ELD) Ekta Vihar (Block A,B& C) near new grain market, Jharoda Road, Naj. Ekta Vihar Baba Haridas Nagar B-Block Extended Abadi, Dhansa Gaon(Gopal Nagar), New Delhi-73 Gopal Nagar Extn., A- Block, Main Dhansa Road, Near Khaira xing, Najafgarh,Delhi 43 Gopal Nagar Extn. E- Block, Najafgarh,Delhi Gopal Nagar Extn.,N1 Block Gopal Nagar Nanda Enclave Gopal Nagar A-Block , Najafgarh, New Delhi Gopal Nagar B-Block Main Dhansa Road, Najafgarh Gopal Nagar Extn., P&R Block, Najafgarh Gopal Nagar M-N Block, Najafgarh, New Delhi-43 Gopal Nagar, N-Block, M.D. Road, Najafgarh Gopal Nagar P Block & Gopal Nagar Extn. (EFG&H Blocks)Main Dhansa road Gopal Nagar Ph-2, Z-Block, New Delhi-43 Gopal Nagar Ph-2, Z-Block, Surakhpur Road, Najafgarh, Delhi Gopal Nagar Ph-II, Shyam Vihar Chandan Enclave, Najafgarh Delhi GopalNagar Adivasi Colony Saraswati Enclave, Gopal Nagar, surakhpur Road Indira Market & Aggarwal Colony, aibatpura, Najafgarh, New Delhi-43 West Gopal Nagar Ph-II, Surakhpur Road, Najafgarh, Delhi- Sunder Nagar Gopal Nagar Extn. Surakh Pur Road, Najafgarh, Delhi GopalNagar Main D Block D-Block, Gopal Nagar, Najafgarh Haibatpura Extn. Near Anaj Mandi Bahadurgarh Road, Najafgarh, Delhi Dichaon enclave Opp. D.K. depot, Nangloi Road Janta Vihar, Jharoda Road, Najafgarh Krishna Enclave Part-II, Dichao Kalan Road, New Delhi-72 Krishna Enclave Opp. C.R.P.F. Camp, Dichaon Road, Jharoda Kalan Laxmi Vihar B-Block Nangli Sakrawati, Delhi Mitraon Extn.Main Dhansa Road, Najafgarh, New Delhi-43 Mitroan Mitraon Uttam Samiti ICE,Factory Road Village Mitraon New Delhi 43 New Gopal Nagar Exten. ABCD Block , South of Dhansa Road, Naj. Nirmal Vihar, Najafgarh, Delhi Sainik Enclave New Delhi - 43

Sl. No.	Name of GOC	Name of Colonies
		Sainik Enclave, Jharoda Kalan Road, Najafgarh Sainik Enclave Part-II, Jharoda Kalan , Najafgarh, Delhi Sainik Enclave, CRPF Colony, Jharoda Kalan, New Delhi-72 Naveen Place, Jharoda road, Najafgarh Naveen Place Block-C-I, Jharoda Road, Najafgarh, Delhi Naveen Place, D-Block, Najafgarh, New Delhi Saraswati Kunj, CRPF Road , Jharoda Kalan, Najafgarh Satyam Puram Jharoda Kalan Border, Delhi Shiv Enclave, Main dichaoon road, Najafgarh, New Delhi-43 Bengali Colony and New Vision Colony Shri Krishna Colony, Surakh colony Road, Gopal Nagar, Najafgarh Shyam Enclave (Z-Block), Gopal Nagar Extn., Najafgarh Shyam Enclave Deendarpur Najafgarh, Delhi Sultan Garden B-Block, Najafgarh, Nangloi Road, Delhi-43 Surya Kunj, Bahadurgarh Road, Najafgarh, Delhi-43 Surya Kunj Pt.-I, Dichaon Road Najafgarh, Delhi Baba Hari Dass Colony, Jharoda Kalan New Delhi 72 Baba Haridass Enclave A-Block, Jharoda Kalan, N.Delhi-72 Jharoda kalan (ELD) Jharoda Kalan Baba Hari Dass Nagar, Najafgarh, Bahadur garh road, Najafgarh Chandan place, Kali Piau, Jharoda Road, najafgarh Dichaon Kalan Mahesh Garden , No.1, Haibatpura, Bahadurgarh Road, Najafgarh, New Delhi Mahesh Garden, Main Bahadur Garh Road, Najafgarh, New Delhi-43 Naveen Palic Colony New Hira Park, Dichaon Road, Najafgarh, New Delhi-43 Nanu Ram Park Haibat Pura, Jharoda Road, Najafgarh, Delhi-43 Hari Dass Enclave, Jharoda Kalan, New Delhi-72 Vinoba Enclave, CRPF, Jharoda Kalan Vinoba Enclave,C-Block, Near CRPF, Najafgarh Bhadurgarh Road Delhi Vinoba Enclave Extn. CRPF Colony, Jharoda kalan, Najafgarh, New Delhi Vinoba Enclave A-1 Block, Najafgarh Main Road opp. DSIDC Shop, Delhi Sainik Niketan, Najafgarh, Delhi Luxmi Ngr. Digupura, Asha Niwas
2	Prem Nagar GOC	Rewala Khampur Dinpur Extn., Goyla More, Dinpur, Najafgarh, New Delhi-93 Dindarpur Extn. Chhawala Road, Delhi-43 Hasanpur Ajay park, Naya Bazar, D-Block, Najafgarh Nathu Ram Park , Tehsil road, Najafgarh

Sl. No.	Name of GOC	Name of Colonies
		Sai Baba Enclave, Najafgarh, Delhi-43 Sai Baba enclave, B-Block(part-B) Najafgarh Chander Mohalla Dharampura Extn., Najafgarh Chinar Enclave, Najafgarh, Delhi Data Ram Park Near Deendarpur Najafgarh, Delhi Shri Anand niketan Laxmi Vihar D-Block, Najafgarh, Delhi Gopal Nagar Extn., A-block, Gopal Nagar (Sabzi Mandi) Najafgarh Dharampura Extn. RD-Block, Kakrola road, Najafgarh, N.Delhi East Krishna Vihar A B Block, Khaira Road Najafgarh Madhav Enclave, khaira Road, Najafgarh, New Delhi- New Gopal Nagar, A&B Block, Nanak Piou, Dhansa Road, Najafgarh Gopal Nagar, Block AM & N Block Extn. Najafgarh Gopal Nagar Extn., A- Block, Gopal Nagar, (Sabzi Mandi) Gopal Nagar Extn. Ph-II Block A & B , Surakhpur Road, Najafgarh Gopal Nagar Extn. Main surakhpur Road, Najafgarh Gopal Nagar extn. Najafgarh Gopal Nagar Extn., A-block, Gopal Nagar (Sabzi Mandi) Najafgarh Gopal Nagar Extn. Ph-I, Main Khaira Road, Delhi-43 Nanda Enclave Dhansa Road, Najafgarh, Delhi Dalip Vihar, Near Saroj Cinema, Najafgarh, Delhi Kashmiri Enclave, Kishan Chand enclave, Basco Colony, arya Nagar, Gopal Nagar Extn. Najafgarh Main Gopal Nagar, Najafgarh, Delhi Haibatpur Amar Vihar Colony, Indra Park Extn, New Delhi-43. Indra Park Extn. Guru Nagar, Najafgarh Indra Park, Najafgarh, New Delhi Indra Park F Block Maksudabad, Najafgarh, N.D Krishna Vihar West, Najafgarh, Delhi Krishna Vihar East Lokesh Park & Heera Park Extn. Najafgarh, Delhi Lokesh Park, Near DTC Bus Terminal, Bahadurgarh Road. Najafgarh extn. (Maksudabad) Nangloi Road, Delhi Najafgarh Extn. Ph-I, (Maksudabad) B -Block Najafgarh Extn. Ph- I, (Maksudabad), B-Block Najafgarh Extn. (Maksudabad), B,E,F- Block Maksudabad Najafgarh Park Colony, Block A,B & C , Dichaon road, Najafgarh Roshan Pura Old Roshan Pura, J-Block, Najafgarh-43 Old Roshan Pura Extn., B-Block, Najafgarh, ND-43 Old Roshanpura Extn. C-Block, Najafgarh. Shiv Vihar, Prem Nagar, G-Block Paprawat Road Najafgarh Raghubir Block, Prem Nagar, Najafgarh Paprawat Road Prem Nagar

Sl. No.	Name of GOC	Name of Colonies
		Prem Nagar YC Block Prem Nagar AB & DEF Najafgarh Prem Nagar C-Block, Najafgarh Delhi Vatasta Enclave (Kashmiri Colony) Prem Nagar, Z- Block, Najafgarh Prem Nagar G-Block Left out Portion, Najafgarh, New Delhi-43 Prem Nagar Z- Block, Najafgarh South West, Delhi Prem Nagar, H-Block, Old Khaira Road, Najafgarh, D-43 Roshanpura Garden Roshan Garden, Najafgarh, Delhi Roshan Garden-II, Kakrola Road, Najafgarh Vivek Nagar, E-Block, Roshan Vihar, Ph-2, Najafgarh, Delhi Roshan Vihar Kakrola Road, Najafgarh, New Delhi Roshan Vihar, Gurgaon road, Najafgarh Roshan Vihar Pt-I, D-Block, Gurgaon Road, Najafgarh New Delhi - 43 Shiv Enclave Extn., Nangloi Road, Najafgarh, Delhi-43 Shiv Enclave D2 block Shiv Enclave E Block Shiv Nagar New Roshanpura Quatab Vihar Ph-I, Najafgarh, Delhi-71 Qutab Vihar Ph-II, New Delhi-71 Surya Vihar, Deendarpur, Gurgaon Road, Najafgarh Gandhi Park Main Gurgaon road, Deenpur, Najafgarh Qutub Vihar Phase I, Extn. E- Block New Delhi 59 Shyam Vihar Phase II, (Behind Pooja Pipe Factory) Near 40 Ft Road Najafgarh New Delhi 43 (LOP) Sudan Garden, Najafgarh, New Delhi Ugarsen Park, Nangloi Road, Delhi-43 Ugrashen Park Durga Vihar Extn. Najafgarh Durga Vihar, Ph-III, Najafgarh, New Delhi Durga Vihar, Phase-I, Gurgaon Road, Najafgarh, New Delhi-43 Durga Vihar Ph-II Najafgarh, Delhi Shivpuri Dindarpur, Part-I New Delhi-43 Sri Ganga Vihar Colony DinDar Pur Najafgarh Dindapur Bhawani Nagar Near Dinpur Najafgarh, Delhi Golden Enclave B Block Nangil Sakrawati, Delhi Chhawla Extension, Paharwa Colony Part-I, New Delhi-71 Chhawla Ext., Kangan Heri Road Chhawla Extn.1 Panchia Mohalla Delhi-71 Daula pur Deen pur Deendarpur Extn. Najafgarh, Delhi Dharam Pura Extn. D-Block, Kakrola Road Najafgarh, New Delhi D-block, Srichand Park (Dharampura Extn.) Najafgarh New Delhi -

Sl. No.	Name of GOC	Name of Colonies
		110043 Shankerpark Dharam Pura Extn. Najafgarh Dharam Pura –II & I Block , Najafgarh, New Delhi-43 H & I Block, Dharampura Najafgarh D-I attach Kamala Parak and Gao Shala Colony at Najafgarh Dharam Pura Ph-I, kakrola Road , Najafgarh Shiv Nagar Virendra Market, Raghuvir enclave, Najafgarh, New Delhi Raghuveer Enclave Prem Nagar, Z-Block, Paprawat Road, Najafgarh, Delhi-43 E- Block Prem Nagar Najafgarh New Delhi 43 Ganpati Enclave X-Block, New roshan Pura Extn. Najafgarh, Delhi-43 Kamla Enclave, New roshan Pura Extn. Najafgarh Ganapati Enclave Extn. Najafgarh, New Delhi. Gupta Market Najafgarh, Delhi Jerman Nagar Kashmiri Colony Revenu Estate Of Village Khera On Old Khaira Road Najafgarh New Delhi Shiv Vihar Khera Dabar Najafgarh New Delhi-73 Baba Garib Das Colony Khera Dabar Najafgarh Delhi-73 Khera Dabar Extn.Colony North West Najafgarh Delhi-73 Khera Dabar Naya Bazaar Colony, Najafgarh Mundela Kalan Mundhala Khurd Najaf garh Nangli Sakarwati New Roshan Pura (KLM Block) Najafgarh, New Delhi New Roshan Pura A2, B1, A2, N1 & P3 Block, Najafgarh, N. Delhi. Prem Nagar A-Block Ph-IV, Najafgarh, Delhi Prem Nagar B-Block, Najafgarh, New Delhi-43 Prem Nagar D-Block, Najafgarh Prem Nagar Ph-1,2,4 thana Road, Najafgar, Delhi Prem Nagar, B-Block Ph-III, Najafgarh, Delhi Prem Nagar, D-Block Extension Prem Nagar, G-Block, Left out portion Near Sant Kabir Ashram, Naj. Prem nagar, F & G Block Prem Nagar Najafgarh G-Block &G-1, Delhi Naya gopal Nagar, Surakhpur Road, Najafgarh New Delhi- New Roshan Pura Extn J Block, Najafgarh, New Delhi New Roshan Pura Extn. Block P,P-1,P-2, N-1,B-1, N Najafgarh New roshan Pura Extn. Z-Block, Najafgarh, Delhi New Roshan Pura, E-Block, Najafgarh, New Delhi-43 Neelkanth Enclave Najafgarh Vardhman Vihar, U&F Block, New Roshanpura Extn., Najafgarh. Kamla Kunj Najafgarh Raota

Sl. No.	Name of GOC	Name of Colonies
		Roshan Mandi, Najafgarh road, Delhi-43 Vijay Park, Extn. (LOP), Gali No.15, Najagarh Roshan Vihar Ph-II, Paprawat Road Najafgarh Sai Lal bagh, Housing complex, village jaffarpur kalan (ELD) Samaspur Khalsa Qazi Pur Surheda Sarika Vihar, Goyla More, Deenpur Extn., Najafgarh Shanti Vihar Shanti Vihar, Dinpur, Najafgarh, New Delhi-43 Durga Park Din Darpur Extn. Najafgarh, Delhi Taj pur Munirka Kunj, Deendarpur Shiv Puri Part-II, Deenpur, Najafgarh Sri Hans Nagar Colony, Ghumanhera Road, Najafgarh Hans Nagar, Pandwala Kalan, Najafgarh, Delhi-43 Sri Sai Baba Enclave Najafgarh, Delhi Kair Geola Khurd Chhawla Extn. Near B.S F CaM. Pur Gurgaon Road Chhawla, Delhi Ragho pur Aggarwal Market Issapur Bakargarh
3	Somesh Vihar GOC	Brij Vihar, Najafgarh, Delhi Defence Enclave Goela Tajpur Khurd Najafgarh, Delhi Defence Enclave Goela Tajpur Rd. Chawla New Delhi-71 Dharam Pura A-1 Block, Najafgarh, Delhi- Dharampura extn. A-2 Block, Najafgarh New Delhi-43 Dharmapura, Block A-3, Najafgarh, New Delhi-43 Dhramapura RD BLOCK Dwarka Vihar, Kakrola Road, Najafgarh, New Delhi-43 Tajpur Khurd Nehru Garden Colony New Roshanpura Najafgarh (LOP) New Roshan Pura Extn. O-Block, Najafgarh, Delhi New Roshan Pura Extn. X-Block, Najafgarh, New Delhi New Roshanpura Extn., Part-II (Prem Nagar 'G' Block) Najafgarh, Delhi New Roshan Pura Extn., Y Block, Paprawat Road, Naj., New Delhi-43 New Roshanpura Colony, S-Block, Najafgarh, New Delhi-110043. Sangam Vihar, kakrola Road, Najafgarh, New Delhi-43 Shyam Kunj, Najafgarh, Delhi-71 Shyam Vihar, Deenpur, Najafgarh Risal Vihar Chhawla Extn Najafgarh, Delhi Chhawala

Sl. No.	Name of GOC	Name of Colonies
		Goyala Vihar, Najafgarh, Delhi Somesh Vihar, Chhawla, Najafgarh Kangan Heri
4	Jhuljhuli GOC	Darya Pur Khurd Dabar Enclave (SR Block A) Raota More , Jaferpur, Najafgarh, Delhi Dabar Enclave sr block A2 Dabar Enclave sr block A3 Durga Enclave, Jaferpur Kalan, Najafgarh, Delhi-73 Dhansa Asalat pur Kawad Badusarai Darya Pur Daurala Galib pur Ghumman Hera Hasan Pur Jhatikra Jhul Jhuli Kharkhari Jatmal Kharkhari Nahar Endra Market Chitra Market Colony Khorkhari Road Nanak Heri Pandwala Kalan Pindwala Khurd Rural Village Malikpur New Delhi 73 Malik Pur Jafarpur Extn. Jafarpur Kalan, Najafgarh, New Delhi-73 Jaffar Pur Kalan Sarang pur Shikar pur Ujwa

ANNEXURE - 10

OKHLA DRAINAGE ZONE (OKH)

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OKHLA DRAINAGE ZONE (OKH)

1. INTRODUCTION

Okhla Drainage Zone is one of the largest extending from Timarpur in the North to Mehrauli-Badarpur road in the South and from River Yamuna in the East to Ridge road and Gurgaon road on the West. The area has a mixed type of development with residential, commercial and industrial areas. Connaught Place towards North and Nehru Place towards South are predominantly commercial areas. There are institutional areas in the south such as Indian Institute of Technology (IIT), Jawaharlal Nehru University (JNU), etc. Some of the garden/opens spaces in the area are Deer Park, Kalkaji District Park, Lodhi Garden, President's Estate and Nehru Park etc. Major industrial areas are towards south of the drainage zone, like Okhla Industrial Area and Okhla Industrial Estate. Location of Okhla Drainage Zone is shown in the *Figure 1*.

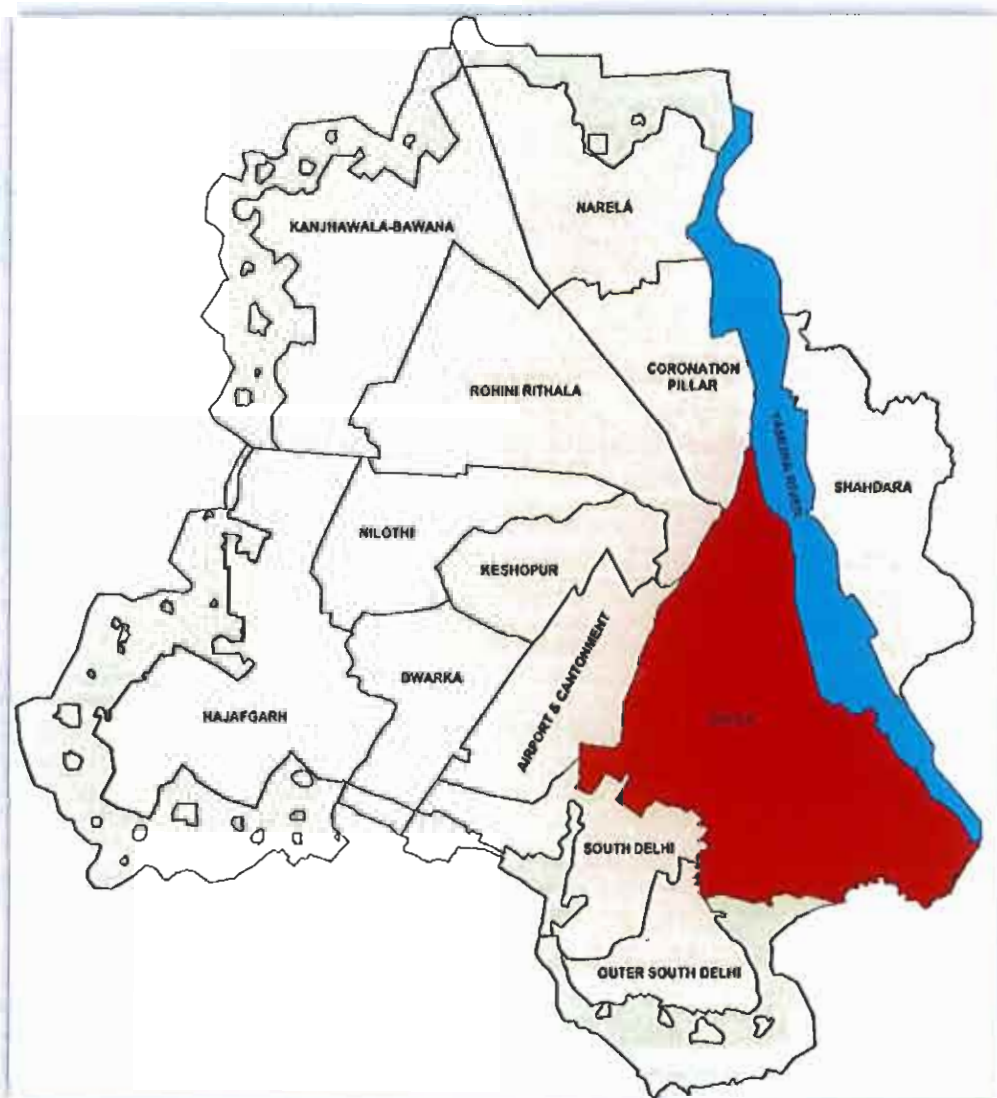


Figure 1: Okhla Drainage Zone

Okhla Drainage Zone comprises major areas like Lodhi Road, India Gate, Connaught Place, Lajpat Nagar, Nehru Place, Sarojini Nagar, Batla House, Badarpur, Sangam Vihar, Sainik Farm, Saidullajab, Neb Sarai, part of Maidangarhi, Pulprehladpur, Shaheen Bagh, Tuklaqabad, Molarband etc. This drainage zone covers major parts of DDA Zone A, F, D and a small part of Zone C as shown in the *Figure 2*.

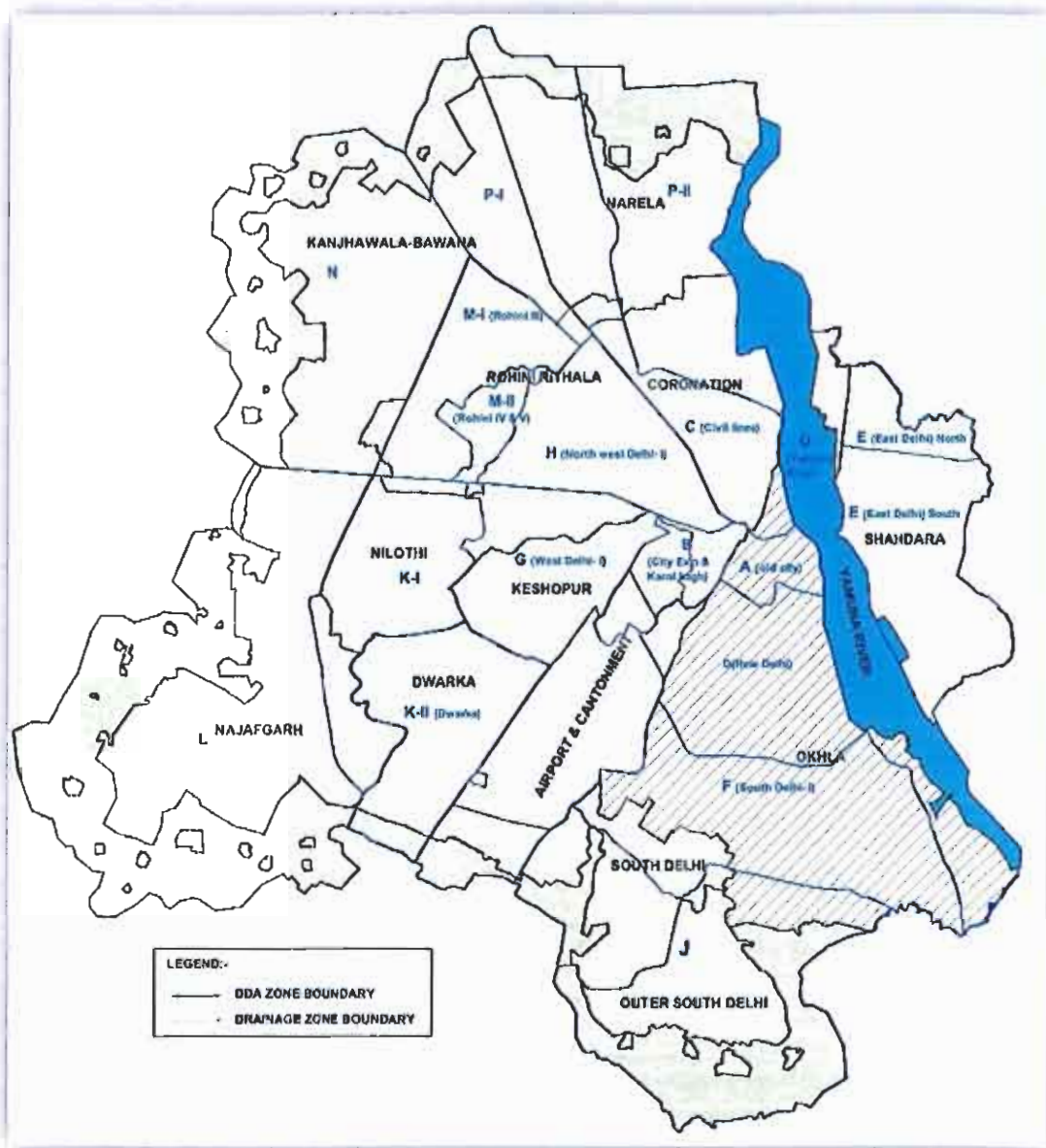


Figure 2: DDA Zones and Okhla Drainage Zone

Soil Description of Okhla

The central belt of this zone is mainly covered with older alluvium deposits including areas like South Ext-I, Lodhi Colony, Defence Colony, Sarojani Nagar, ChanakyaPuri, Pahargunj, Chandni Chowk, Sadar Bazaar etc. whereas the peripheral belt having areas like Vasant kunj, South Sanik Baag, TuglakaBad etc. are under Delhi Super Group. Okhla zone having areas like Chandni Chowk, Pahargunj, Sadar Bazaar, CP, Pragati Maidaan, Jang Pura, Maharani Baag, ChanakyaPuri, Sarojni Nagar, Safdarjung Enclave, Lodhi Colony, Defence Colony, Kalkaji, Nehru place etc. is considered to be in Central delhi zone with Moderate Hazard due to amplification in mid frequency level and Basin margin effect. Only the portion of Badrapur and Sarita vihar is having layer of impedance contrast at shallow depth (<30m) with Moderate hazard. The upper portion of this zone covering majorly Chandni Chowk, Pahargunj, sadar Bazaar, CP, Pragati Maidaan, Jang Pura, Maharani Baag etc. is having water depth varying from 5 – 20m. The bottom portion of this zone which includes ChanakyaPuri, Sarojni Nagar, Safdarjung Enclave, Lodhi Colony, Defence Colony, Kalkaji, Nehru place etc. is having water depth varying from 20-60m. Half of this zone towards left end along the river Yamuna i.e. C.P., Pragati Maidan, Chandni Chowk, Pahargunj, Lodhi Colony, Lajpat Nagar, Nizamudin, Jangpura, defence Colony etc. is covered with Bangar Soil. Rest of the portion having Ramakrishna Pura, Safdarjung Enclave, Huaz khaz, Munirka, Sangam Vihar etc. is having Kholi Soil.

2. MASTER PLANNING FOR OKHLA DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

The zone comprises planned and well maintained posh residential localities. It also includes rehabilitation colonies and government housing areas. A significant feature of this zone is its urban heritage, where first four cities of Delhi namely, Lal Kot, Siri, Tuglakabad and Jahanpanah are located. There are number of developed parks which also include city forests and the ridge area. This zone also has well planned residential areas.

The major area of Okhla Drainage Zone is sewered except for South Eastern side of the drainage zone. Topographical Survey & GIS integration has been carried out for unsewered portion of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

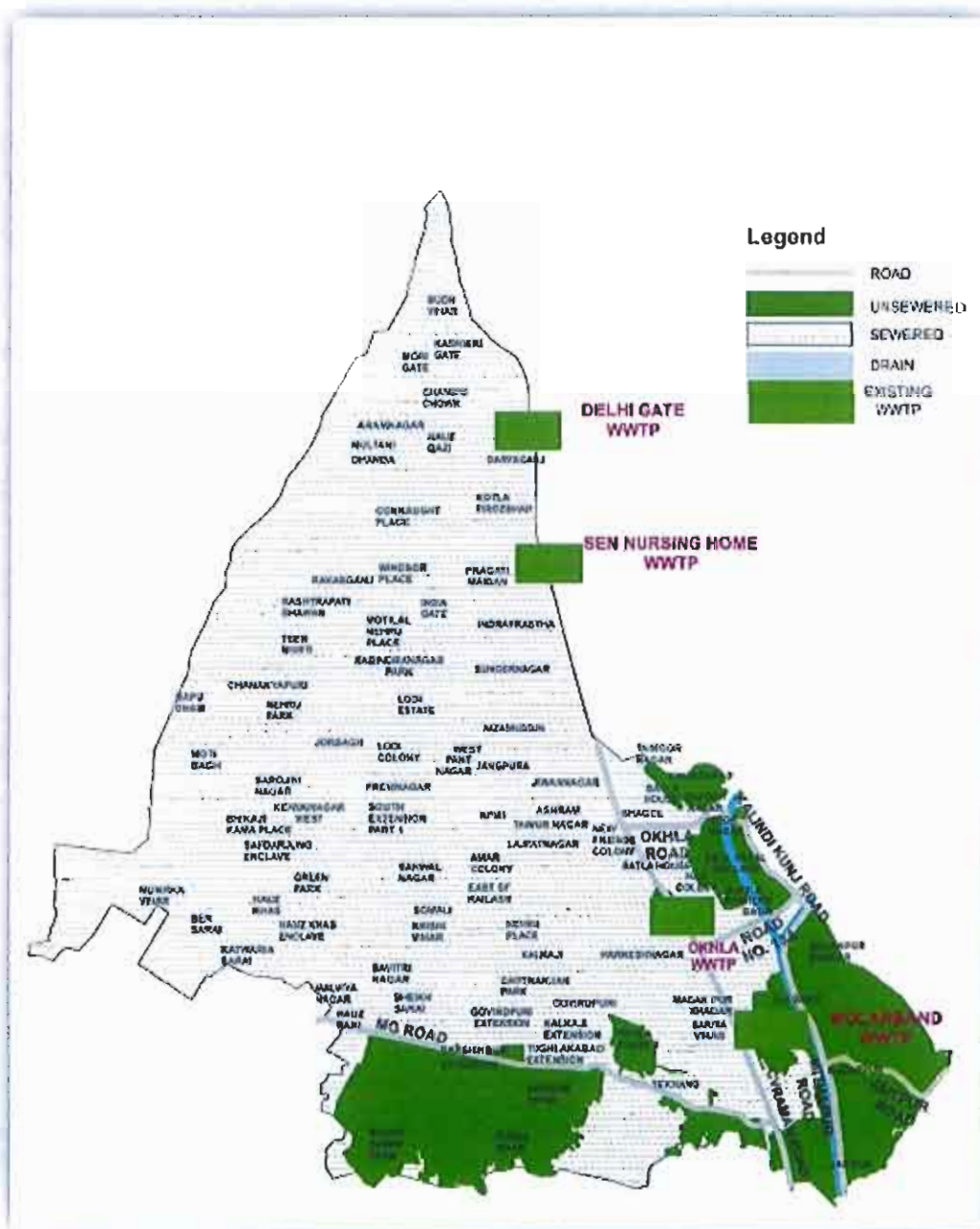


Figure 3: Sewerage Status of Okhla Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Okhla Drainage Zone has been divided into 2 Sub Drainage Zones as below:

- Okhla (OKH-OK)
- Tajpur (OKH-TP)

Okhla Sub Drainage Zone (OKH-OK) has been further delineated into OKH-OK1 and OKH-OK2 wherein former is sewered and the latter is unsewered.

Sub Drainage Zone Map and Contour Map are shown in the *Figures 4 & 5*.

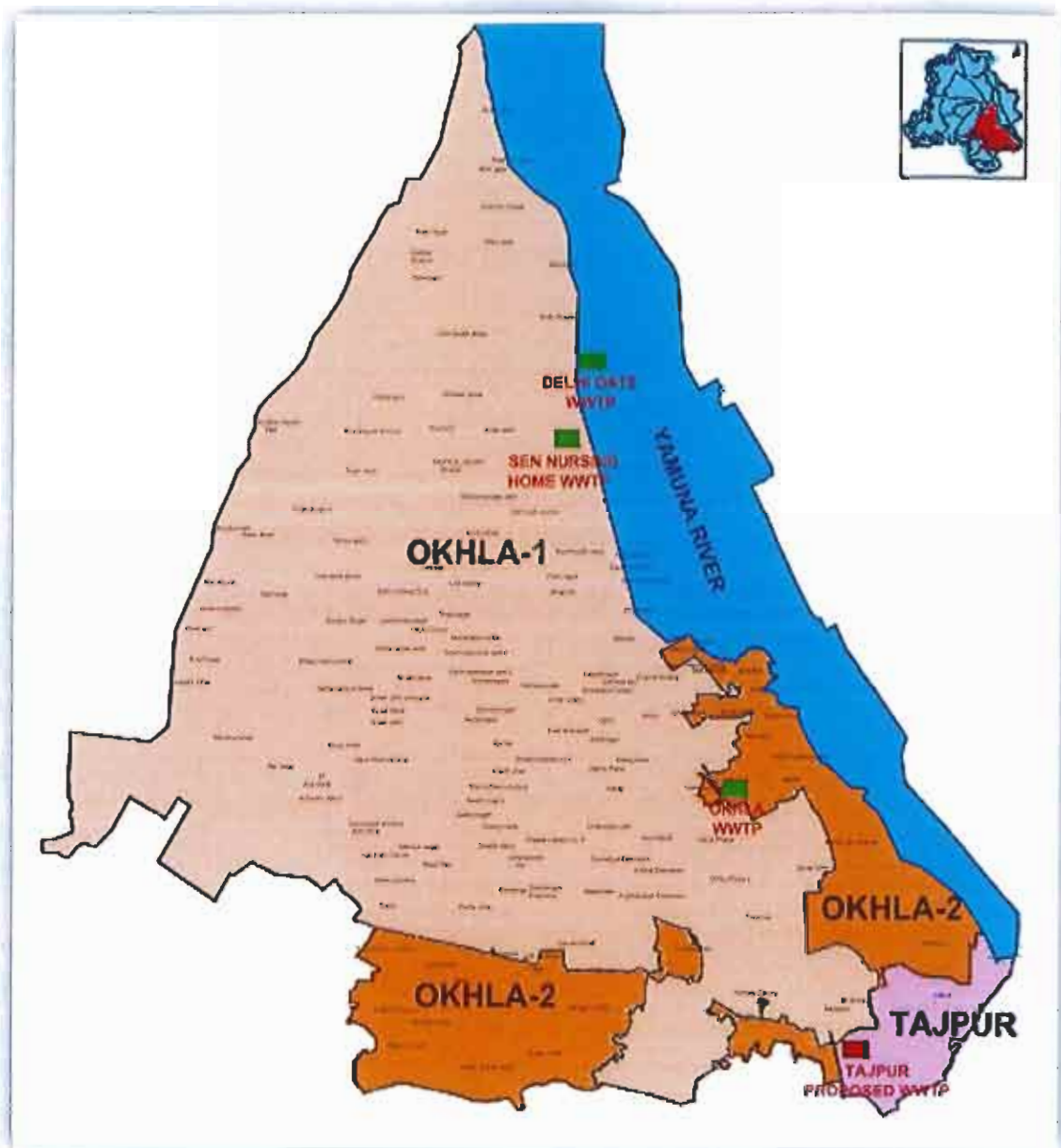


Figure 4: Sub Drainage Zone Map of Okhla Drainage Zone (OKH)

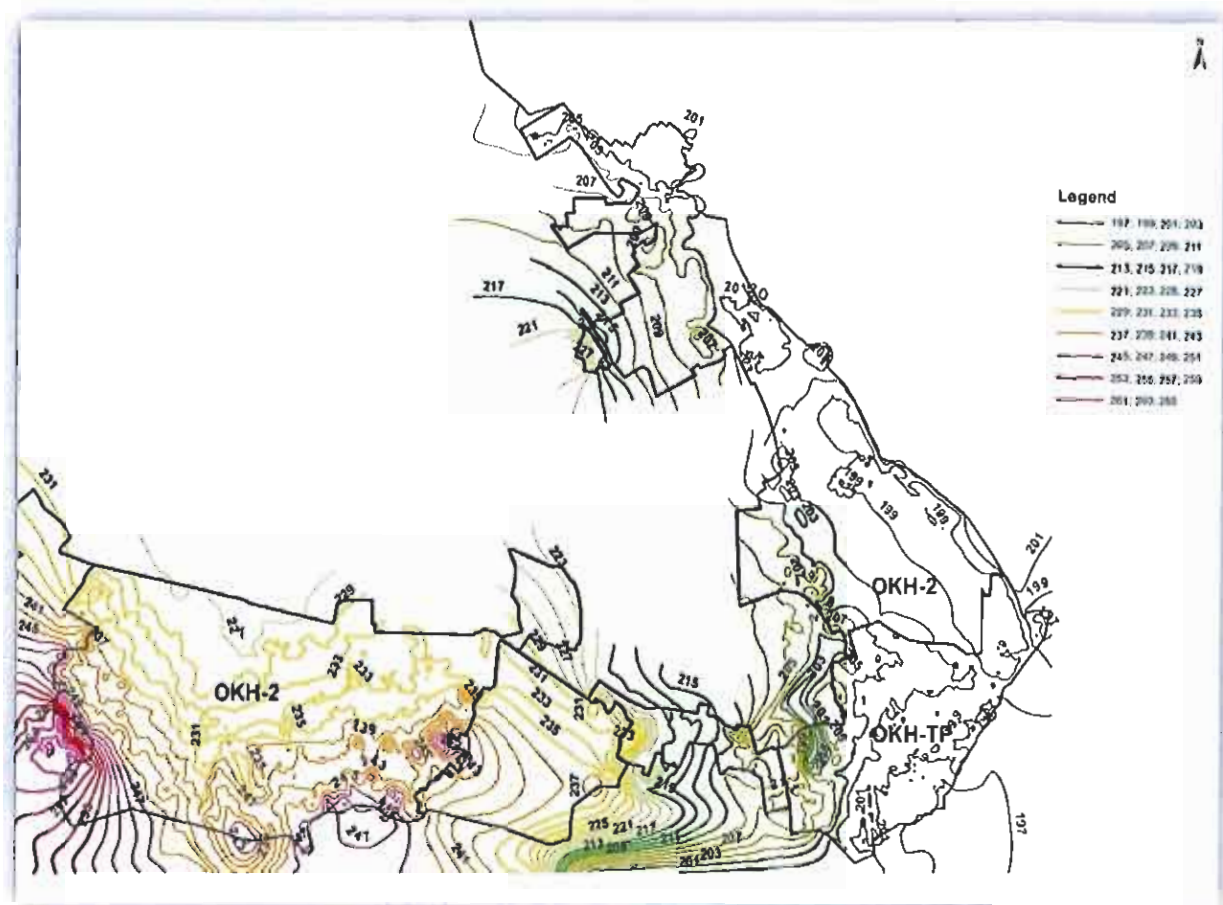


Figure 5: Contour Map of Unsewered Area of Okhla Drainage Zone (OKH)

Based on population projections Sub-Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Okhla Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
OKH-OK1	498.91	589.96	681.00	109.90	129.90	150.00
OKH-OK2	66.52	78.66	90.80	14.70	17.30	20.00
OKH-TP	56.54	66.86	77.18	12.50	14.70	17.00
Total	621.98	735.48	848.98	137.00	162.00	187.00

3.1 Sub Drainage Zone (OKH-OK): OKH-OK1

This Sub Drainage Zone comprises all the existing sewered portions of Okhla Drainage Zone. Land use map is as shown in the **Figure 6**.

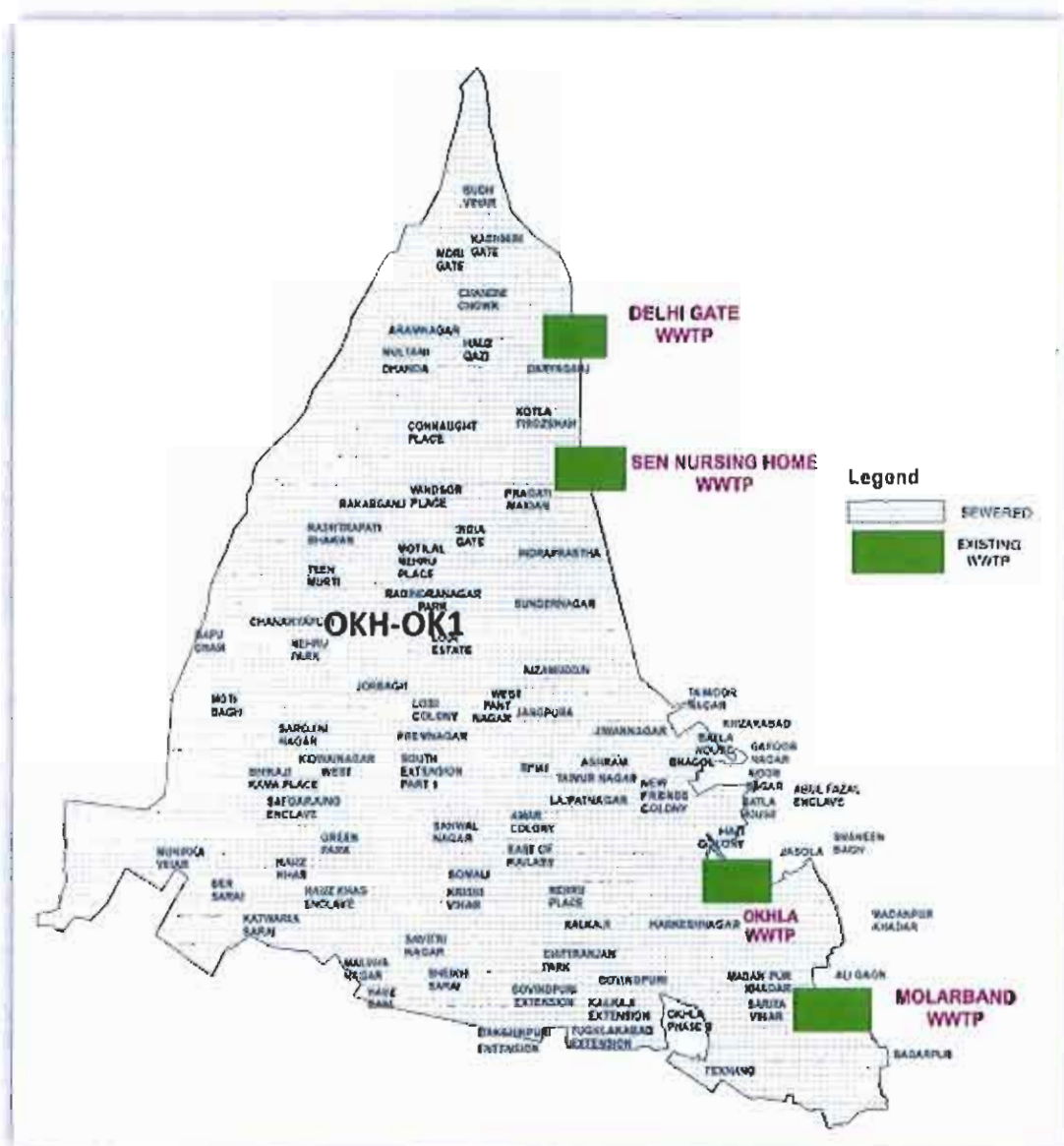


Figure 6: Land Use Map of Okhla 1 Sub Drainage Zone (OKH-OK1)

Existing Sewerage Infrastructure

This Sub Drainage Zone has one large existing WWTP i.e. Okhla WWTP of 170 MGD and two small WWTPs namely Sen Nursing home WWTP [2.2 MGD] and Delhi Gate WWTP [2.2 MGD], as shown in **Figure 6**.

The wastewater generated from this Sub Drainage Zone leads to four major WWPS's namely Pragati Vihar, Kilokri, Ring road and Andrews Ganj. The wastewater from these WWPS's is pumped to gravity ducts, which in turn convey the wastewater to the WWTP at Okhla. Existing sewerage infrastructure of the Sub Drainage Zone is shown in the **Figure 7**.

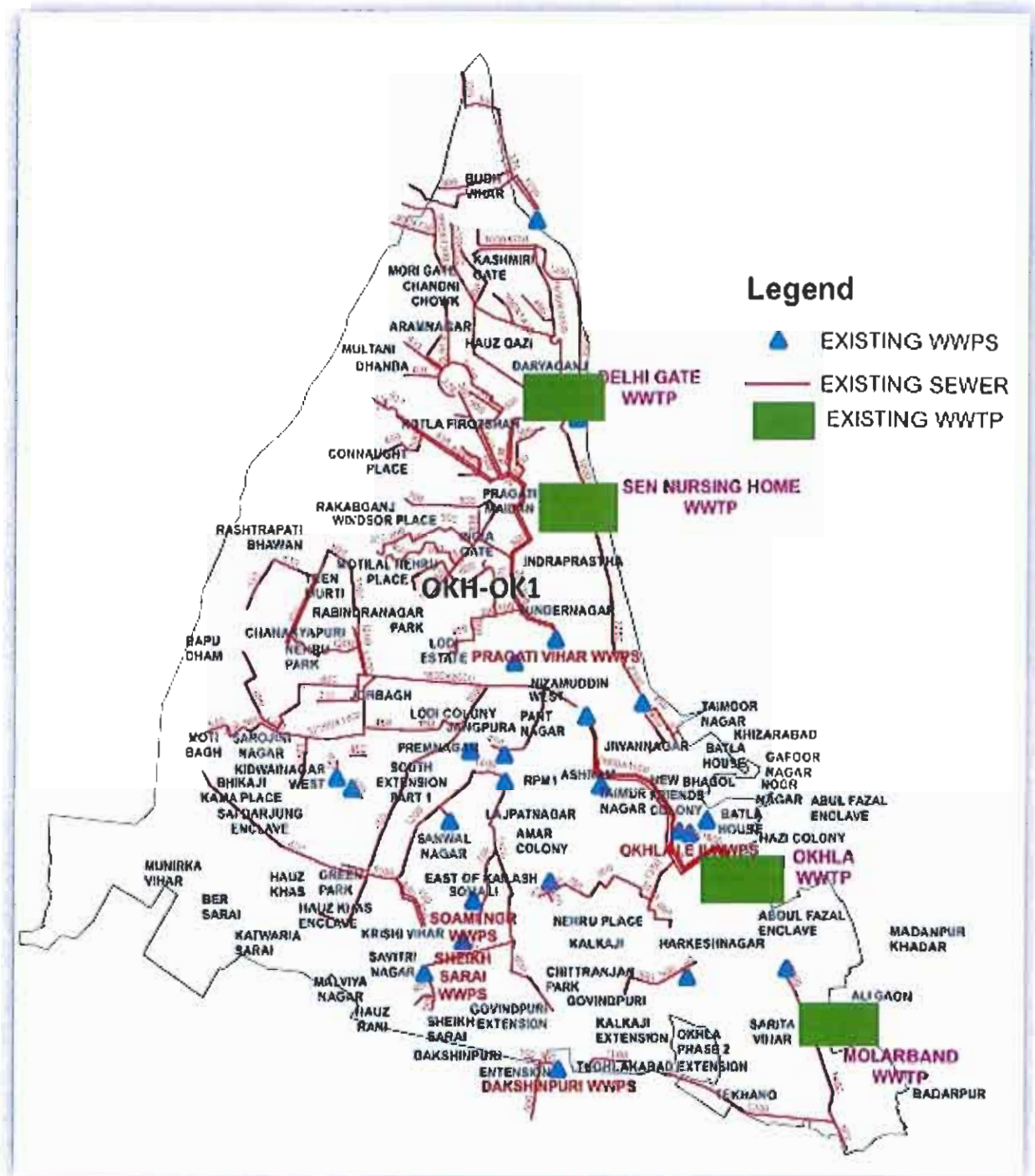


Figure 7: Existing sewerage infrastructure of Okhla 1 Sub Drainage Zone (OKH-OK1)

This Sub Drainage Zone has several major storm water drains which outfalls in to River Yamuna. This Sub Drainage Zone has large sanitary landfill site on Maa Anand Mai Marg (Okhla Industrial Area Ph-I). However, for disposal of garbage, modern technologies and methods which are environmentally safer needs to be adopted so as to avoid any mixing and silting in the gravity conveyance conduit.

3.2 Sub Drainage Zone (OKH-OK): OKH-OK2

This Sub Drainage Zone is spread across Batla House, Badarpur, Sangam Vihar, Sainik Farm, Saidullajab, Neb Sarai, part of Maidangarhi, Pulprehladpur, Shaheen Bagh, Tuklaqabad, Molarband etc. This zone comprises mostly un-planned colonies. The area is unsewered. Land use map is as shown in the **Figure 8**.



Figure 8: Land Use Map of Okhla Sub Drainage Zone (OKH-OK2)

Existing Sewerage Infrastructure

Trunk Sewer and WWPS exist in parts of the drainage Zone. Sewage from this drainage zone is conveyed to Okhla WWTP in Sub Zone OK-1.

Trunk Sewer on Mehrauli Badarpur Road exists from Saidullajab to Existing Dakshinpuri WWPS. It is further routed via rising main to Trunk Sewer upto Existing Sarita Vihar WWPS and ultimately to Okhla WWTP. Another Trunk Sewer is from Sarai Jhuliana to Existing Ring Road WWPS.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 9**:

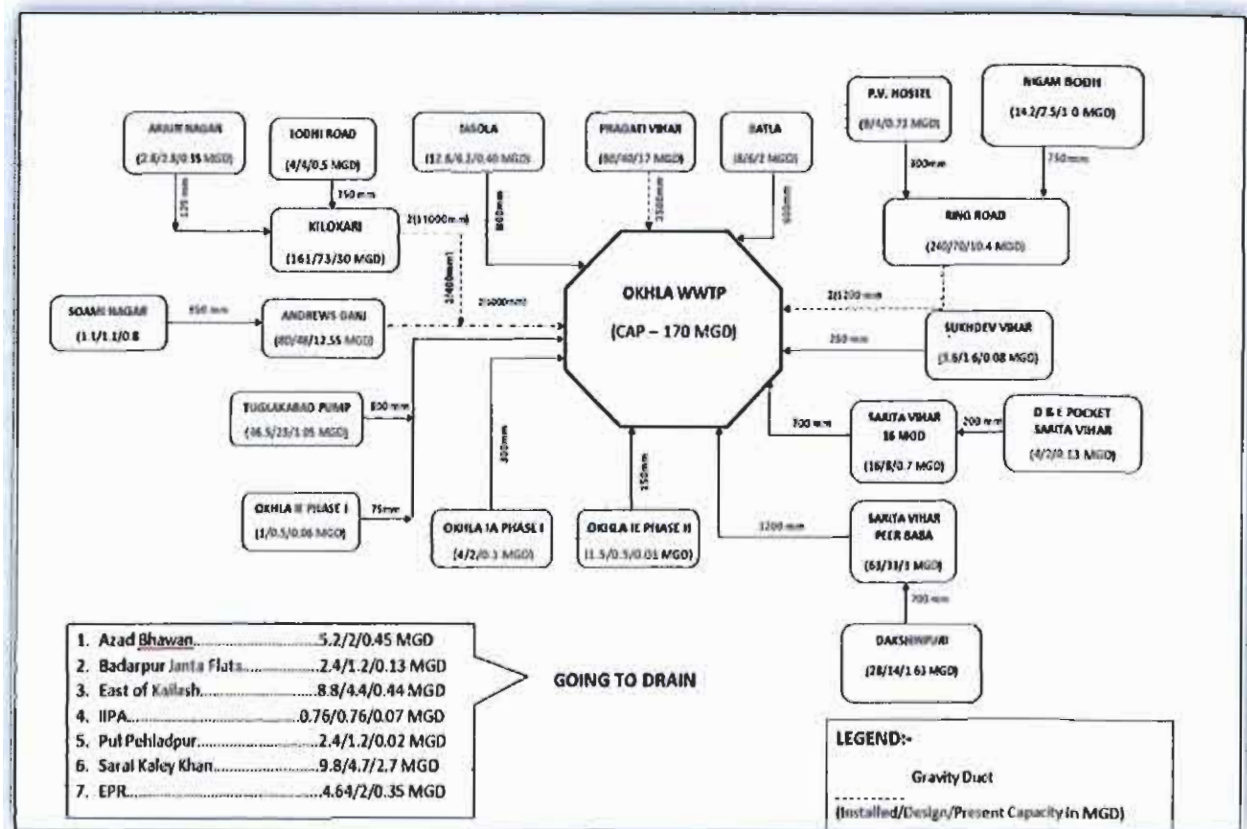


Figure 9: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 10**:

- The area is unsewered and is planned to be drained towards Okhla WWTP under Sub Drainage Zone OK-1.
- Sewage from Maidangarhi, Saidullajab and nearby area is routed to Existing Trunk Sewer towards Dakshinuri WWPS.
- Sewage from Sangam Vihar, Durga Vihar, Talimabad, Balmiki Colony and nearby area is routed to Existing Trunk Sewer towards Dakshinuri WWPS.
- Major part of Tuglakabad is discharging sewage to Proposed Tuglakabad Fort WWPS and then via rising main to Existing Tuglakabad WWPS. A fraction of area is discharging to Existing Trunk Sewer towards Sarita Vihar WWPS.
- Sewage from Lal Kuan, Pulpehlادpur, Gautampuri Awas and nearby area is routed to Existing Trunk Sewer towards Sarita Vihar WWPS.
- Sewage from Aligaon and nearby area is routed to Sarita Vihar WWPS.
- Sewage from Khirki Extn. and nearby area is routed to Existing Trunk and ultimately to Okhla WWTP.

- Sewage from Madanpur Khadar and nearby area is routed to Proposed Madanpur Khader WWPS and then via rising main to Okhla WWTP.
- Sewage from Batla House and nearby area is partly routed to Existing Batla House WWPS and partly to Proposed Batla Phase II WWPS and then via rising main to Okhla WWTP.
- Sewage from Harkesh Nagar and nearby area is routed to Proposed Harkesh Nagar WWPS and then via rising main to Proposed Sewer and ultimately to Okhla WWTP.
- Sewage Shaheen Bagh, Abu Fazal Enclave, Jasola and nearby area is routed to Existing Jasola WWPS.

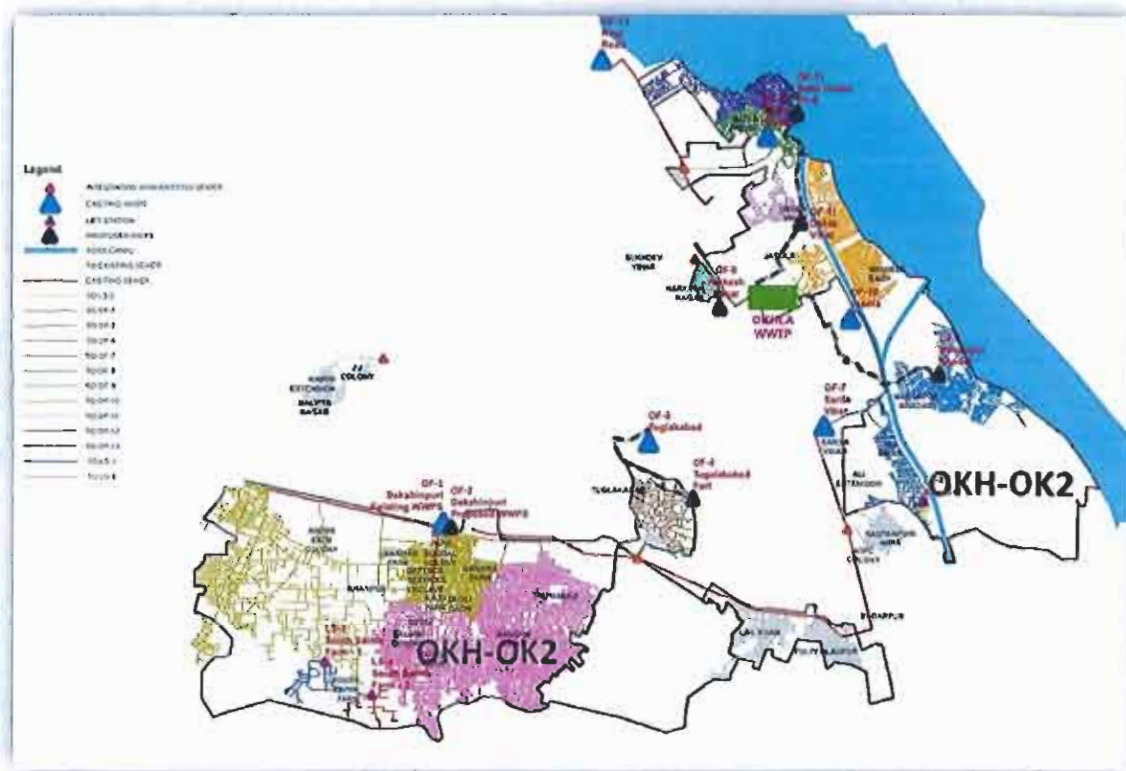


Figure 10: Scheme Map of OKH-OK2

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Okhla-2 Sub Drainage is shown in the **Figure 11**.

Proposed Gravity Sewerage Network

Sewer GEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	836081
300	HDPE/DWC	11306
350	HDPE/DWC	2868
400	HDPE/DWC	18228

Diameter (mm)	Material	Length (m)
500	HDPE/DWC	13668
563.6	HDPE/DWC	2994
635.2	HDPE/DWC	3758
700	RCC NP3/NP4	2584
800	RCC NP3/NP4	4388
900	RCC NP3/NP4	1479
1000	RCC NP3/NP4	2407
1100	RCC NP3/NP4	563
1400	RCC NP3/NP4	375
1600	RCC NP3/NP4	1070
1800	RCC NP3/NP4	231
Total		902000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 12**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

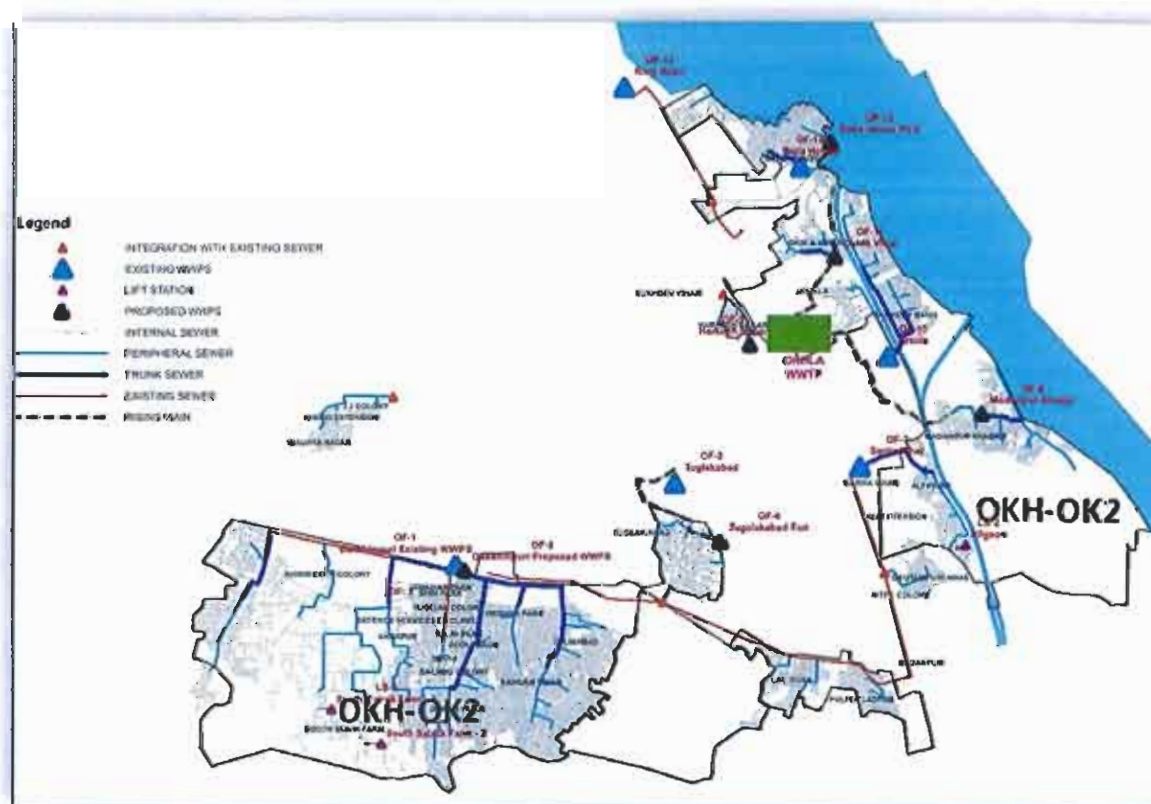


Figure 11: Proposed Sewerage Infrastructure of OKH-OK2

Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Okhla Vihar	WWPS	4.00	500	1	2000	Okhla WWTP
2	Harkesh Nagar	WWPS	2.00	300	1	750	Trunk Sewer in West
3	Batla House Ph 2	WWPS	8.00	700	1	4000	Okhla WWTP
4	Aligaon	LS	0.50	150	1	15	Nearest Manhole
5	Madanpur Khadar	WWPS	10.50	700	1	5000	Okhla WWTP
6	Tuglakabad Fort	WWPS	4.50	450	1	2500	Existing Tuglakabad WWPS

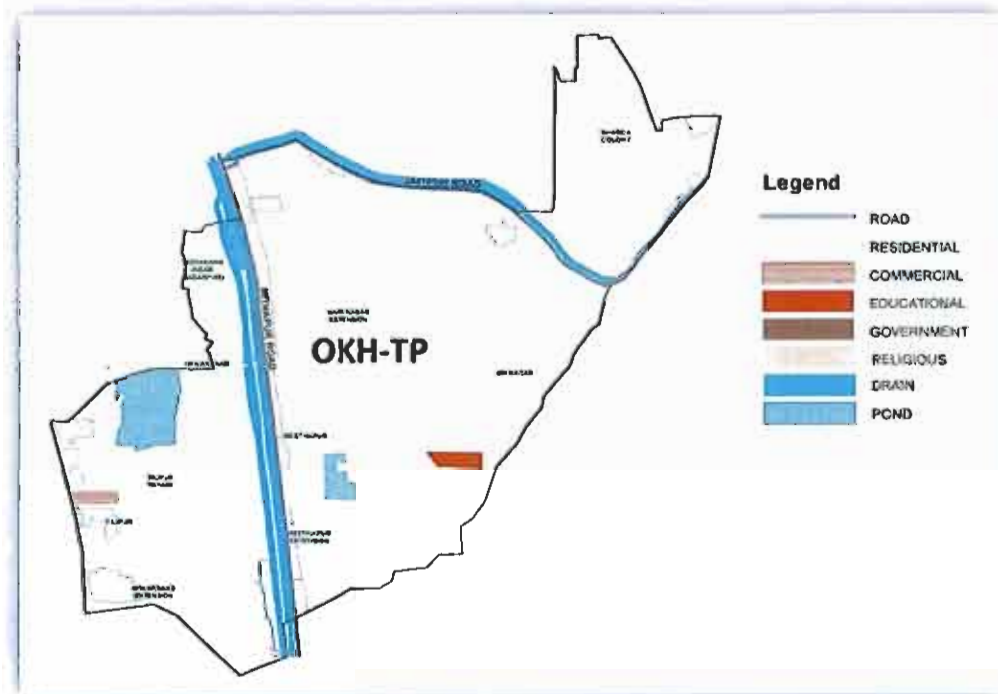
For existing Dakshinpur WWPS, augmentation of 23 MGD is proposed to cater the flow of design year. Alternatively, a WWTP of appropriate capacity may be considered as an option at same premises.

Waste Water Treatment Requirements

The existing Waste Water Treatment capacity of 170 MGD at Okhla was found to be sufficient to cater anticipated sewage load for design year 2031 from the sub drainage zone. No additional treatment capacity has been proposed for this Sub Drainage Zone.

3.3 Sub Drainage Zone: Tajpur (OKH-TP)

This sub drainage zone comprises of unsewered areas of Harinagar Extension, Meethapur Extension, Khadda Colony, Tajpur, Molarb and Extension and Badarpur Extension etc. The study area falls in DDA planning zone 'O'. Land use map is as shown in the **Figure 12**.

**Figure 12: Land Use Map of Tajpur Sub Drainage Zone (OKH-TP)**

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 13**:

- The area is unsewered and one WWTP is proposed in Tajpur. Alternatively WWPS can be constructed to pump sewage towards Okhla WWTP. For master planning purposes, new WWTP at Tajpur is considered.
- Sewage from Khadda Colony, Jaitpur and nearby area is routed to proposed Jaitpur WWPS and then via rising main to proposed sewerage network towards Tajpur WWTP.
- Sewage from Meethapur and nearby area is routed to proposed Meethapur Lift Station and then via rising main to proposed sewerage network towards Tajpur WWTP.
- Sewage from Tajpur, Molarband, Hari Nagar Extn, Om Nagar and nearby area is routed to Proposed Tajpur WWPS and then via rising main to proposed Tajpur WWTP.

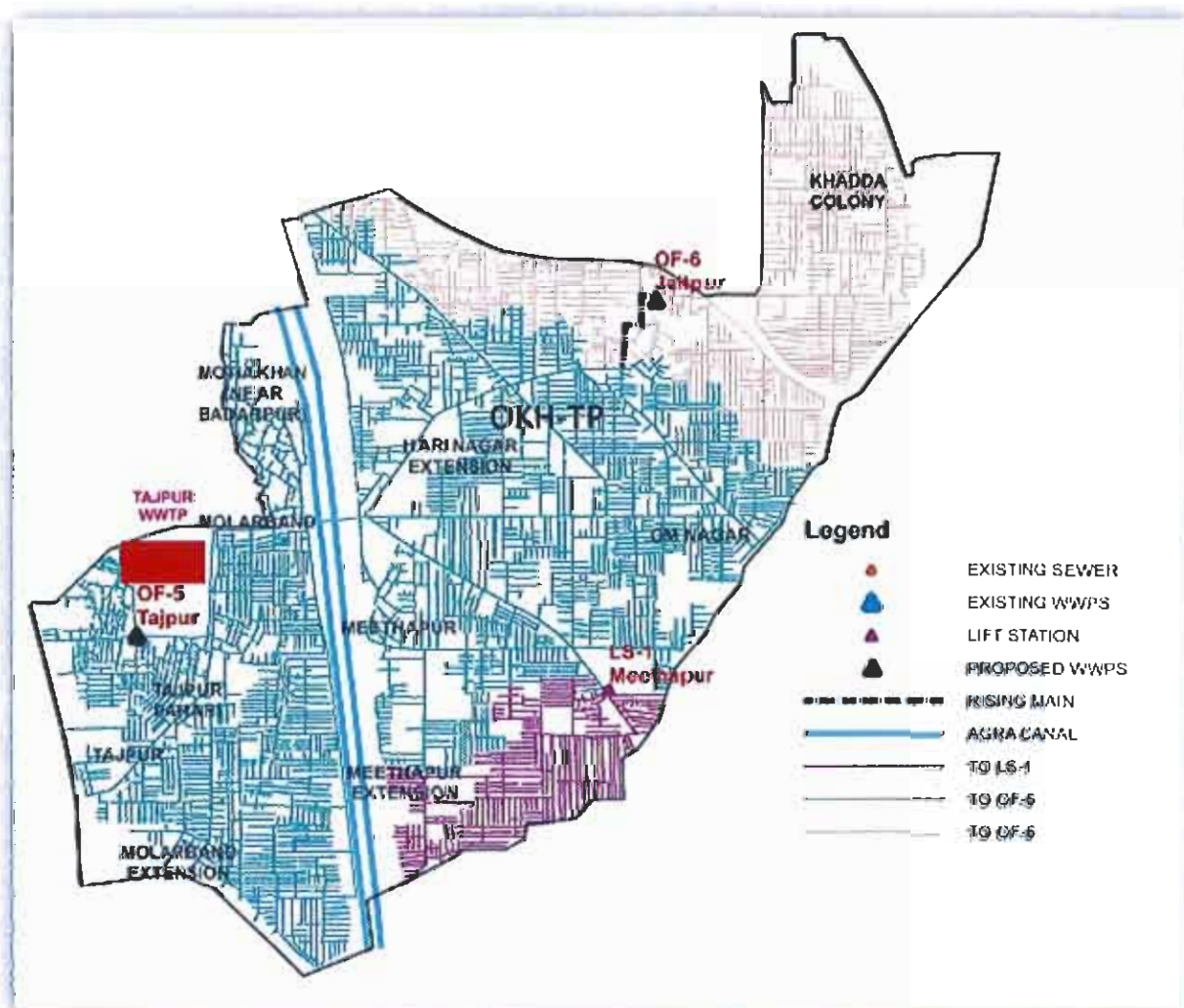


Figure 13: Scheme Map of Tajpur Sub Drainage Zone (OKH-TP)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Tajpur Sub Drainage Zone is shown in the **Figure 14**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Table 4: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	282833
300	HDPE/DWC	2865
350	HDPE/DWC	2707
400	HDPE/DWC	1523
500	HDPE/DWC	2628
563.6	HDPE/DWC	956
635.2	HDPE/DWC	1011
700	RCC NP3/NP4	702
800	RCC NP3/NP4	387
900	RCC NP3/NP4	210
1000	RCC NP3/NP4	634
1100	RCC NP3/NP4	1511
1600	RCC NP3/NP4	33
Total		298000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 14**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

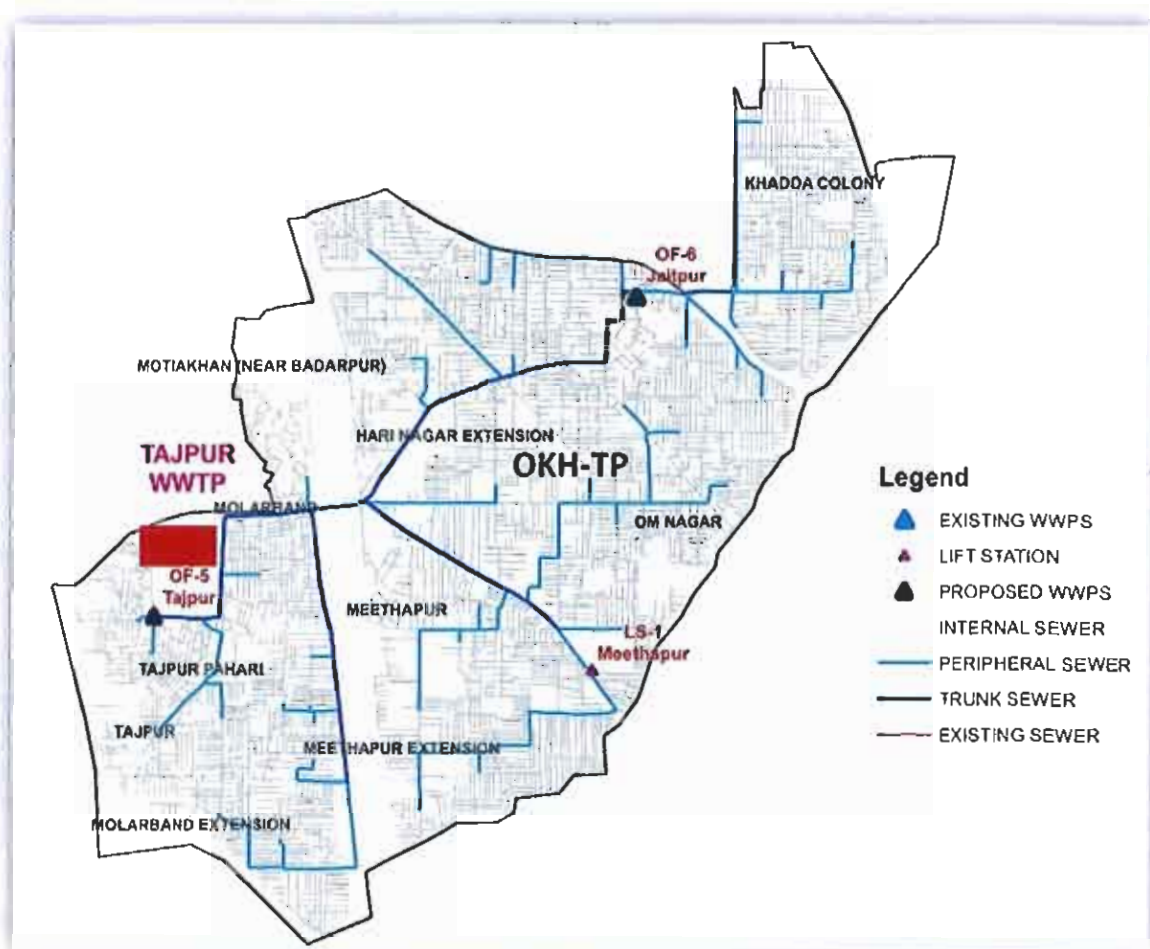


Figure 14: Proposed Sewerage Infrastructure of Tajpur Sub Drainage Zone (OKH-TP)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Tajpur	WWPS	39.00	-	-	-	-
2	Jaitpur	WWPS	9.00	800	1	500	Tajpur Trunk
3	Meethapur	WWPS	4.00	400	1	30	Nearest Manhole

Waste Water Treatment Requirements

One WWTP is proposed at Tajpur (17 MGD). Alternatively WWPS can be constructed to pump sewage to Okhla WWTP. For master planning purposes, new WWTP at Tajpur is considered.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 6**.

Table 6: Summary of Proposed Sewerage Infrastructure

SubZone	Proposed Infrastructure			
	Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Okhla - 1 (OKH-OK1)	-	-	-	-
Okhla - 2 (OKH-OK2)	720	5	2	-
Tajpur (OKH-TP)	172	2	1	1
Total	892	7	3	1

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 7**.

Table 7: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP		Pumping Station			
	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Okhla		-	Okhla Vihar	WWPS	4.00	2151.3
			Harkesh Nagar	WWPS	2.00	1076.96
			Batla House Ph 2	WWPS	8.00	2729
			Tuglakabad Fort	WWPS	4.50	2081.7
			Maidan Garhi	L.S.	0.15	
			Madanpur Khadar	WWPS	10.50	2741.7
			Aligaon	LS	0.50	34.1
Tajpur	17	9.6 - 12.4	Tajpur	WWPS	39.00	
			Jaitpur	WWPS	9.00	2826.3
			Meethapur	LS	4.00	2084.0

Line Diagram for Proposed WWPS and WWTP for Okhla is shown in **Figure 15**:

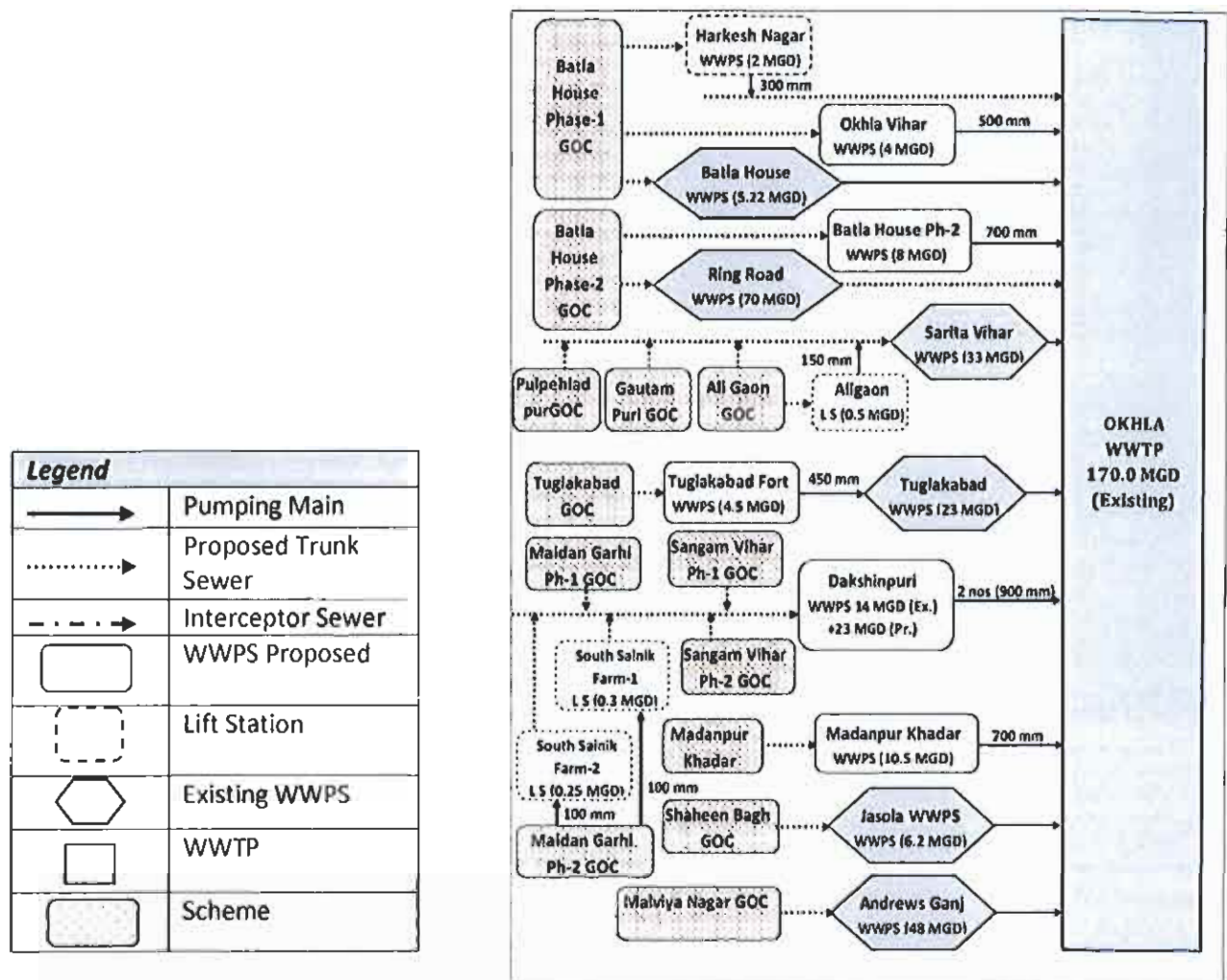


Figure 15: Line Diagram for Proposed WWPS and WWTP – Okhla

Line Diagram for Proposed WWPS and WWTP for Tajpur is shown in **Figure 16**:

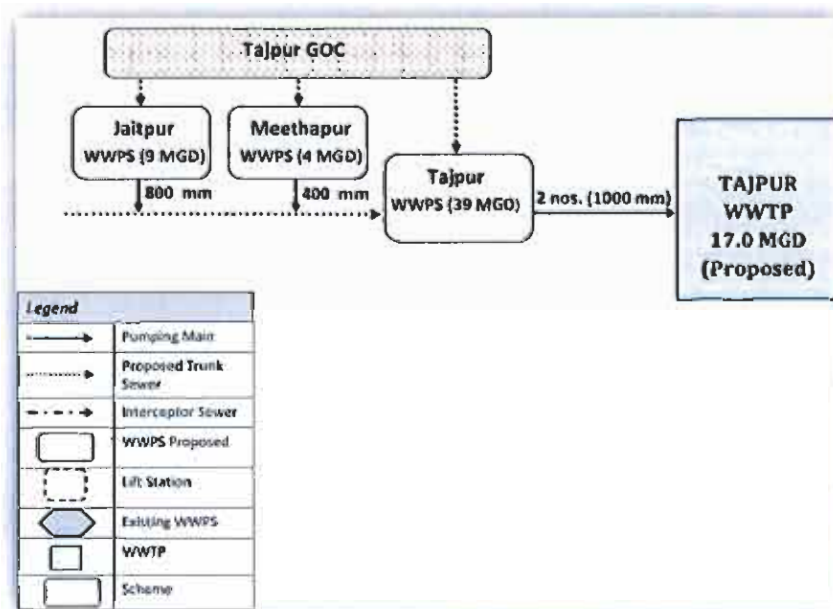


Figure 16: Line Diagram for Proposed WWPS and WWTP

Disposal of Treated Effluent

Current practice of disposal is to discharge it to Gurgaon Canal and directly to Yamuna River. Likely users of Treated Effluent are CPWD, NTPC, DDA. Okhla Industrial Area for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area. Treated effluent from proposed WWTP at Tajpur has been planned to discharge to Gurgaon/ Agra Canal.

The proposed Sewerage scheme for Okhla Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 17**.

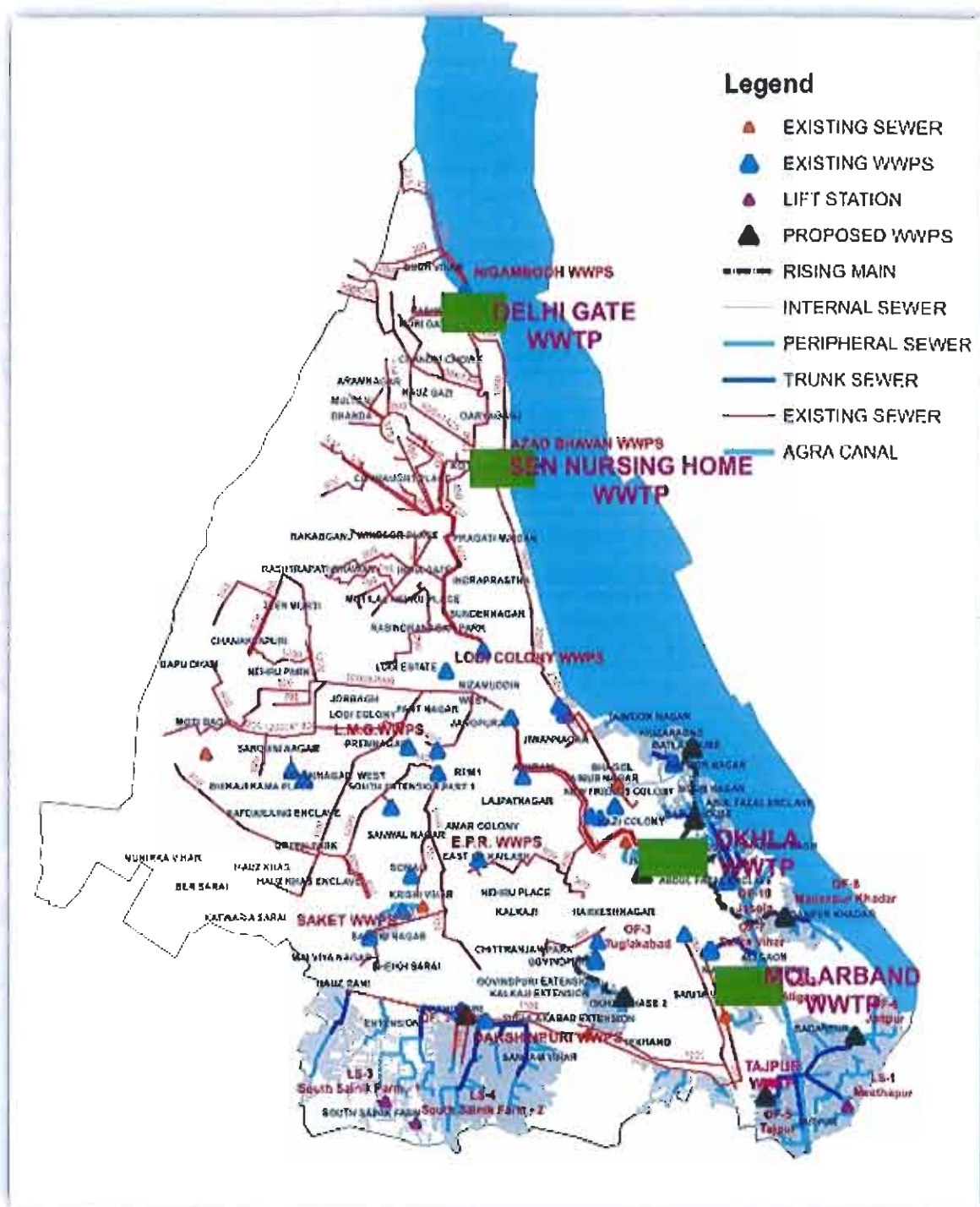


Figure 17: Proposed Sewerage Scheme for Okhla Drainage Zone

Various Group of Colonies (GOCs) – wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 18**:

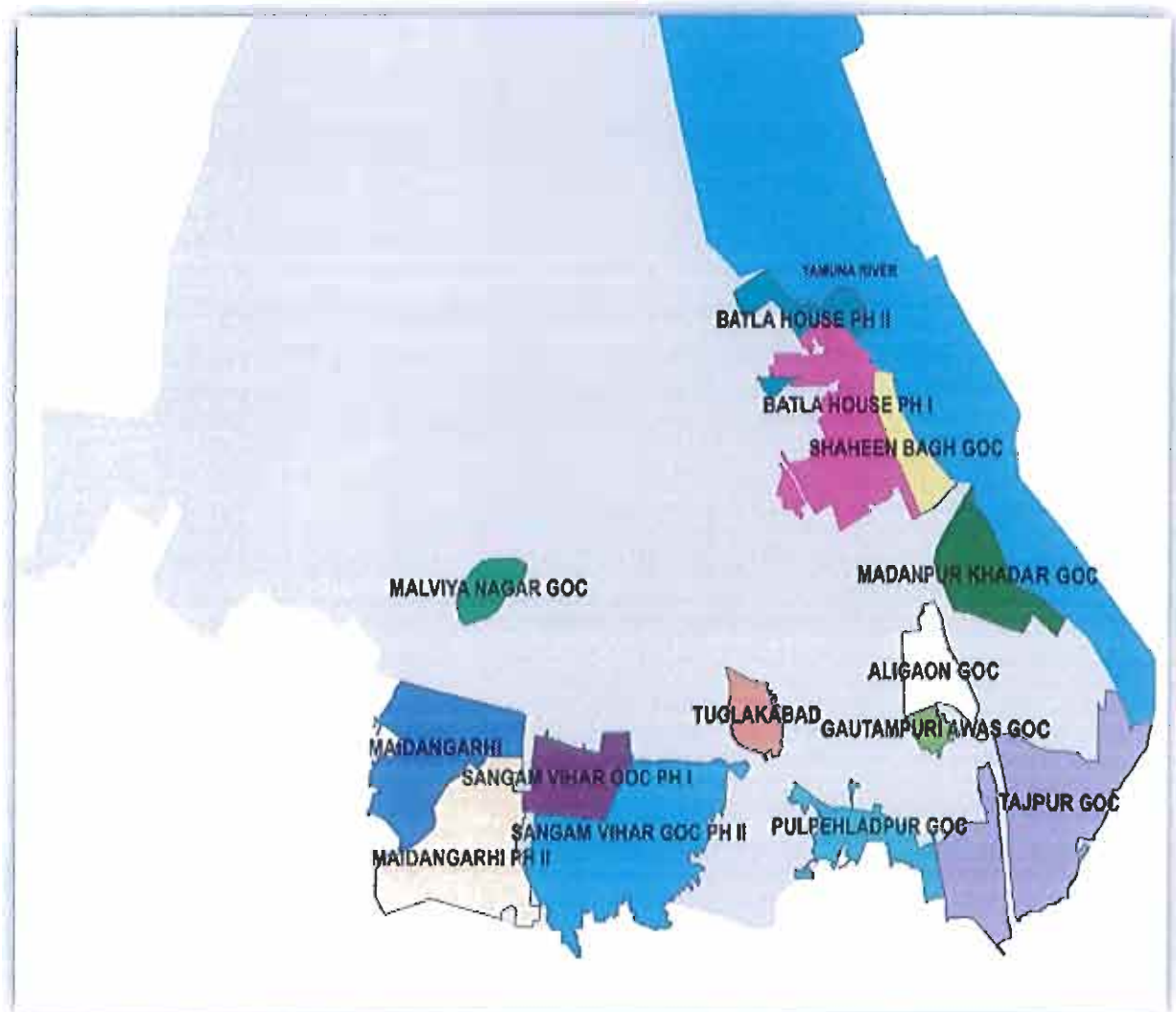


Figure 18: GOC-wise Sewerage Schemes – Okhla Drainage Zone

5. Implementation Plan

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 8: Summary of Proposed Sewerage Infrastructure

Sl. No.	WWTP Catchment	SubZone	Scheme Details		Implementation Schedule			
			Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Okhla	OK2	OKH-OK2-BHP1	Batla House Phase I				
2	Okhla	OK2	OKH-OK2-BHP2	Batla House Phase II				
3	Okhla	OK2	OKH-OK2-SB	Shaheen Bagh				
4	Okhla	OK2	OKH-OK2-MSJ	Maidangarhi & Saidullajab				
5	Okhla	OK2	OKH-OK2-MSJ2	Maidangarhi Phase II				
6	Okhla	OK2	OKH-OK2-TKD	Tuglakabad				
7	Okhla	OK2	OKH-OK2-SVP1	Sangam Vihar GOC Ph I				
8	Okhla	OK2	OKH-OK2-SVP2	Sangam Vihar GOC Ph II				
9	Okhla	OK2	OKH-OK2-PP	Pulprehladpur				
10	Okhla	OK2	OKH-OK2-MK	Madanpur Khadar				
11	Okhla	OK2	OKH-OK2-ALI	Aligaon				
12	Okhla	OK2	OKH-OK2-GA	Gautampuri Awas				
13	Okhla	OK2	OKH-OK2-MN	Malviya Nagar GOC				
14	Tajpur	OK2	OKH-OK2-TP	Tajpur GOC				

Table 9: List of colonies falling under respective GOCs:

Sl. No.	Name of GOC	Colonies Name
1.	Shaheen Bagh	Shaheen Bagh Abul Fazal Enclave, Block-E to N, New Delhi-25 Abul Fazal Enclave Pt-II Block G & H Delhi-25 Abul Fazal Enclave Pt-II Shahin Bagh, Delhi Abul Fazal Enclave (Main), Kalindikunj Road Okhla, New Delhi Nai Basti, (Harijan Basti) Okhla
2.	Malviya Nagar	Jahapanah Mohalla Panchsheel Vihar Khirkhi Extn.
3.	Madanpur Khadar	Madanpur Khadar Extn., New Delhi-44 Madanpur Khadar Extn., Part-1, 2, 3, Badarpur, New Delhi Madan Pur Khadar Extension
4.	Aligaon	Aali Ali Extn., Block A&B, Badarpur, Delhi Jagdamba Colony Ali Vihar Badarpur, Delhi Ali Vihar (Block A B C D E F G & H) Aali Village Extended, Abadi, New Delhi-44
5.	Gautampuri Awas	Gautam Puri Awas
6.	Sangam Vihar Ph-I	Raju Park C-II Block, South Delhi-Deoli Village, Delhi-62 Raju Park C-1 Block Khanpur New Delhi-62 Raju park C- Block Devli Vill Delhi-62 Deoli Extn. Khanpur Duggal Colony, Khanpur Extn. Part-II, New Delhi-62 Khiri Extn. Colony Carriappa Marg, M.B. Road, New Delhi-62 Shiv Park Khanpur Extn. New Delhi-62 Duggal Housing Complex School Road Khanpur New Delhi-62 Jawahar Park F- Block New Delhi-62 Khanpur Extended Abadi, F-Block, Khanpur, New Delhi-62 Defence Service Enclave, Khanpur, New Delhi-62 Jawahar Park, Khanpur, Deoli Road, A, B, C, D & E Block, New Delhi Jawahar Park, B, C, D & F Blocks located at Khanpur, Deoli Road, Delhi Krishna park, Khanpur, Devli Road Aabasia Vikas samiti, Krishna park Extn., D-Block Devli Road, Khanpur Krishna Park Extn. Block D Devli road Delhi-62 Krishna Park Extension, D-Block, Deoli Village Sainik Farms Western Avenue New Delhi Defence Service Enclave (Sainik Farm)
7.	Sangam Vihar Ph-II	Sangam Vihar, A-Block, New Delhi-62 Sangam Vihar A- Block New Delhi-62 Sangam Vihar, Block M-I, New Delhi-72 Church Colony, L-Block Sangam Vihar, New Delhi-62 Sangam Vihar, J-II, New Delhi-62 Gyan Jyoti Budh Vihar, J-3, Sangam Vihar

Sl. No.	Name of GOC	Colonies Name
		Sangam Vihar, K-II, New Delhi-62 Sangam Vihar, L-1, Pocket-C, New Delhi Sangam Vihar Wazirabad, Delhi Sangam Vihar, Block-I & II, New Delhi Sangam Vihar, L-Block, New Delhi-62 Sangam Vihar, Block M-II, Sangam Vihar, H-Block Sangam Vihar, L-1, A-Block, New Delhi Sangam Vihar, Block-C, Part-1 Sangam Vihar, J&B Block Sangam Vihar, D-Block, Delhi-62 Sangam Vihar, L-1st Block, New Delhi-62 Sangam Vihar, J-1st, New Delhi-62 Sangam Vihar Colony, New Delhi Sangam Vihar, B-Block, New Delhi-62 Sangam Vihar, C-Block, New Delhi-62 Sangam Vihar, B-I, Block, Sangam Vihar, New Delhi-62 Sangam Vihar, L-Block, New Delhi-62 Sangam vihar L-Block (Pkt-1) New Delhi-62 Sangam Vihar F-3 Block New Delhi-62 Sangam Vihar Block K-I New Delhi-62 Sangam Vihar K- Block Near Batra Hospital M.B.Road, Delhi-62 Sangam Vihar G- Block- N.D-62 Sangam Vihar Block C, Part-II Delhi-62 Sangam Vihar I- Block Delhi-62 Sangam Vihar G- Block Delhi-62 Sangam Vihar, J2-B, Tugalakabad, New Delhi-110062 Sangam Vihar E- Block Delhi-62 Sangam Vihar L-I Block Delhi-62 Sangam Vihar F-2 Block Hamdard Near Batra Hospital, M.B.Road, Delhi. Sangam Vihar F-1 Block, N.D Sangam Vihar G- Block Near Shooting Range Delhi-62 Sangam Vihar, G-II, Gali No.18, New Delhi-62 Sangam Vihar, B-Block, Y-Area, New Delhi-62 Deoli Durga Vihar Devli Extn.Delhi-62 Tigri Extn.Ph-II New Delhi-62 Tigri Extn Ambedkar Nagar Sect-I New Delhi-62
8.	Pul Pehladpur	Pul Pehlad Pur Pul Pahladpur M. B.Road N.D-44 Pul Parhalad Pur Village Lal Kuan, Block-D, Chungi No.3 & Block A, B Pul Pehlad Pur, Village Lal Kuan, Block-A to J, Mehrauli Badarpur Road, New Delhi-44 Harijan Nardan Basti Lal Kuan, M.B.Road, New Delhi-44 J-Block Prem Nagar, Lal Kuan, M.B.Road, Delhi-44

Sl. No.	Name of GOC	Colonies Name
		Vishwakarma Colony M.B.Road Pul Pahladpur Delhi-44 Vishwakarma Colony B- Block M.B.Road Pul Pahladpur Delhi-44
9.	Tajpur	Pir Baba Basti, Vill. Jaitpur, Badarpur, New Delhi-44 Mithapur Extn.Part-III New Delhi-44 Mitha Pur Extn.1 Block A B C 2 D,Delhi Meetha Pur Extn., Block -B, Pt- I, Badarpur Meetha Pur Extn., Badarpur Mitha Pur Hari Nagar Extn. M- Block ,Saurabh Vihar Badarpur, New Delhi Hari Nagar Extn. I- BlockJaitpur Road Badarpur, Delhi Hari Nagar Extn. C BlockPart 2 Badarpur, Delhi Mitha Pur Extn. A- Block Badarpur, Delhi Meethapur Extn. Block 'D' ,Part-I, Badarpur, New Delhi-44 Mithapur Extn., A-Block, Badarpur, New Delhi-44 Mithapur Extn., A-Block, Badarpur, New Delhi-44 Hari Nagar Extn., F-Block, Part-II, Badarpur Hari Nagar Extn., Block D-I, Jaitpur, Badarpur Hari Nagar Extn, Jaitpur Road, Badarpur, Delhi Hari Nagar Extn.,Block-D, Jaitpur, Badarpur, New Delhi-44 Hari Nagar Extn. N_ Block Jaitpur Badarpur New Delhi-44 Hari Nagar colony Pt-II D- Block Badarpur New Delhi-44 Hari Nagar Extn.A Block Jaitpur Road Badarpur,Delhi Hari Nagar A B Block Extn.Pt-II Badarpur,Delhi Jait pur Saurabh Vihar,N-Block (Amar Market) Hari Nagar Extn. Badarpur, New Delhi Lakhpat Colony, Part-II, Mithapur Extn. New Delhi Saurabh Vihar, S-Block, Hari Nagar Extn. Jaitpur, Badarpur Saurabh Vihar, R-Block,Hari Nagar E xtn., Part-I, Badarpur Ekta Vihar (Block A, B & C) Jaitpur, Badarpur Saurabh Vihar, O-Block, Hari Nagar Extn.-II, Badarpur Sai Nagar, Mithapur, Extn. Badarpur, New Delhi Ekta Vihar, Mithapur Extn. Badarpur, New Delhi Shakti Vihar, Meethapur, Badarpur, New Delhi-44 Shiv Puri Mithapur Extn., Badarpur Harsh Vihar Hari Nagar, Part-3, Badarpur Harsh Vihar Hari Nagar, Part-3, Block- A,B, C, D badarpur Harsh Vihar Hari Nagar, Badarpur Prince Colony,Hari Nagar Ext.Pt-III, Block D, E & F, Delhi-44 Prince Colony, Hari Nagar Part 3, Delhi 44 Prince Colony, Hari Nagar Part 3, Delhi 44 Meetha Pur Colony-B Block, Badarpur, Delhi-44 Hari Nagar Part-II E- Block, Badarpur, New Delhi Lakhpat Colony Pt-I Mithapur Extn.Badarpur, Delhi Meethapur Extn., Lakhpat colony (1) N D

Sl. No.	Name of GOC	Colonies Name
		Bachh Raj Colony Mithapur Extn.Delhi-44 H-Block, Hari Nagar Extn, Jaitpur Road Badarpur New Delhi 44 Sourabh Vihar K- Block Hari Nagar Jait Pur Badarpur,Delhi Hari Nagar Extn., J, K, L, M- Block, Jait Pur, Sourabh Vihar Mitha Pur Extn.Badarpur Delhi-36 Ch.Lakha Ram Colony School Rd.Shakti Vihar Pt-I Delhi-44 Hari Nagar Etn., L-Block, Saurabh Vihar, Jaitpur, New Delhi A- Block, Meethapur Extn. Shree Colony Badarpur New Delhi 44 Jait pur Extn. L-Block, Badarpur, New Delhi-44 Arpan Vihar, J-Block, Jaitpur Extn. Part-I, Badarpur, New Delhi Jaitpur Extn., K-Block, Badarpur, New Delhi Jaitpur Extn., E-1 Block, Badarpur, New Delhi Sudarshan Park, Badarpur Jaitpur Extn., Part-1, Badarpur Jaitpur Vistar Part-1, Block E F G H Jaitpur Extn,A-Block, Badarpur Badarpur Extn., D-1, Block, New Delhi Badarpur Extn., Block C&D, Badarpur, New Delhi Om Nagar, Badarpur, New Delhi-44 Badarpur Extn.Pocket A,B, Mathura Road, Delhi-44 Bera Badarpur Extn. Bera Badarpur Extn. Block- A & B Jaitpur Extn, Part-1, Block-1, Delhi Jaitpur Extn.Part-II Badarpur, New Delhi-44 Molarband Tajpur Shakti Vihar Block A, Molar Band Extn., Badarpur Gagan Vihar (near Molar Bund), Badarpur, New Delhi Molar Band Extn., Block No.-E/3, Part-2, Badarpur, New Delhi Molar Band Ext. New Delhi-44 Molar Band Extn.E-I Block Badarpur,Delhi Molar Band Extn.Block ABC D (Gali No.1-25) Badarpur,Delhi Molar Band Extn.Block E-2 Badarpur,Delhi Molar band Extn.Block F-Delhi-44 Molar Band Extn. G Block Badarpur Molar Band Extn. Block E-III Badarpur Molarband Extn. E1,E2,E3 Block, Badarpur New Delhi 44 Molarband Village Badarpur New Delhi 44 Molar Band, Ph.-I Molar Band, Ph.-II Budh Vihar Extension, Badarpur Mohan Baba Nagar, Tajpur Extn. Badarpur, Delhi-44 Mohan Baba Nagar, Tajpur Extn. Badarpur, Delhi-44 Tajpur Pahari, Badarpur, New Delhi-44 Budh Vihar(Tajpur Pahari) Badarpur,Delhi

Sl. No.	Name of GOC	Colonies Name
		Mohan Baba Nagar, Badarpur, New Delhi-44 Old Jasola Village Badarpur N.D-25 Mohan Baba Nagar, G-Block, Tajpur Extn., Badarpur Village Molarband, B-Block, New Delhi Khadda Colony
10.	Batla House Ph-I	Old Village Jasola Extension, Delhi-44 Jasola Jasola Vill Delhi-25 Harkesh Nagar Noor Nagar Extn., Ph-1, Jamia Nagar, Okhla, Delhi-25 Noor Nagar Extn., Jamia Nagar Noor Nagar Haji Colony Okhla Vihar, Jamia Nagar, New Delhi-25 Gafar Manzil, Extn.-II, Jamia Nagar, Okhla, New Delhi Gaffar Manzil Extension, Jamia Nagar, Okhla, Delhi Zakir Nagar, H-Block, Okhla Zakir Nagar H-Block, Okhla Delhi-25 Mahbub Nagar Zakhir Nagar New Delhi-25 Zakir Nagar West Jamia Okhla Nagar, New Delhi-25 Zakir Nagar, Gali No.6 to 21-A Batla House Okhla, Delhi Okhla
11.	Batla House Ph-II	Sarai Jhuliana Taimoor Nagar, Kapasia Mohalla Village Main Road, Taimoor Nagar, Delhi-25 Taimoor Nagar, Mohalla Pijanji, Delhi-65 Extended Abadi, Taimoor Nagar -I, Near Village Community Centre Taimoor Nagar Delhi Taimoor Nagar Extn. Near Kizrabad Delhi-65 Joja Bai Jogabai Zakir Nagar (Okhla) New Delhi-25 Khizrabad C.V. Raman Road
12.	Tuglakabad	Sant Mohalla (Chhuriya Mohalla) Tuglakabad, Delhi Navgrah Mohalla Tuglakabad Pandit Mohalla Bhargava Mohalla Shardar Mohalla Kanver Mohalla Kumhar Mohalla Valmiki Mohalla
13.	Maidangarhi	Neb Sarai Freedom Fighter Enclave, IGNOU Road, Neb Sarai, New Delhi-68

Sl. No.	Name of GOC	Colonies Name
		Freedom Fighter Vihar, Nebsarai, New Delhi Indira Enclave, Neb Sarai Freedom Fighter Enclave, Nev Sarai, Delhi-68 Neb Sarai Extn.Area Delhi-68 Freedom Fighter Enclave Neb Sarai Delhi-68 Neb Sarai Harijan colony Delhi-68 Neb Valley IGNOU Road, Neb Sarai, Delhi-68 Freedom Fighter Enclave Neb Sarai Delhi-68 Neb Sarai Extn.,Ph-II IGNOU Road Delhi Freedom Fighter Colony, Mehrauli Freedom Fighter Enclave, Near Neb Sarai, Mehrauli, Delhi-68 FF CC Colony, Neb Sarai, New Delhi Neb Sarai Extn. Area New Delhi 68 Freedom Fighter Comuniti Development & Welfare Association, Neb Sarai New Delhi 68 Neb Sarai New Delhi 68 Neb Sarai, Saidulajab Market Association New Delhi 68 Anupam Garden, Delhi-68 Saidulajab Extn. Mehrauli, New Delhi-68 Freedom Fighter Enclave Delhi-68 Dang Complex, IGNOU Road, Saidulajab Extn., New Delh-30 Sultan Apartment, Gali No.2, Saidulla Jaib, M.B. Road, Delhi-30 Anupam Enclave, Pt-II, Saidulajaib Extn. New Delhi-30 Saidulajaib Village Residance Welfare Association New Delhi Saidullahjab Saidulajaib Extn., Kohinoor Enclave, M.B.Road, Opp. CISF Complex. Saidulajaib Extn., New Delhi-30 Saidulajab Extn. Paryavaran Complex Delhi-30 Saidulatab Extn.J-Block, Paryavaran Complex, Delhi-30 Maidangarhi
14.	Maidangarhi PH-II	Maidangarhi

ANNEXURE - 11

SOUTH DELHI DRAINAGE ZONE (SD)

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SOUTH DELHI DRAINAGE ZONE (SD)

1. INTRODUCTION

South Delhi Drainage Zone is bounded by Airport, Northern Railway Line and Gurgaon Border towards west and south, Okhla Drainage Zone and Outer South Delhi Drainage Zone towards North and South East. South Delhi is mainly residential area including cluster housing development, unauthorized colonies and farm houses, with southern side mainly as green area. Location of South Delhi Drainage Zone is shown in the *Figure 1*.

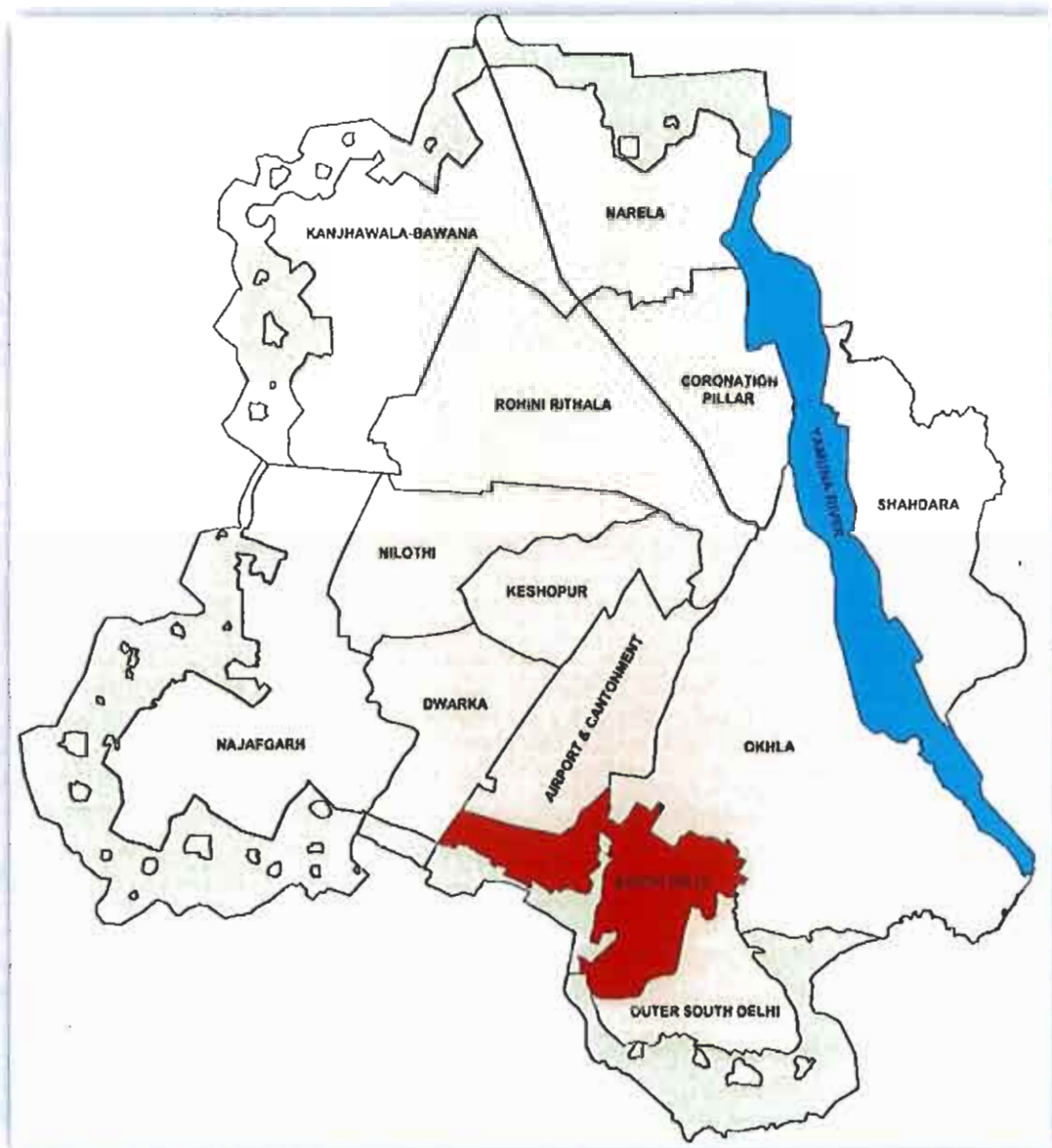


Figure 1: South Delhi Drainage Zone

South Delhi Drainage Zone comprises major areas like Mehrauli, Ghitorni, Vasant Kunj, Mahipalpur, Rajokri & Rangpuri etc. This drainage zone falls partly under the DDA planning zone G, J and F as shown in the *Figure 2*.

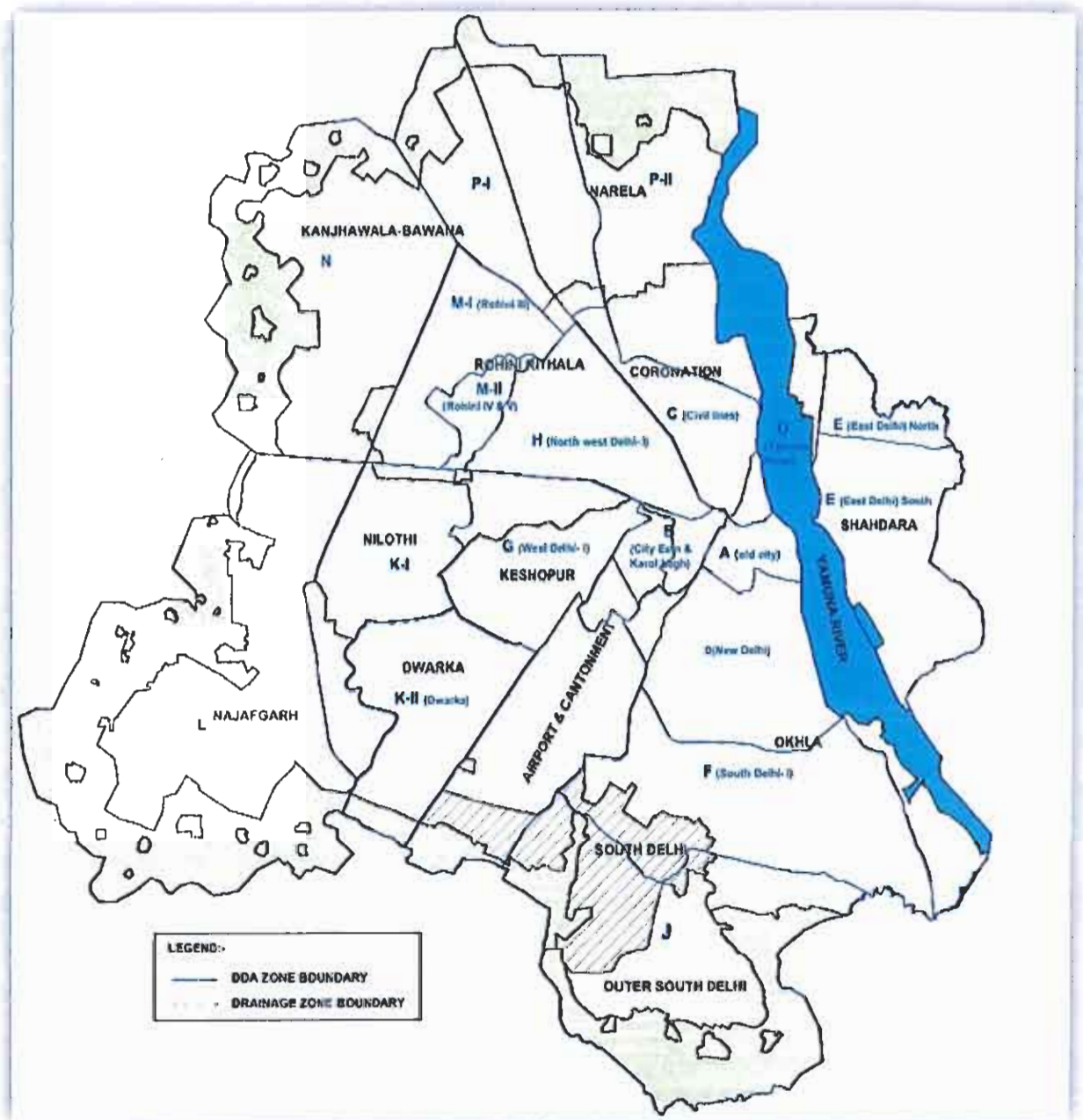


Figure 2: DDA Zones and South Delhi Drainage Zone

Soil Description of South Delhi

North of this zone i.e. Ghitorni, Kishan Garh is covered with Aeolian deposits & East of this zone i.e. Vasant Kunj, Mehrauli, Qutab Minar is covered with Delhi super Group and rest of the portion i.e. Rajokri, Ranpuri, is covered with older alluvium deposits. South Delhi zone i.e. Rajokari, Rangpuri area is covered with Moderate hazard due to High Amplification & Liquefaction. Rest of the Portion (Vasant Kunj, Ghitorni, Qutab Minar etc.) is covered with high Hazard due to basin effect. This hazard factor is due to Chhatarpur basin. The Water depth in this zone is majorly found at 40 – 60m in the areas like ghitorni, Vasant Kunj, Rajokari, Mehrauli, Chhatarpur, Qutab Minar etc. Most of the area (Ghitorni, Vasant Kunj etc.) is covered with Bangar soil except the areas like Rajokari, Qutab Minar, Mehrauli etc. is having Kohi soil.

2. MASTER PLANNING FOR SOUTH DELHI DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

South Delhi Drainage Zone is partially sewered. Topographical Survey & GIS integration has been carried out for unsewered portion of the Drainage Zone. Sewerage Status and Land Use is shown in the **Figure 3**.

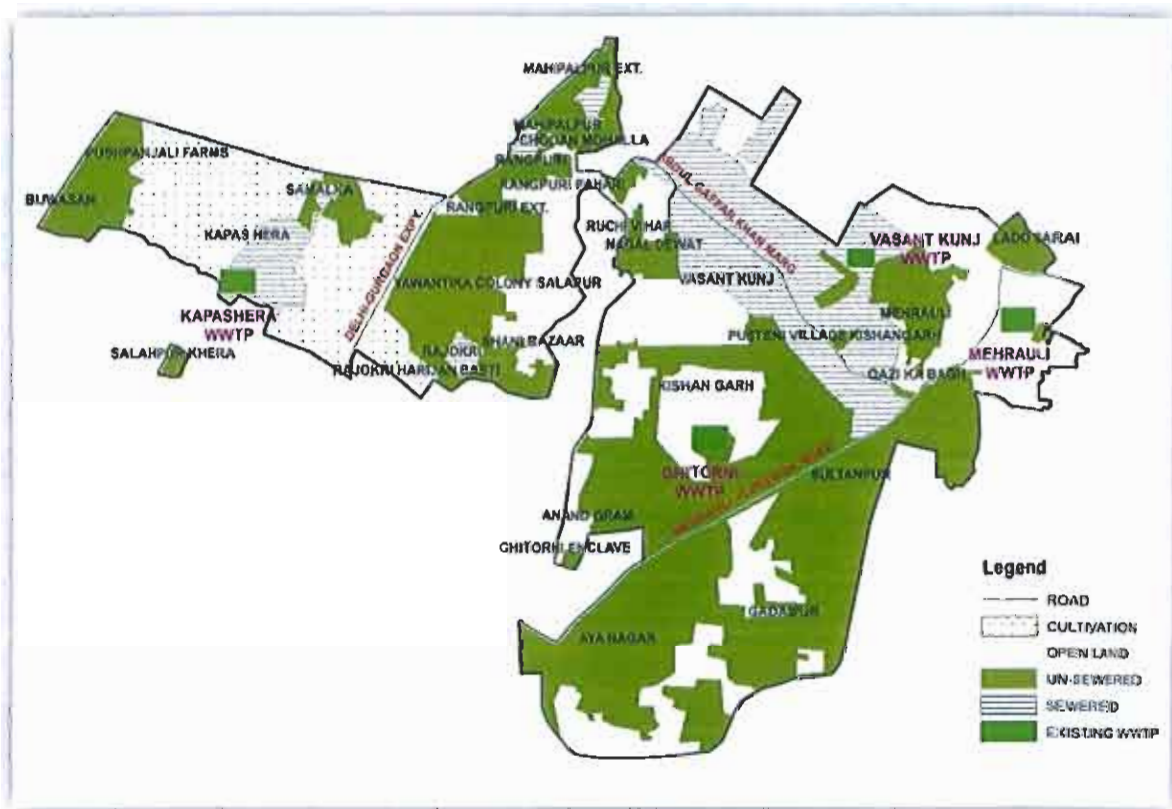


Figure 3: Sewerage Status of South Delhi Drainage Zone

Subzoning

Sub drainage zones have been formulated considering the following criteria and constraints.

- Delineation based upon catchment contours
- Existing sewerage network in the catchment
- Existing/proposed design capacity of WWTP's and its capacity assessment for treating the design year sewage generation load
- Existing/proposed capacity of various WWPSs in the catchment
- Land availability for newly proposed WWPS
- Hydraulic analysis and capacity assessment of existing sewerage assets being integrated
- Feasibility implications as per site constraints

Site Feasibility Study

Comprehensive data gathered to plan Sewerage Schemes and assess additional WWPS and WWTP requirements. Investigations were carried out in the unsewered areas to attribute related information and develop hydraulic model for Sewerage Scheme. Feasibility Study has been carried out comprising hydraulic design and simulation as per design and site constraints. The alignments and model were then re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

For unsewered area, sewerage infrastructure is proposed considering maximum feasible utilization of existing treatment and network capacity and already planned/under construction works.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

Feasibility of additional capacities, if needed, near existing WWTP or new location or alternative locations have been studied and proposed in this report. It is important to mention here that area of Ayanagar, Part of Chhatarpur, Sultanpuri and Gadaipur was part of Outer Delhi Drainage Zone earlier, however, in order to better utilize capacities of existing WWTPs, this area has been routed to existing Ghitorni and Mehrauli WWTP in South Delhi Drainage Zone. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

South Delhi Drainage Zone has been divided into 5 Sub Drainage Zones as below:

- Kapashera (SD-KH)
- Mahipalpur (SD-MP)
- Vasant Kunj (SD-VK)
- Mehrauli (SD-MH)
- Ghitorni (SD-GH)

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

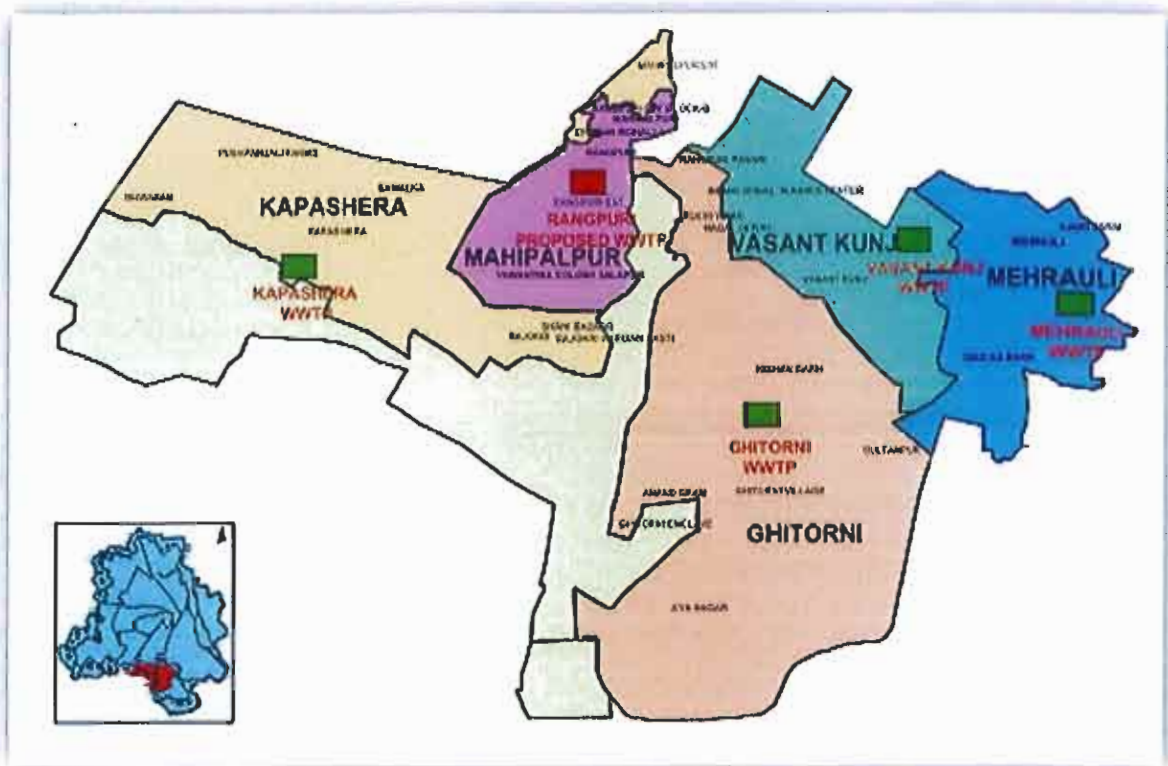


Figure 4: Sub Drainage Zone Map of South Delhi Drainage Zone (SD)

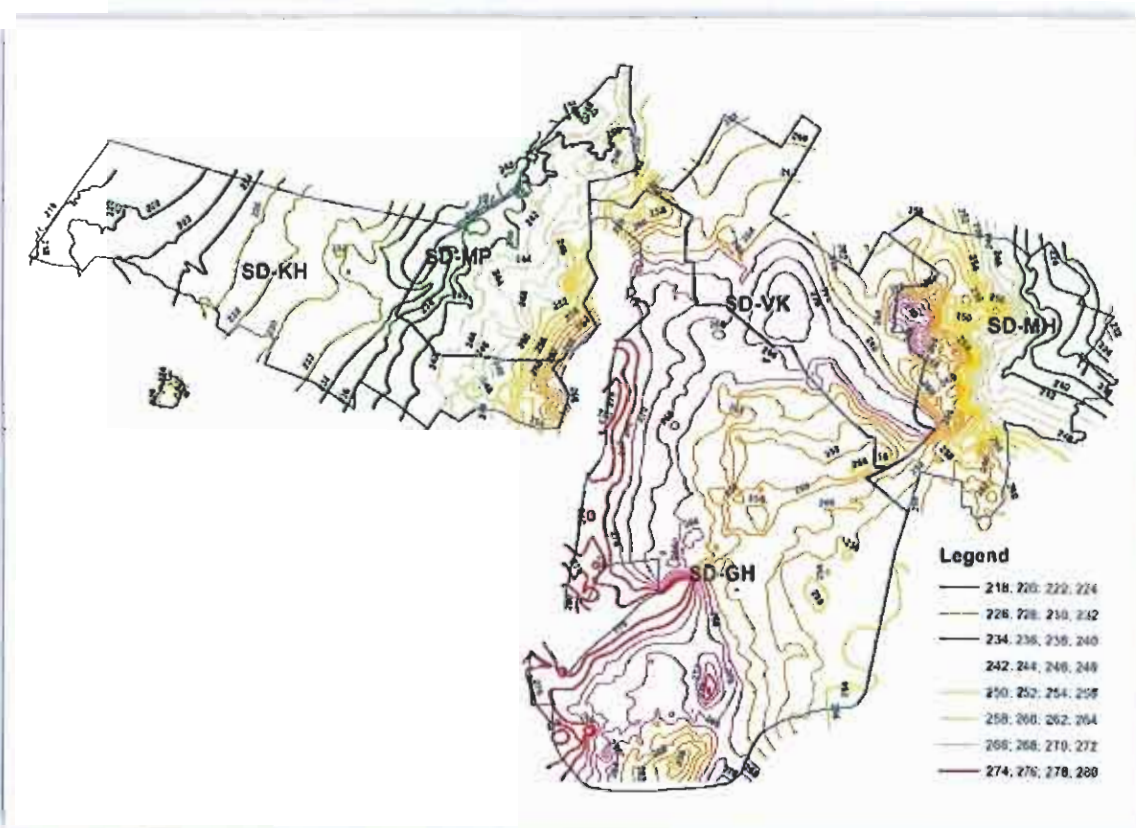


Figure 5: Contour Map of South Delhi Drainage Zone (SD)

Based on population projections Sub-Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of South Delhi Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
SD-MH	12.92	19.10	22.70	2.80	4.20	5.00
SD-VK	12.92	19.10	22.70	2.80	4.20	5.00
SD-GH	36.19	53.49	63.56	8.00	11.80	14.00
SD-MP	12.92	19.10	22.70	2.80	4.20	5.00
SD-KH	29.47	43.56	51.76	6.50	9.60	11.40
Total	104.42	154.36	183.42	23.00	34.00	40.40

3.1 Sub Drainage Zone: Kapashera (KH)

This Sub Drainage Zone spread across West Bijwasan, Pushpanjali Farms, Kapashera, Samalka, Rajokri, Salahpur Khera, Part of Mahipalpur etc. The area is partially sewered and there is an existing WWTP of 5 MGD Capacity known as Kapashera WWTP. Land use map is as shown in the **Figure 6**.

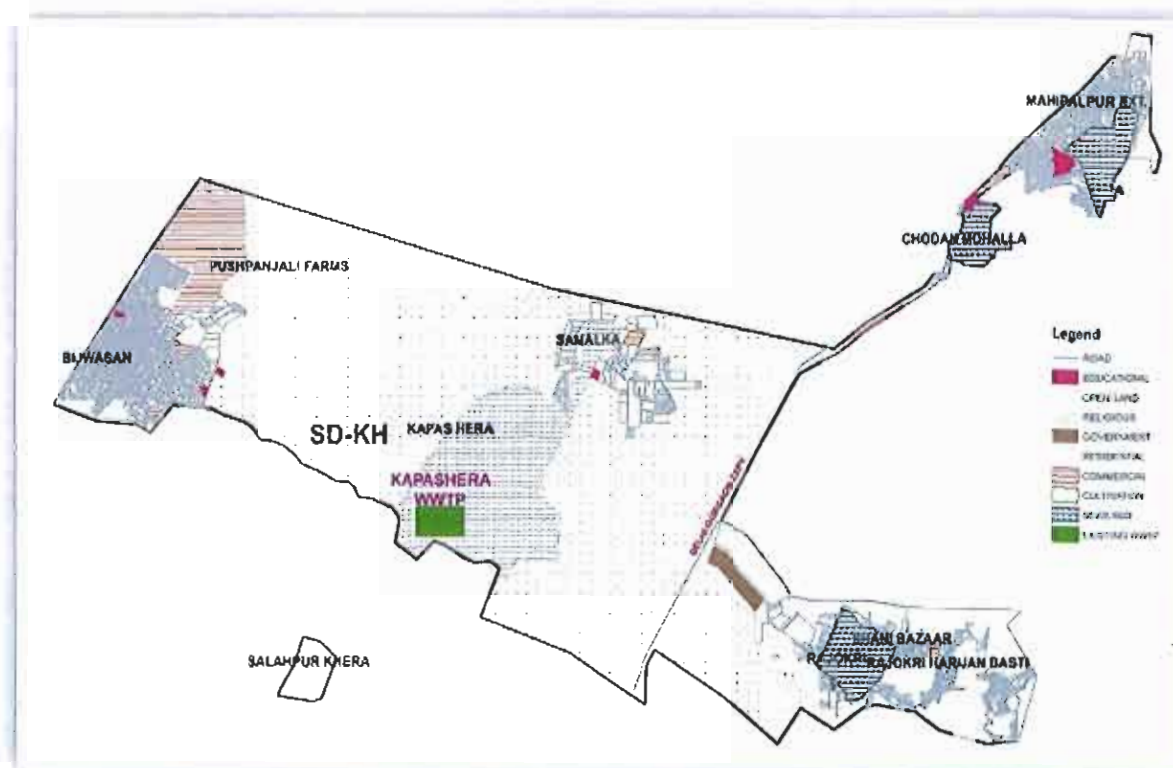


Figure 6: Land Use Map of Kapashera Sub Drainage Zone (SD-KH)

Existing Sewerage Infrastructure

Few pockets of the sub drainage zone are sewered. Sewerage network exists in part of the Sub Zone including parts of Mahipalpur, Rajokri, Kapashera etc. as shown in the figure above. There is an existing WWTP known as **Kapashera WWTP (5 MGD)** capacity.

The details of existing WWPS and their integration arrangement have been shown in the line diagram as **Figure 7**.

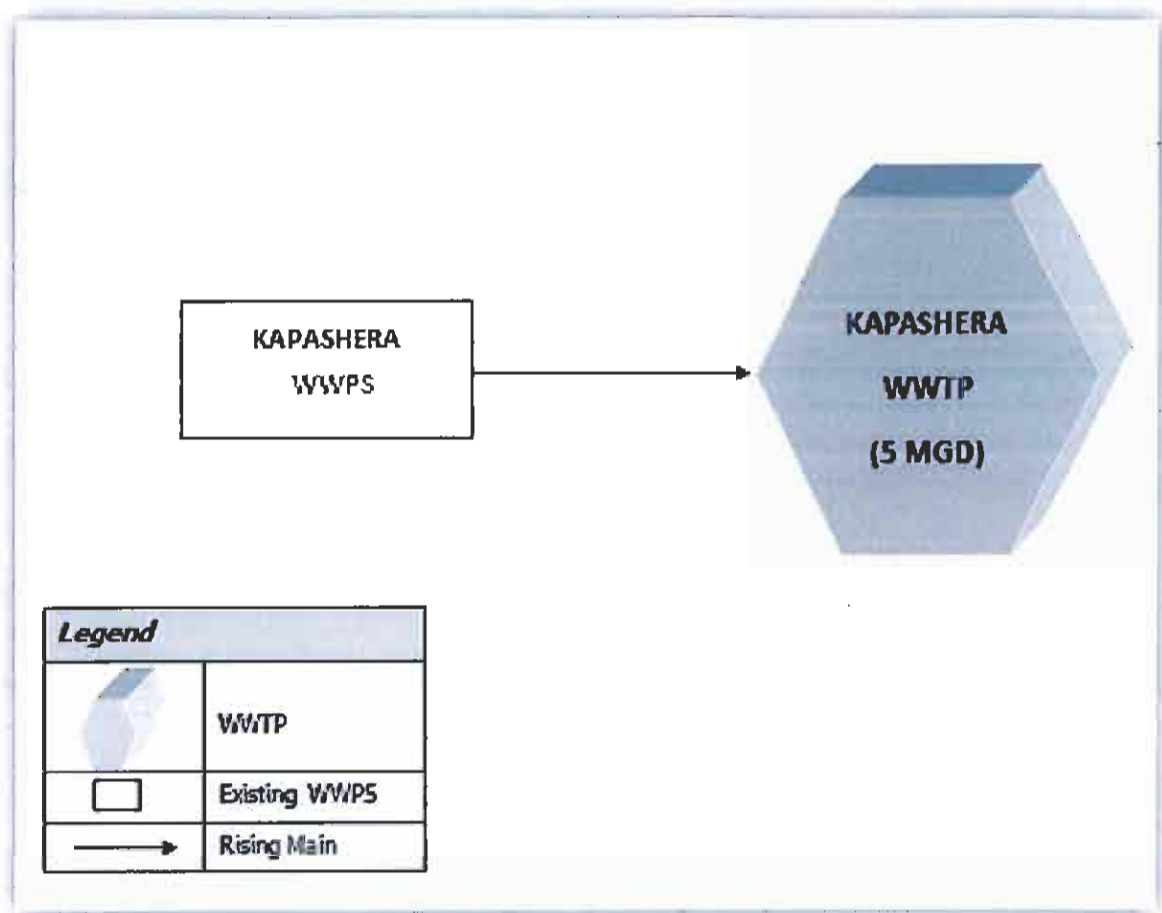


Figure 7: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets. Existing trunks are planned to integrate with proposed sewerage infrastructure. The hydraulic analysis shows that the capacity of trunk sewer will be sufficient to cater 2031 sewage load from this sub zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 8**.

- Area is partially sewered including part of Mahipalpur, Rajokri, Samalka and Kapashera.
- Sewage from Salahpur Khera is routed to proposed Salahpur Khera WWPS then via rising main to Kapashera WWTP.
- Sewage from Bijwasan area is routed to proposed Bijwasan WWPS then via rising main to Kapashera WWTP.
- Sewage from Samalka, Rajokri, Mahipalpur and nearby area is routed to existing trunk sewer towards Kapashera WWTP.

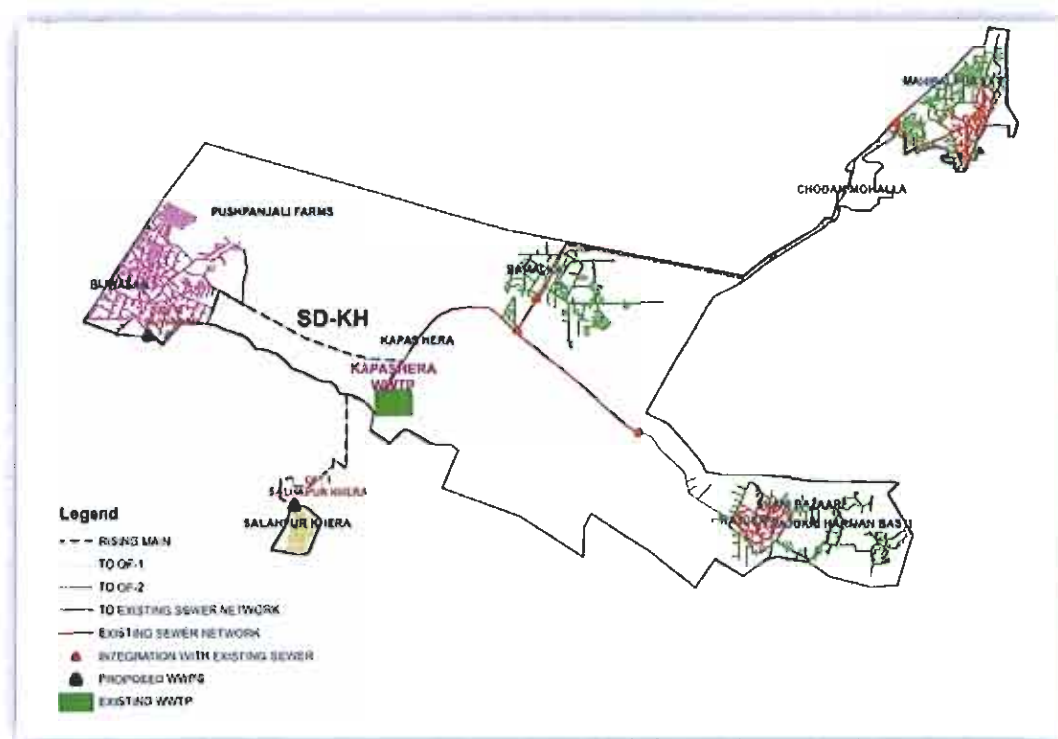


Figure 8: Scheme Map of Kapashera Sub Drainage Zone (SD-KH)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Kapashera Sub Drainage Zone is shown in the **Figure 9**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	122901
300	HDPE/DWC	631
350	HDPE/DWC	388
400	HDPE/DWC	418
500	HDPE/DWC	1050
563.6	HDPE/DWC	198
635.2	HDPE/DWC	414
Total		126000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 9**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

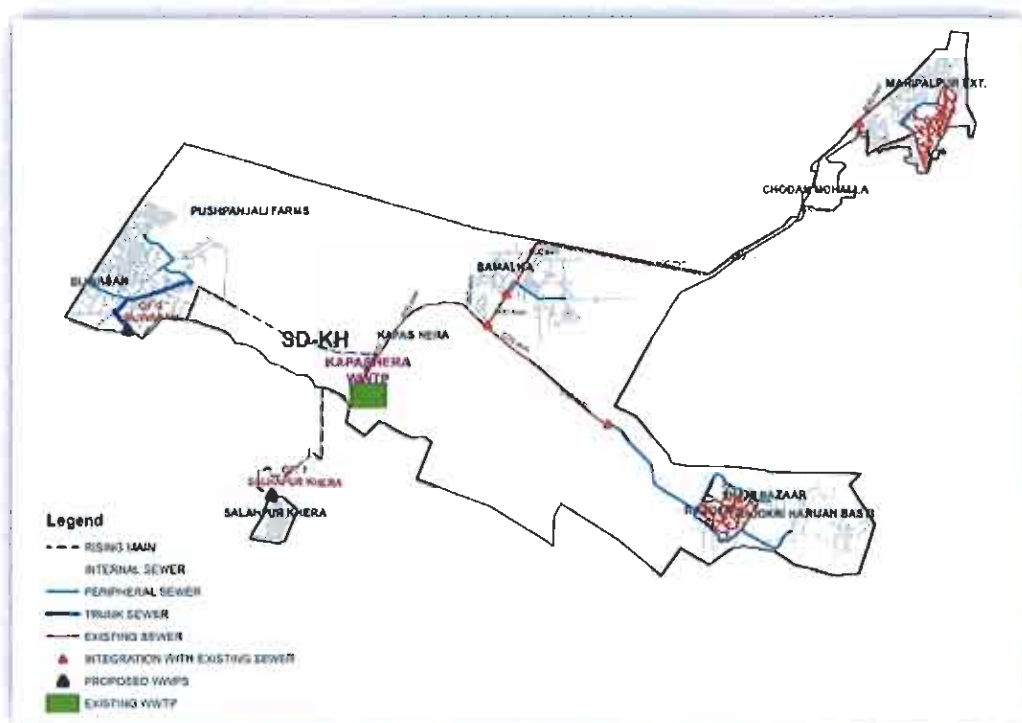


Figure 9: Proposed Sewerage Infrastructure of Kapashera Sub Drainage Zone (SD-KH)

Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Bijwasan	WWPS	3.00	400	1	3500	Kapashera WWTP
2	Salahpur Khera	LS	0.50	200	1	2100	Kapashera WWTP

Waste Water Treatment Requirements

The existing 5 MGD WWTP will be sufficient to cater the sewage generation for Phase 1. Additional Capacity of 6.4 MGD is proposed for Phase 2. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Mahipalpur (SD-MP)

This Sub Drainage Zone spread across part of Mahipalpur, Rangpuri, Rangpuri Extn. and nearby area. The area is unsewered and no sewage treatment facility exists. Land use map is as shown in the **Figure 10**.

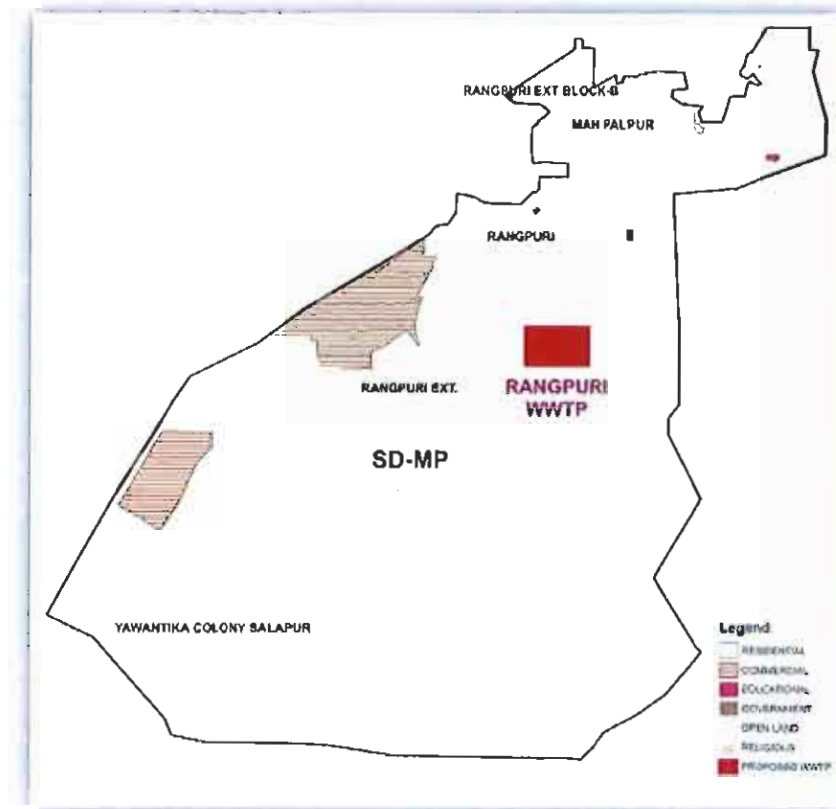


Figure 10: Land Use Map of Mahipalpur Sub Drainage Zone (SD-MP)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 11**:

- The area is unsewered and no sewage treatment facility exists.
- One WWTP is proposed at Rangpuri.
- Sewage from Rangpuri and part of Mahipalpur is routed to Proposed WWPS at Rangpuri and then via rising main to Proposed Rangpuri WWTP.

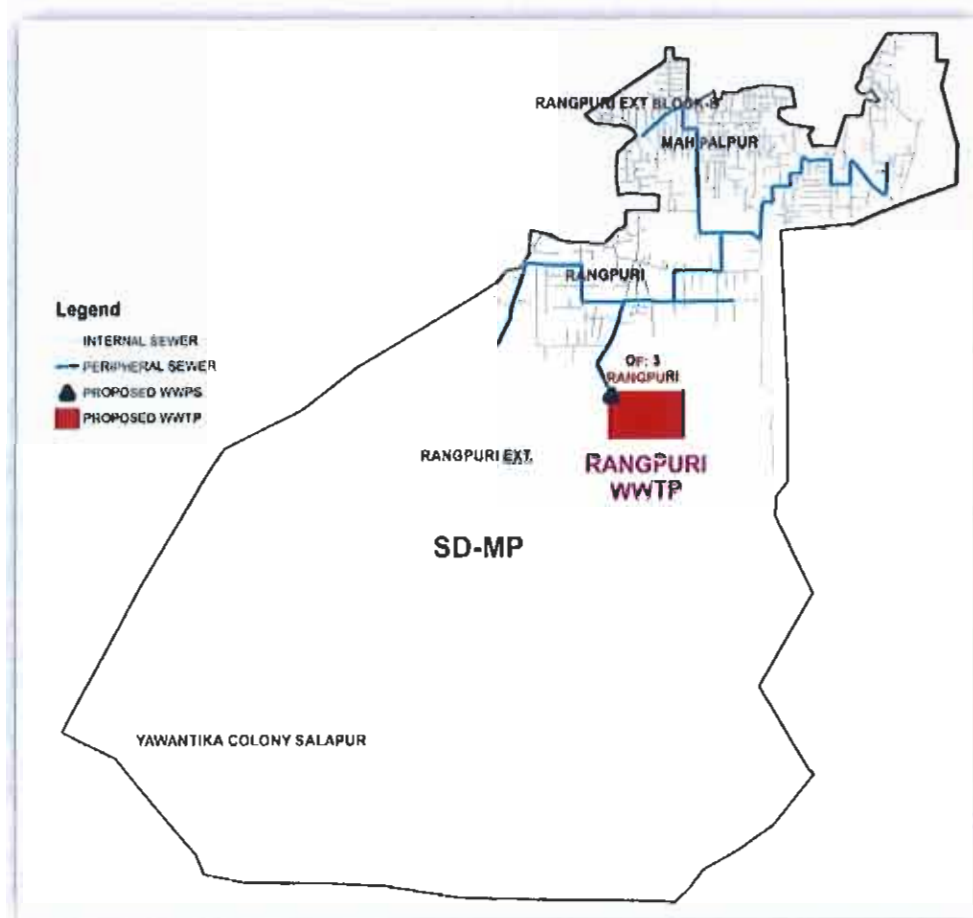


Figure 11: Scheme Map of Mahipalpur Sub Drainage Zone (SD-MP)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Mahipalpur Sub Drainage Zone is shown in the *Figure 10*.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design, and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in *Table 4*.

Table 4: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	93483
300	HDPE/DWC	175
400	HDPE/DWC	4049
500	HDPE/DWC	1783
635.2	HDPE/DWC	1641
700	RCC NP3/NP4	192
800	RCC NP3/NP4	377
Total		101700

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 12**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

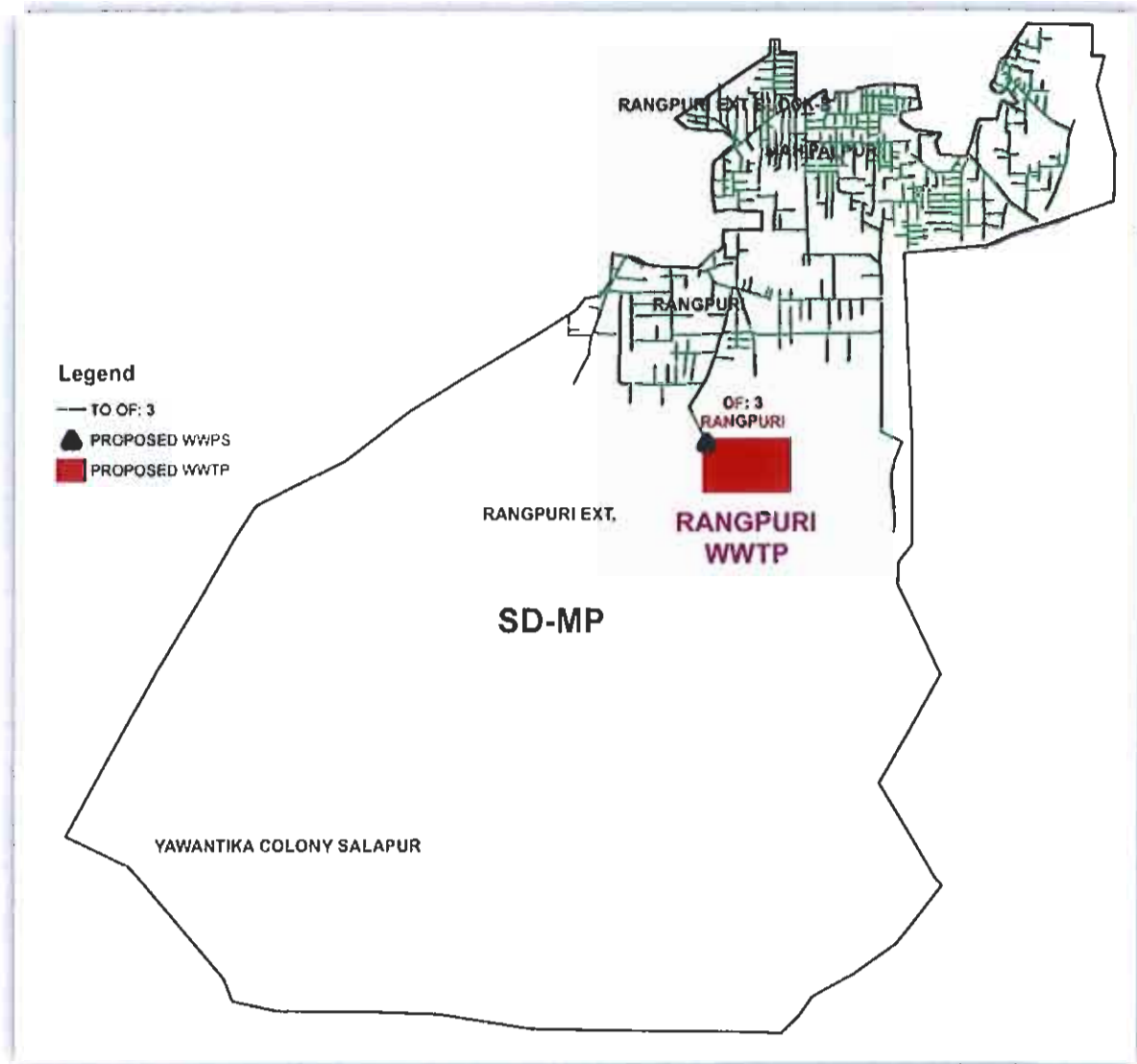


Figure 12: Proposed Sewerage Infrastructure of Mahipalpur Sub Drainage Zone (SD-MP)

Waste Water Pumping Requirements

The location of proposed WWPSs and rising mains are shown in the figure above. Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Rangpuri	WWPS	5.00	400	1	100	Proposed WWTP

Waste Water Treatment Requirements

One WWTP is proposed at Rangpuri (5 MGD) in phased manner. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.3 Sub Drainage Zone: Vasant Kunj (SD-VK)

This Sub Drainage Zone spread across Vasant Kunj, Kishangarh etc. The area is mostly sewered with few unsewered pockets and there is an existing WWTP of 5 MGD Capacity known as Vasant kunj WWTP. Land use map is as shown in the **Figure 13**.

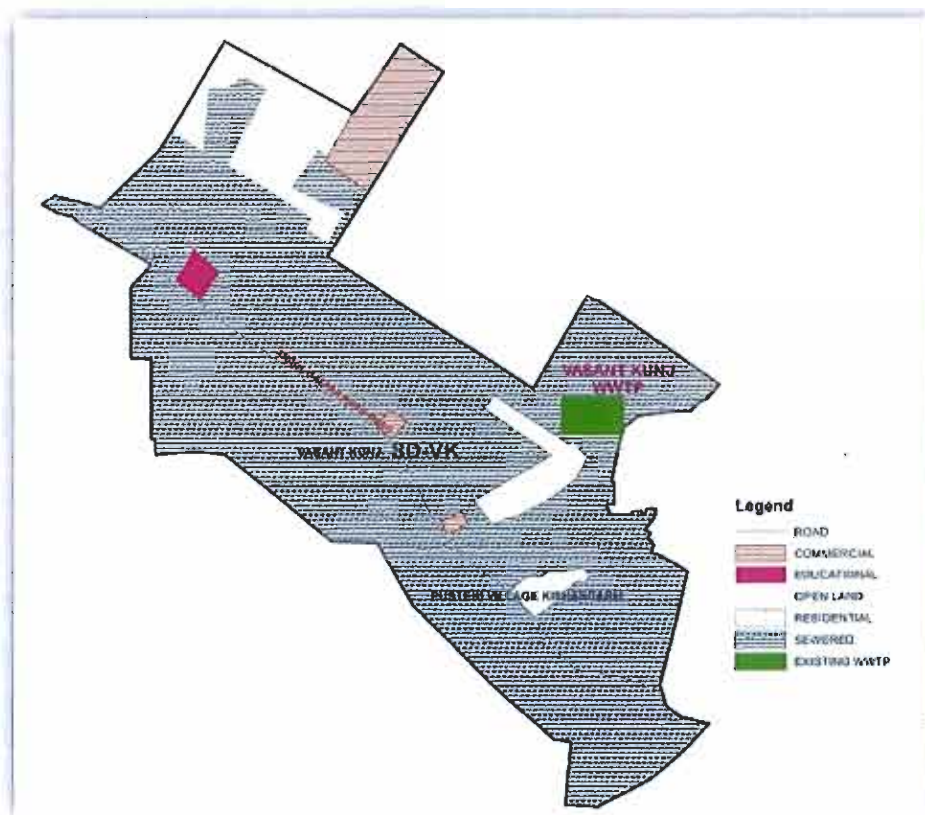


Figure 13: Land Use Map of Vasant Kunj Sub Drainage Zone (SD-VK)

Existing Sewerage Infrastructure

Sewerage Network already exists in the Sub Zone except for a few unsewered pockets as shown in the **Figure 13**. There is an existing WWTP known as **Vasant Kunj WWTP (5 MGD)**.

Sewage from Vasant Kunj Northern part, Sector B, Sector D and nearby area is routed to Existing Trunk sewers outfalling into Existing WWPS's at Sector B and D and then via rising main to WWTP at Vasant Kunj. However current arrangement is to pump sewage towards Ghitorni WWTP via rising mains.

Sewage from Vasant Kunj Southern part is routed to Existing Trunk sewers outfalling into Existing WWPS at Vasant Kunj and then via rising main to WWTP at Vasant Kunj.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 14**.

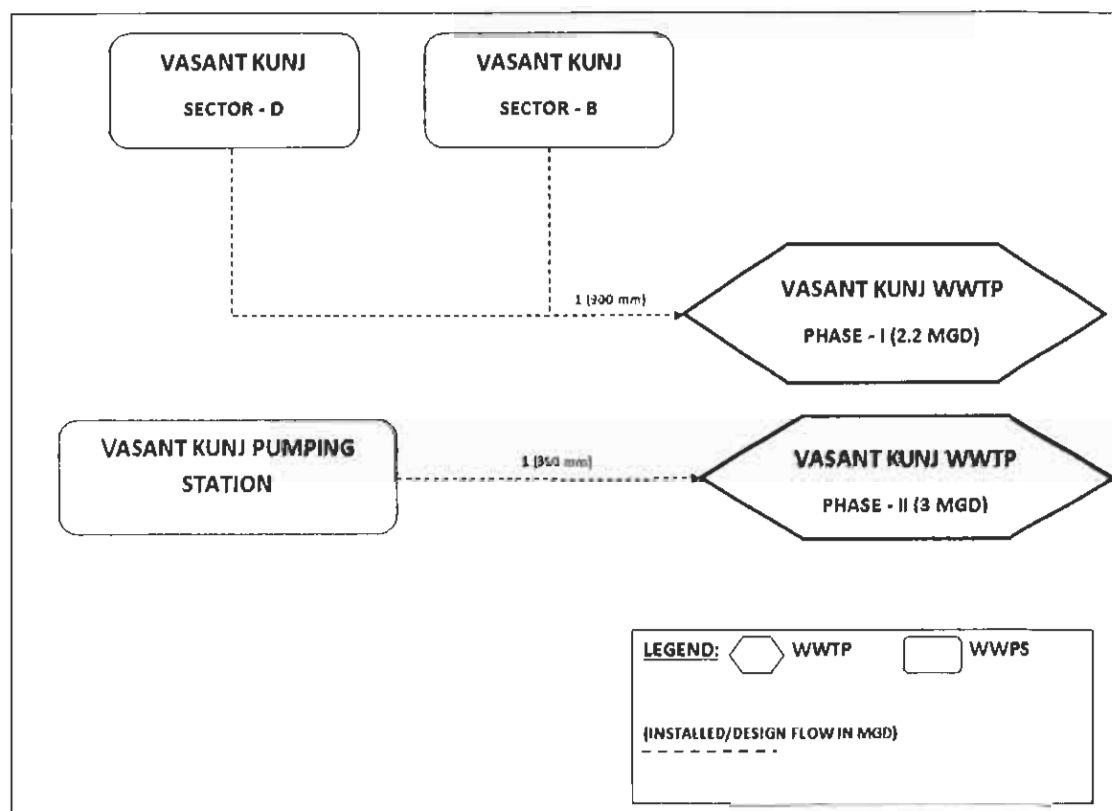


Figure 14: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 15**:

- Area is mostly sewerage with few unsewered pockets in Kishangarh Pushtaini Village.
- One Existing WWTP is present and known as **Vasant kunj WWTP (5 MGD)** capacity.
- Sewage from unsewered parts of Kishangarh Pushtaini Village and Neela Hauz is routed to existing sewerage network towards Vasantkunj WWTP.

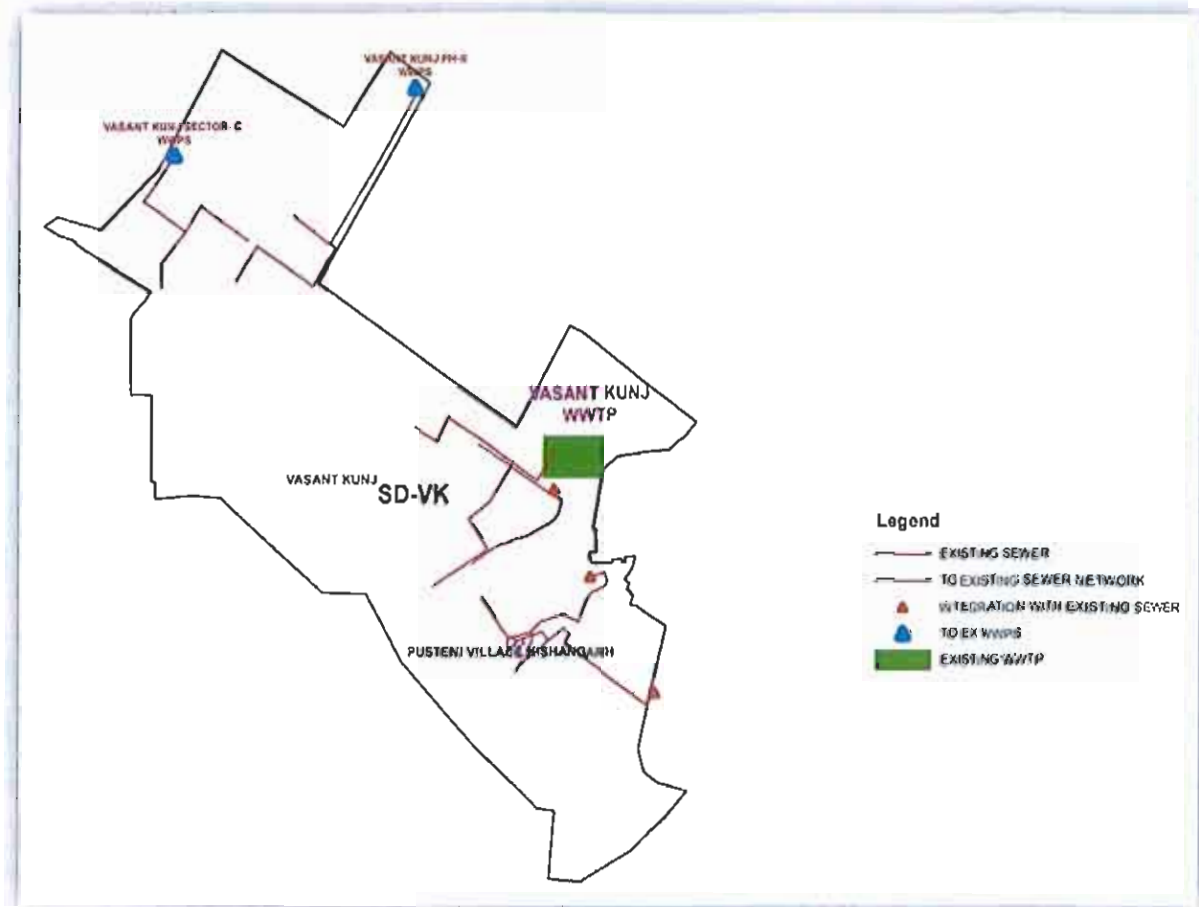


Figure 15: Scheme Map of Vasant Kunj Sub Drainage Zone (SD-VK)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Vasant Kunj Sub Drainage Zone is shown in the **Figure 16**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 6**.

Table 6: Proposed Gravity Sewerage Network – Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	6000
Total		6000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 16**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on as-built drawings.

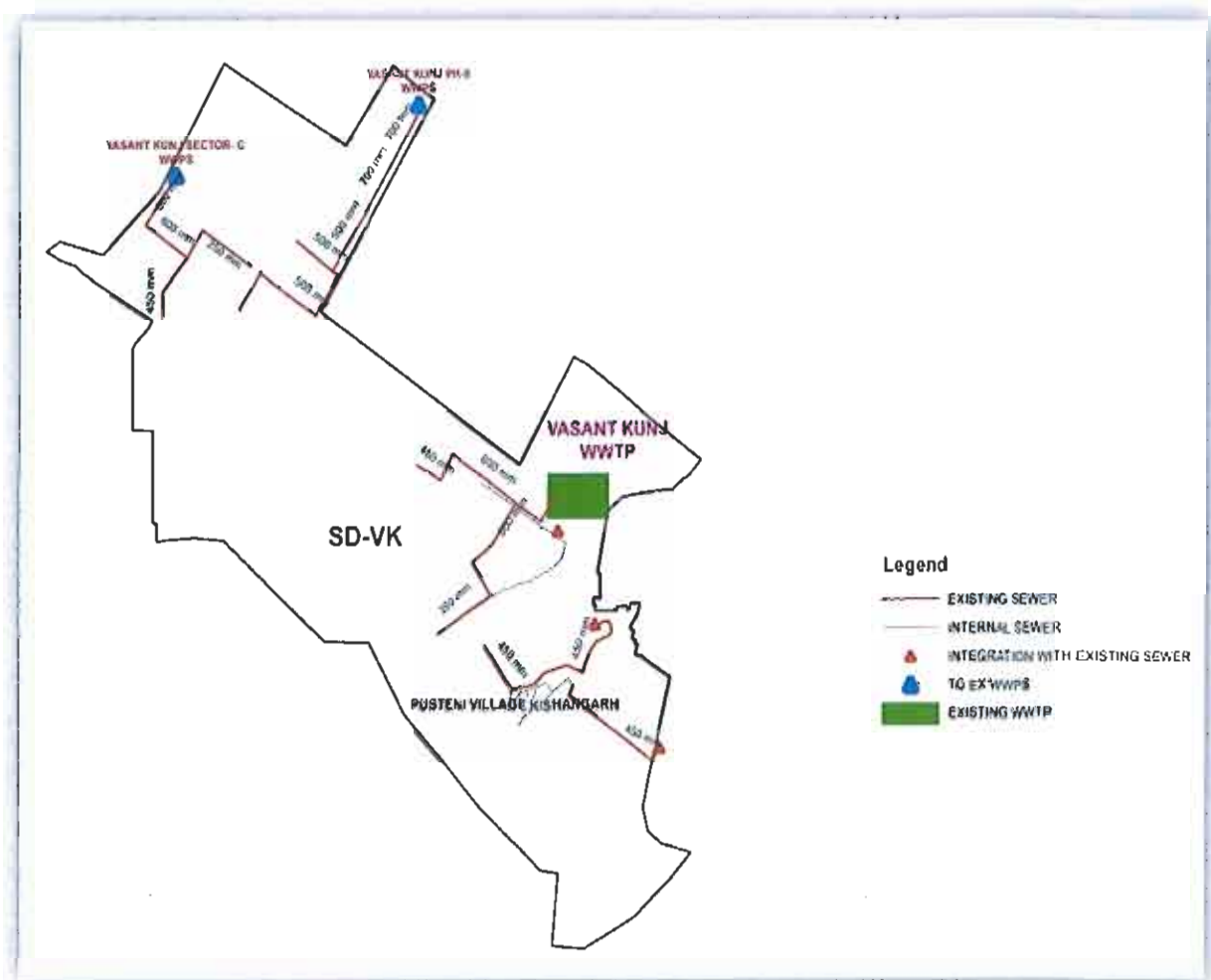


Figure 16: Proposed Sewerage Infrastructure of Vasant Kunj Sub Drainage Zone (SD-VK)

Waste Water Pumping Requirements

No additional Pumping Stations have been proposed for unsewered pockets of Sub Drainage Zone.

Waste Water Treatment Requirements

The existing 5 MGD WWTP will be sufficient to cater the sewage generation from the sub-drainage zone.

3.4 Sub Drainage Zone: Mehrauli (SD-MH)

This Sub Drainage Zone spread across part of Lado Sarai, Mehrauli, Chhatarpur, Manglapuri and nearby area. The area is unsewered with few pockets of sewered areas i.e. Lado Sarai and Mehrauli. There is an existing WWTP of 5 MGD Capacity known as Mehrauli WWTP. Land use map is as shown in the **Figure 17**.

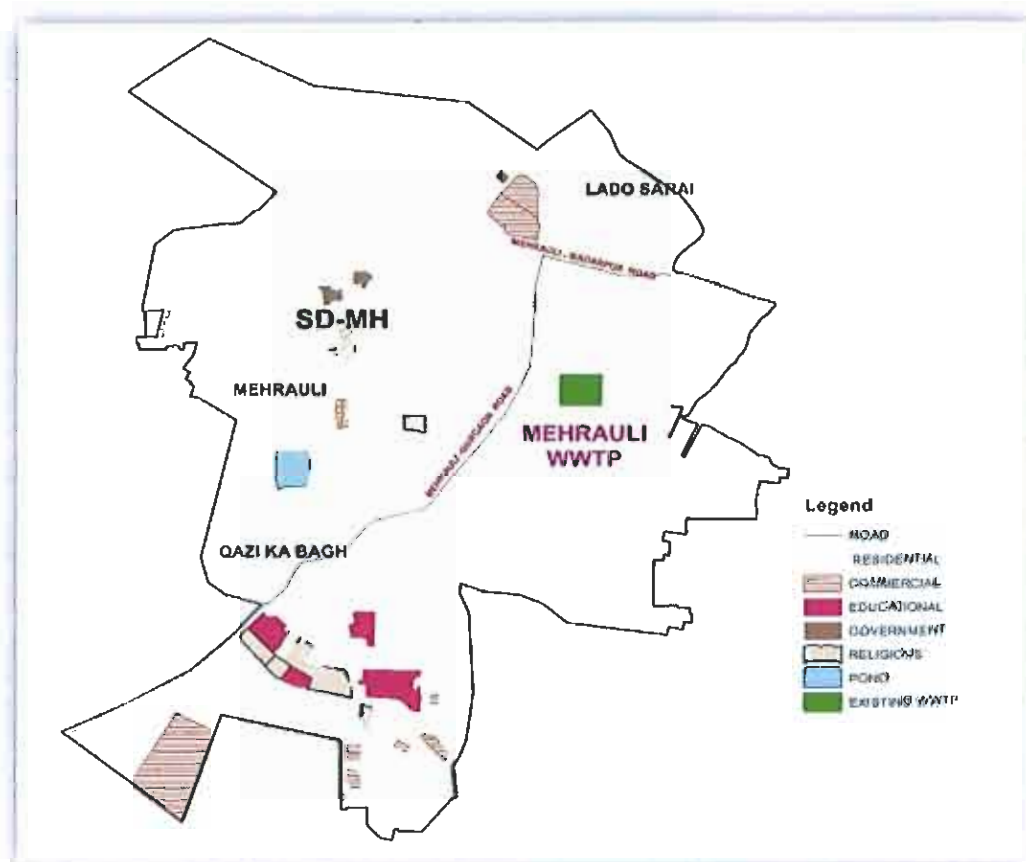


Figure 17: Land Use Map of Mehrauli Sub Drainage Zone (SD-MH)

Existing Sewerage Infrastructure

Sewerage Network already exists in few parts of the Sub Zone including Lado Sarai. There is an existing WWTP known as Mehrauli WWTP (5 MGD) capacity.

The details of existing WWPS and their integration arrangement have been shown in the line diagram as Figure 18.

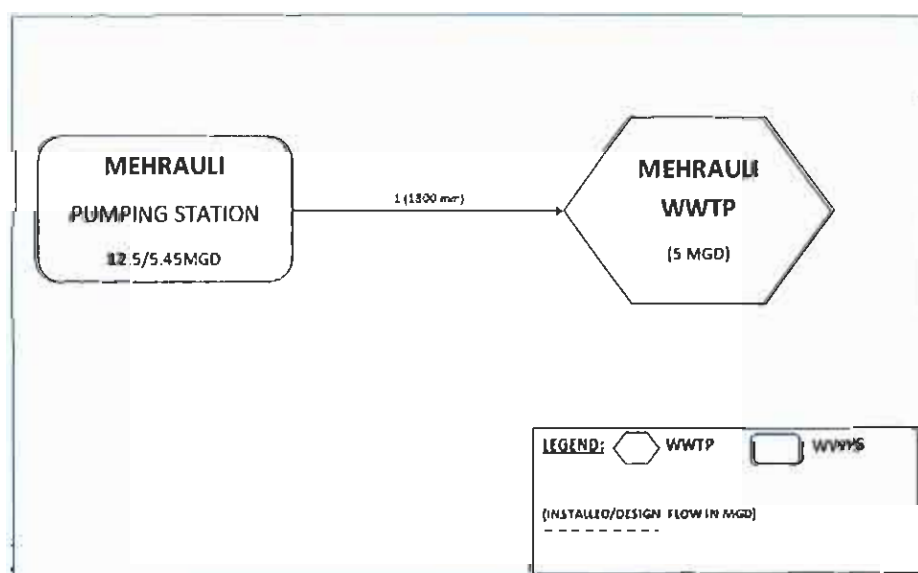


Figure 18: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 19**.

- The area is unsewered and a small portion of Lado Sarai and Mehrauli area is sewerred.
- Sewage from part of Ladosarai is routed to Proposed WWPS at Lado Sarai and then via rising main to existing Mehrauli WWTP.
- Sewage from part of Chhatarpur, Manglapuri and Mehrauli is routed to Mehrauli WWTP.

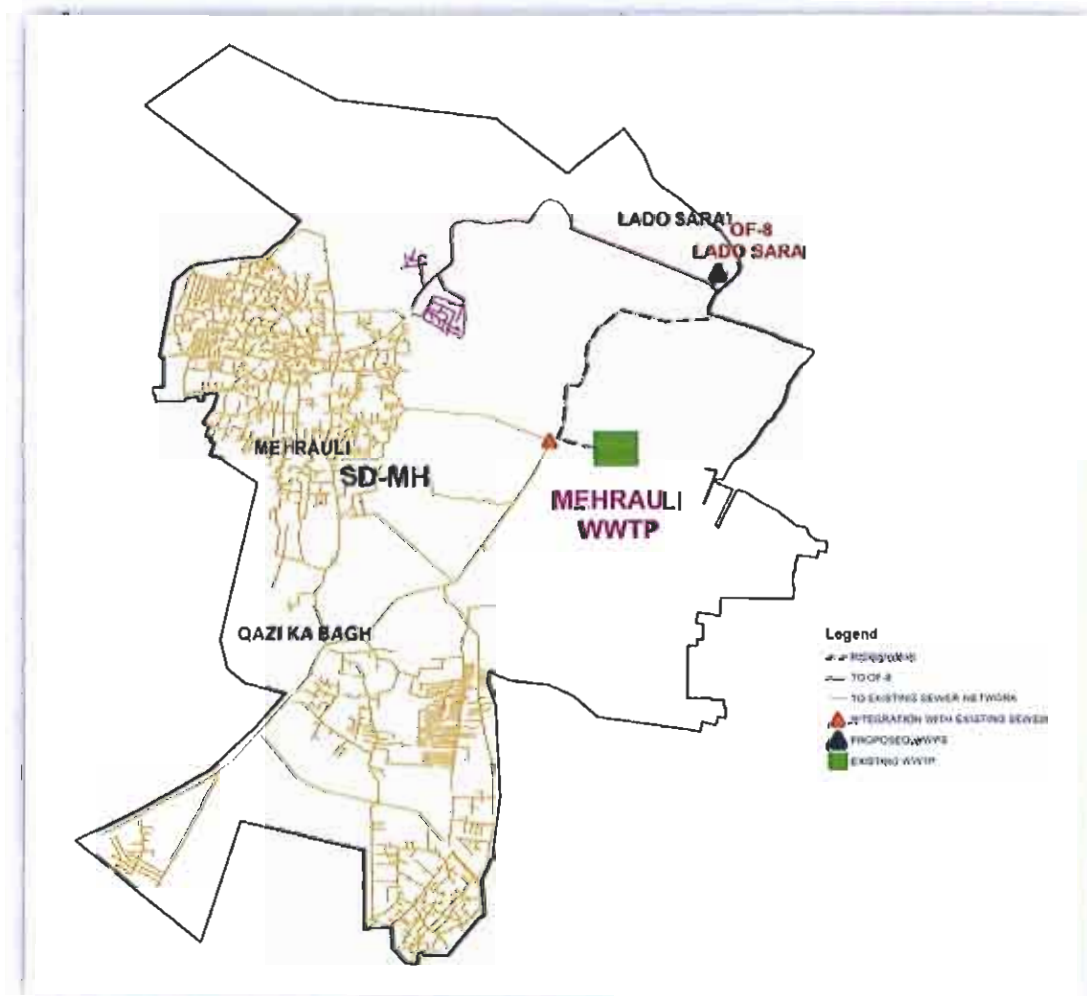


Figure 19: Scheme Map of Mehrauli Sub Drainage Zone (SD-MH)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Mehrauli Sub Drainage Zone is shown in the **Figure 20**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 7**.

The details of proposed sewerage network is represented in **Table 7**:

Table 7: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	81925
300	HDPE/DWC	2769
350	HDPE/DWC	435
400	HDPE/DWC	4124
500	HDPE/DWC	2732
563.6	HDPE/DWC	404
635.2	HDPE/DWC	833
700	RCC NP3/NP4	479
800	RCC NP3/NP4	699
Total		94400

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 20**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

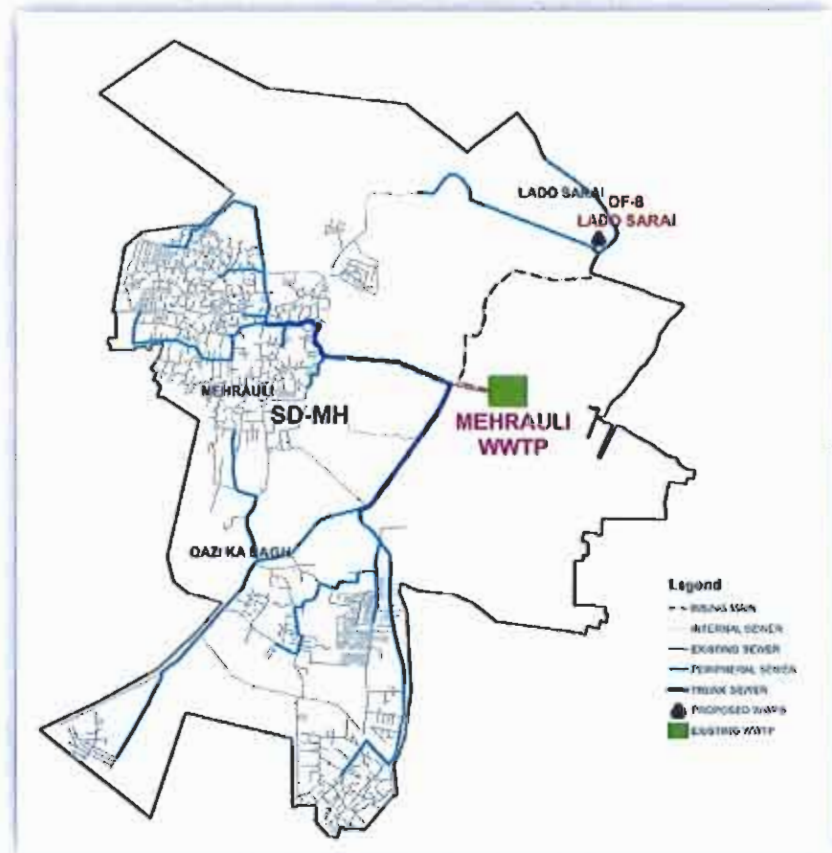


Figure 20: Proposed Sewerage Infrastructure of Mehrauli Sub Drainage Zone (SD-MH)

Waste Water Pumping Requirements

The location of proposed WWPSs and rising mains are shown in the figure above. Though considerable efforts have been made during feasibility study and site visits in finalising location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Tables 8**.

Table 8: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Lado Sarai	WWPS	2.50	400	1	1950	Existing WWTP

Waste Water Treatment Requirements

The existing 5 MGD WWTP will be sufficient to cater the sewage generation from the sub-drainage zone.

3.5 Sub Drainage Zone: Ghitorni (SD-GH)

This Sub Drainage Zone spread across part of Rangpuri Pahari, Nangal Dewat, Ghitorni, Ayanagar, Gadaipur and nearby area. The area is unsewered and a small fraction of area is sewerred in Ghitorni and Rangpuri Pahari. There is an existing WWTP of 5 MGD Capacity known as Ghitorni WWTP. Land use map is as shown in the **Figure 21**.

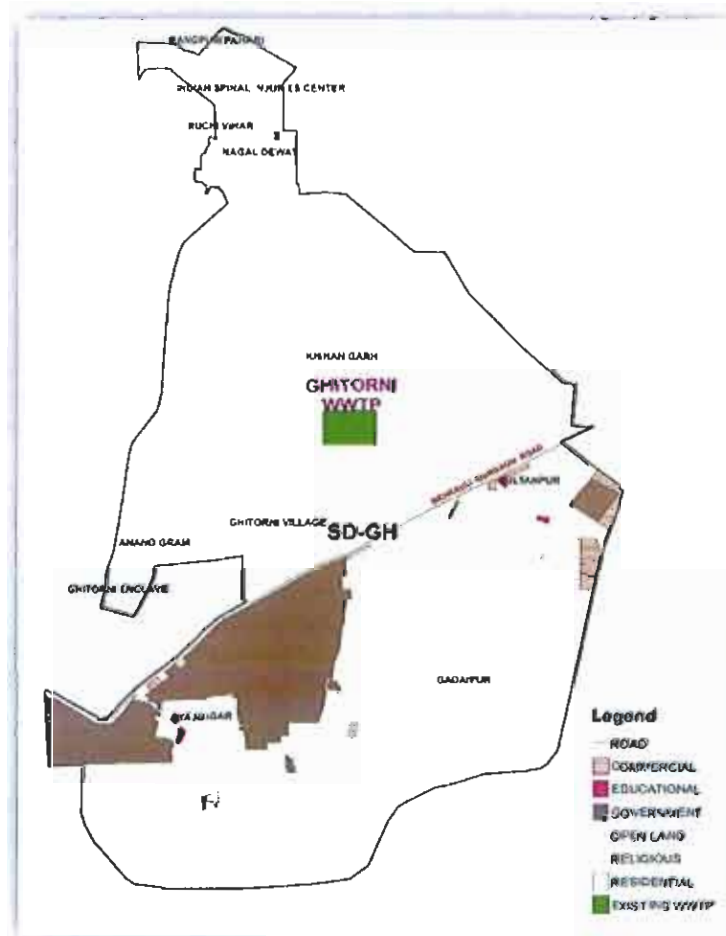


Figure 21: Land Use Map of Ghitorni Sub Drainage Zone (SD-GH)

Existing Sewerage Infrastructure

Sewerage Network already exists in part of the Sub Zone including parts of Rangpuri Pahari and Ghitorni. There is an existing but yet to be commissioned WWTP known as Ghitorni WWTP (5 MGD).

Sewage from part of Rangpuri Pahari and nearby area is conveyed to Existing WWPS at Rangpuri Pahari and then via rising main to WWTP at Ghitorni.

Line Diagram for Existing WWPS and WWTP is shown in **Figure 22**:

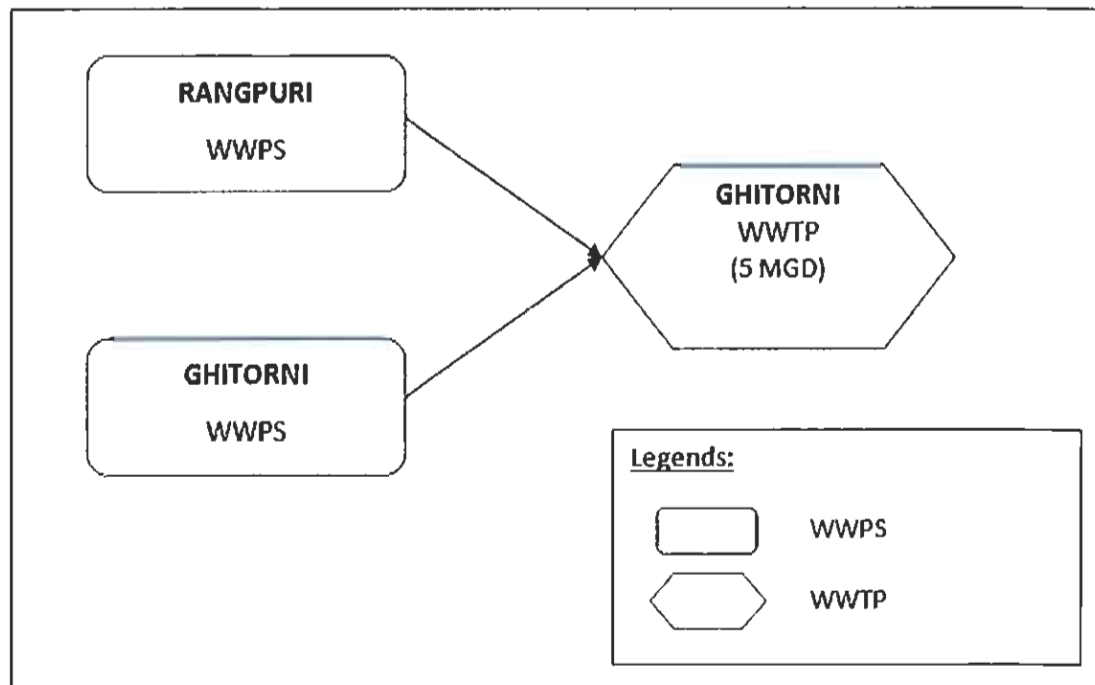


Figure 22: Flow Chart of Existing Sewerage Infrastructure in the Sub Drainage Zone

Utilization of Existing Sewerage Infrastructure

The proposed network has been planned considering optimum utilization of existing sewerage assets.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 23**:

- The area is unsewered and a small portion of Rangpuri Pahari and Ghitorni area is sewerred.
- Sewage from part of Rangpuri Pahari is routed to Proposed Lift Station and pumped to nearest Manhole in Proposed Sewerage outfalling into Existing Rangpuri Pahari WWPS.
- Sewage from part of Ruchi Vihar, Nangal Dewat etc is routed to Existing Rangpuri Pahari WWPS.
- Sewage from Ghitorni area is routed to Existing WWPS at Ghitorni WWTP.

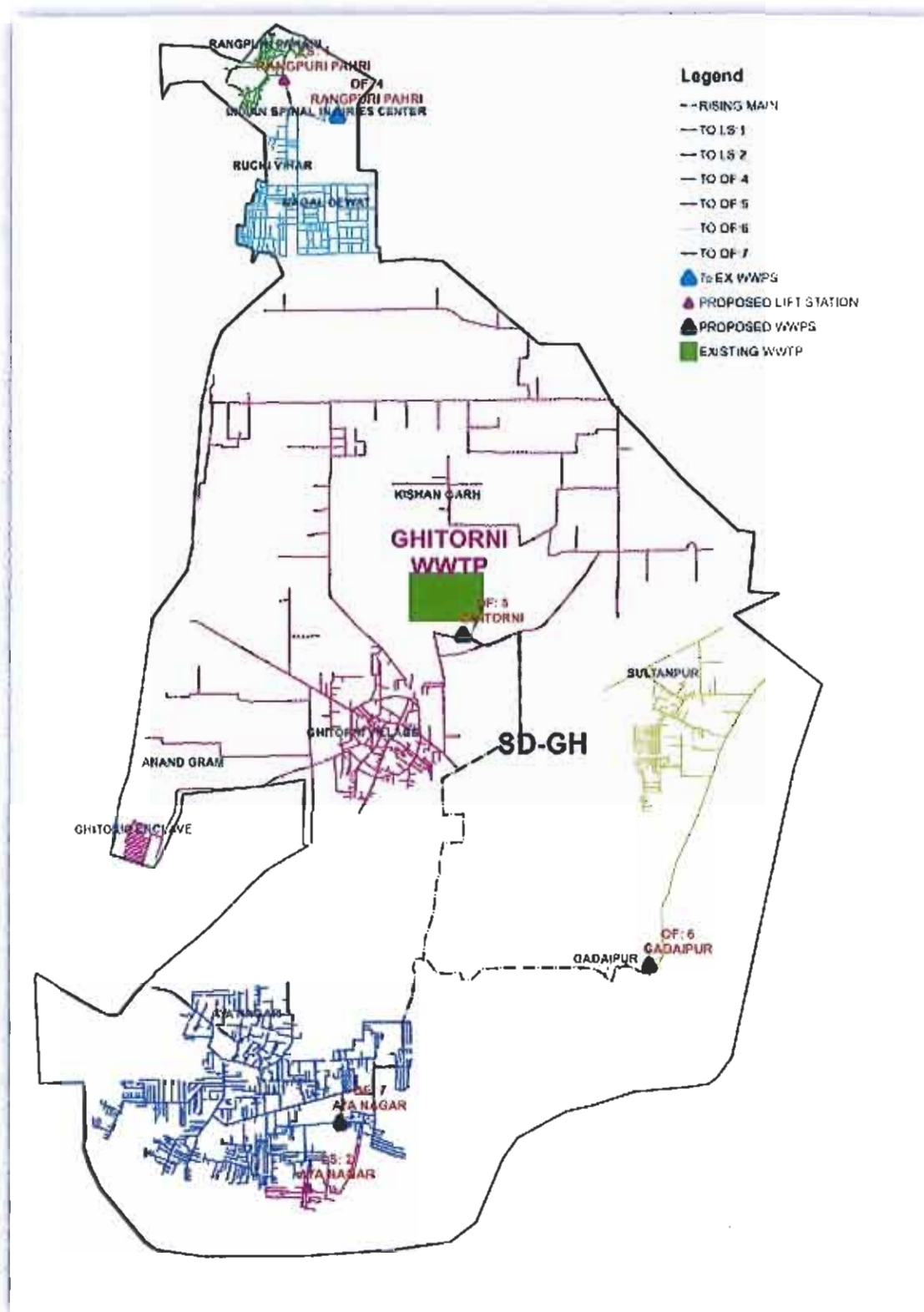


Figure 23: Scheme Map of Ghitorni Sub Drainage Zone (SD-GH)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements. Scheme map for Ghitorni Sub Drainage Zone is shown in the **Figure 24**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize and hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 9**.

Table 9: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	149797
300	HDPE/DWC	4950
350	HDPE/DWC	2292
400	HDPE/DWC	4431
500	HDPE/DWC	8324
563.6	HDPE	570
635.2	HDPE	1212
700	RCC NP3/NP4	1264
900	RCC NP3/NP4	60
Total		172900

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 23**. However actual categorization with respective details, such as length, diameter, and invert levels shall be done based on the as built drawings.

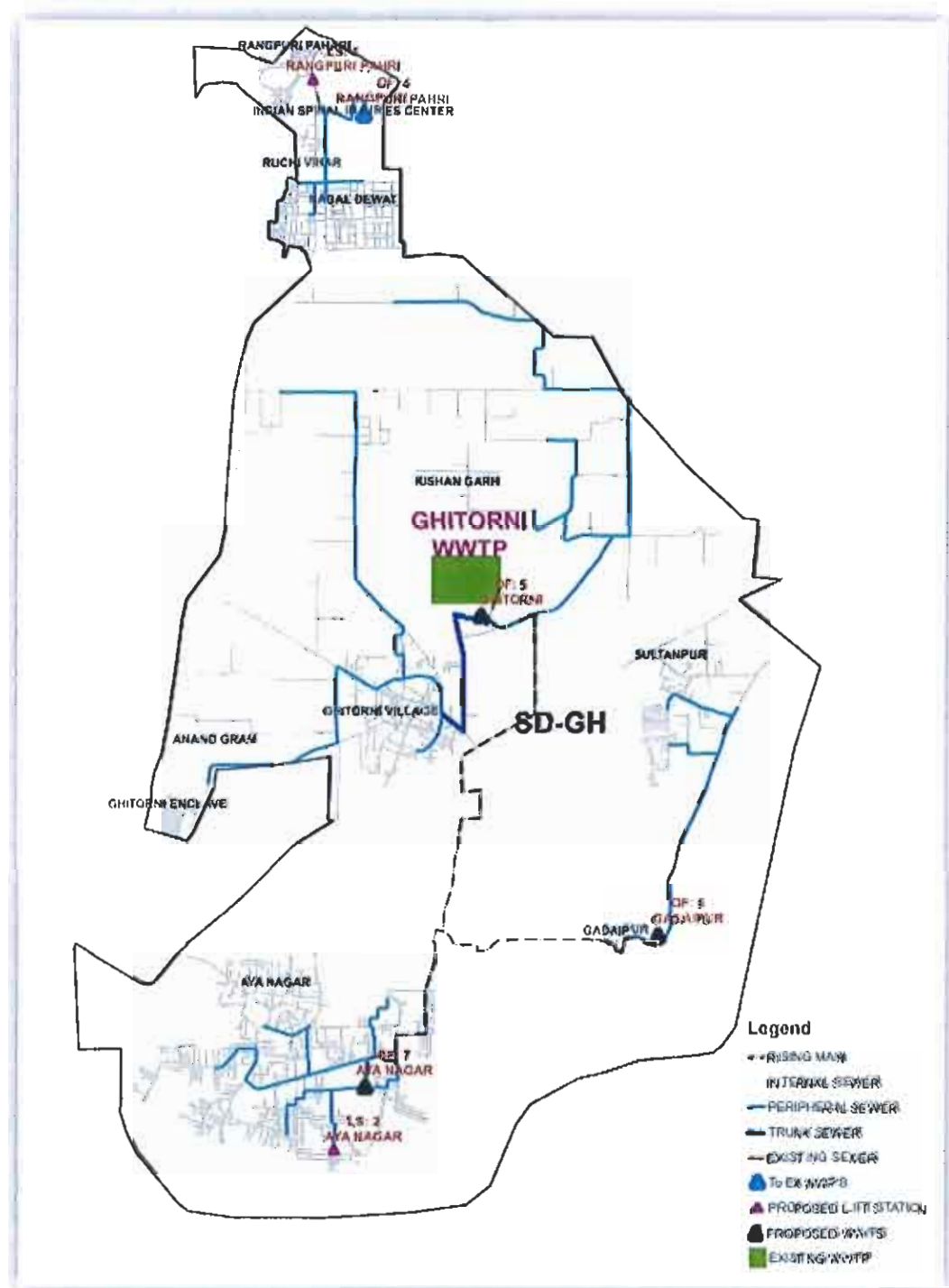


Figure 24: Proposed Sewerage Infrastructure of Ghitori Sub Drainage Zone (SD-GH)

Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWTs and details of proposed Rising Mains are listed in the **Table 10**.

Table 10: Proposed Waste Water Pumping Arrangement

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Rangpuri Pahari	LS	1.00	250	1	350	Nearest Manhole
2	Ghitorni	WWPS	8.00	600	1	500	Existing WWTP
3	Aya Nagar LS	LS	0.50	150	1	30	Nearest Manhole
4	Aya Nagar WWPS	WWPS	5.00	600	1	5000	Existing WWTP
5	Gadaipur WWPS	WWPS	2.50	400	1	3000	Existing WWTP

Waste Water Treatment Requirements

The 5 MGD WWTP at Ghitorni, which is yet to be commissioned, will be sufficient to cater the sewage generation for Phase I. Additional Capacity of 9 MGD is proposed in Phase 2 in nearby area. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 11**.

Table 11: Summary of Proposed Sewerage Infrastructure

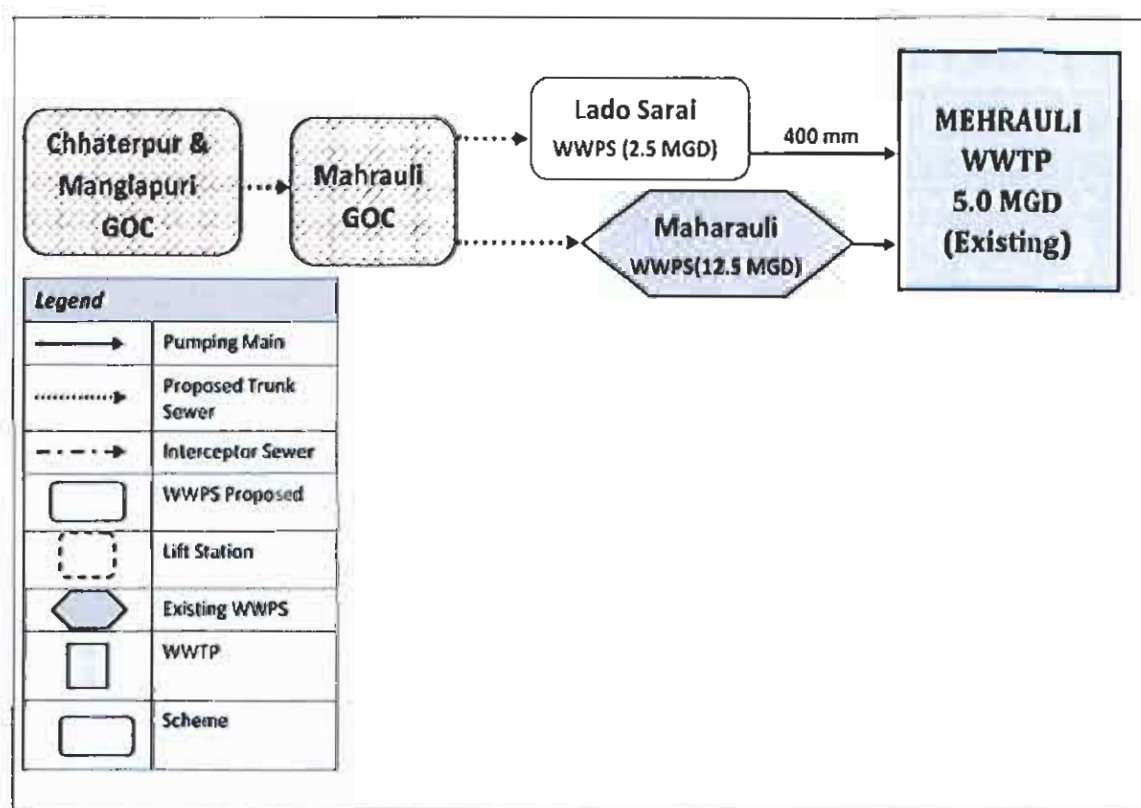
SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Kapashera	(SD-KH)	126	1	1	-
Mahipalpur	(SD-MH)	101.7	1	-	1
Vasant Kunj	(SD-VK)	6	-	-	-
Mehrauli	(SD-MH)	94.4	1	-	-
Ghitorni	(SD-GH)	172.9	3	2	-
Total		501	6	3	1

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 12**.

Table 12: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Reqd. (ha)	Location	Type	Design Capacity (MGD)	Area Reqd. (sq.mt.)
Kapashera		6.4	3.6 - 4.7	Bijwasan	WWPS	3.0	2147.68
				Salahpur Khera	LS	0.5	34
Mahipalpur	Rangpuri	5	2.8 - 3.6	Rangpuri	WWPS	5.0	2025
Vasant Kunj	-	-	-	-	-	-	-
Mehrauli	-	-	-	Lado Sarai	WWPS	2.5	1450
Ghitorni		9	5.1 - 6.5	Rangpuri Pahari	LS	1.0	37
				Ghitorni	WWPS	8.0	2496
				Aya Nagar LS	LS	0.5	34
				Aya Nagar WWPS	WWPS	5.0	2162
				Gadaipur WWPS	WWPS	2.5	1147

Line Diagram for Proposed WWPS and WWTP Mehrauli is shown in **Figure 25**.

**Figure 25: Line Diagram for Proposed WWPS and WWTP of Mehrauli**

Line Diagram for Proposed WWPS and WWTP Ghitorni is shown in **Figure 26**.

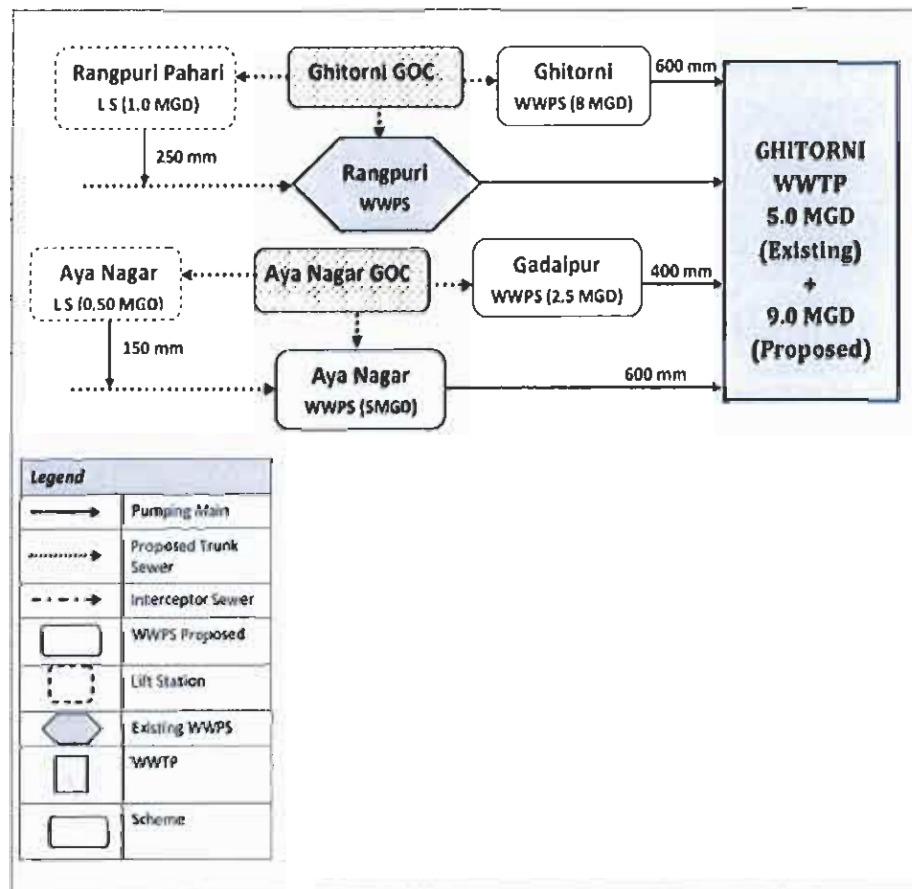


Figure 26: Line Diagram for Proposed WWPS and WWTP of Ghitorni

Line Diagram for Proposed WWPS and WWTP Mahipalpur is shown in **Figure 27**:

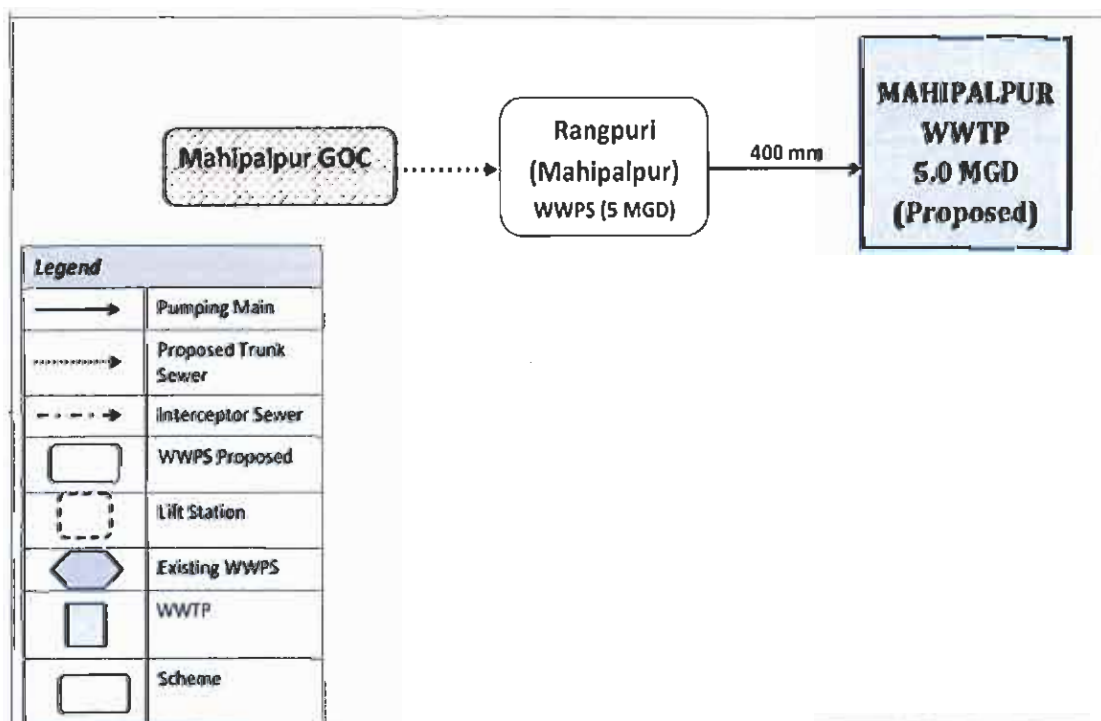


Figure 27: Line Diagram for Proposed WWPS and WWTP of Ghitorni

Line Diagram for Proposed WWPS and WWTP Kapashera is shown in **Figure 28**:

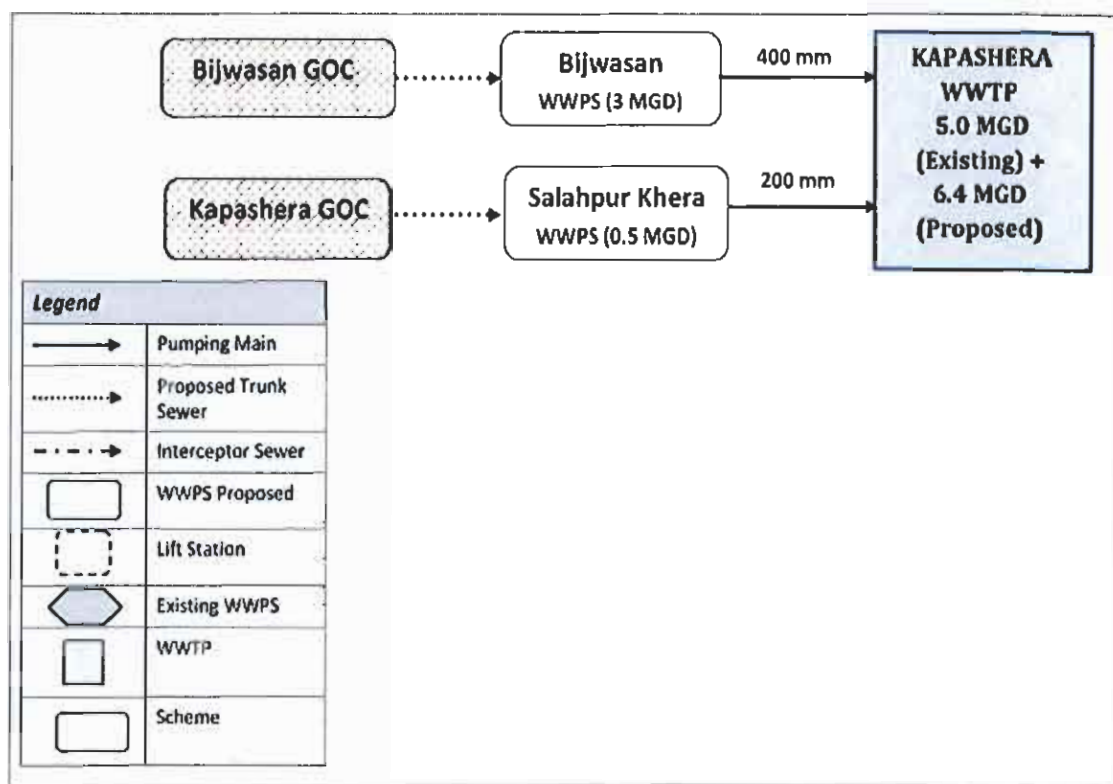


Figure 28: Line Diagram for Proposed WWPS and WWTP of Kapashera

Line Diagram for Proposed WWPS and WWTP Vasant Kunj is shown in **Figure 29**:

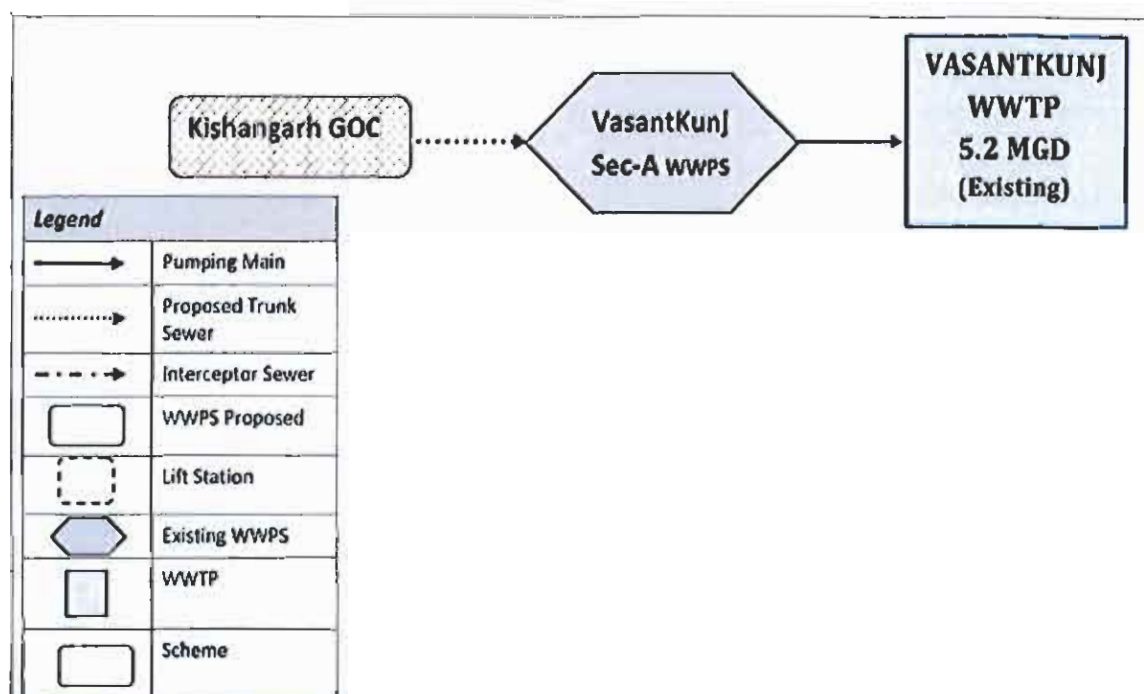


Figure 29: Line Diagram for Proposed WWPS and WWTP for Vasant Kunj

Disposal of Treated Effluent

Current practice of treated effluent disposal is to discharge it to nearby drain which ultimately discharges to Yamuna River.

Treated effluent of high grade quality can also be utilized for non-potable uses. Likely users of Treated Effluent may be DDA, Golf Course, Archeology Deptt. (Qutab), Farm houses, and MCD for their direct non-potable and other uses. The Treated waste water can also be used for horticulture in the nearby area and Ridge forest area. Treated effluent may also be utilized to recharge nearby water bodies.

The proposed sewerage scheme for South Delhi Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in **Figure 30**.

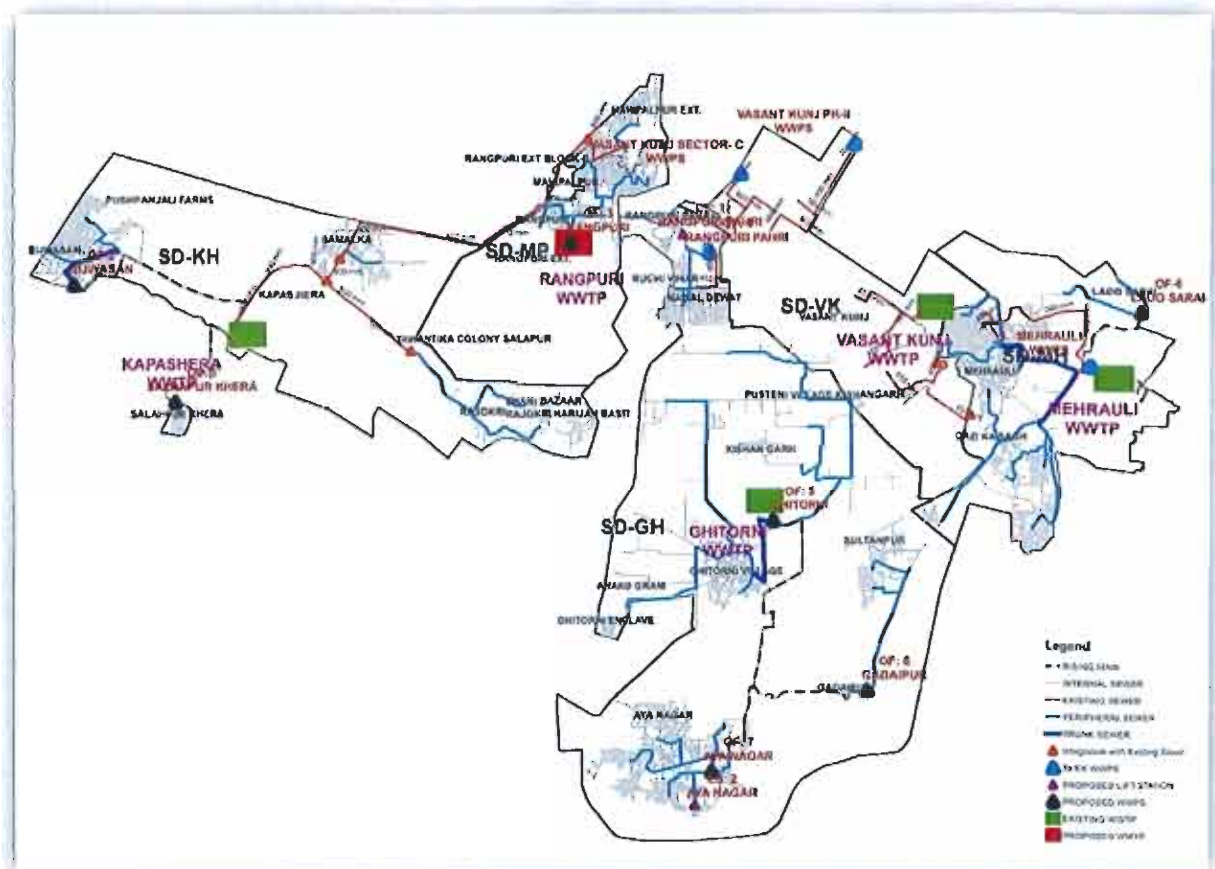


Figure 30: Proposed Sewerage Scheme for South Delhi Drainage Zone

Various Group of Colonies (GOCs) – wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 31**.

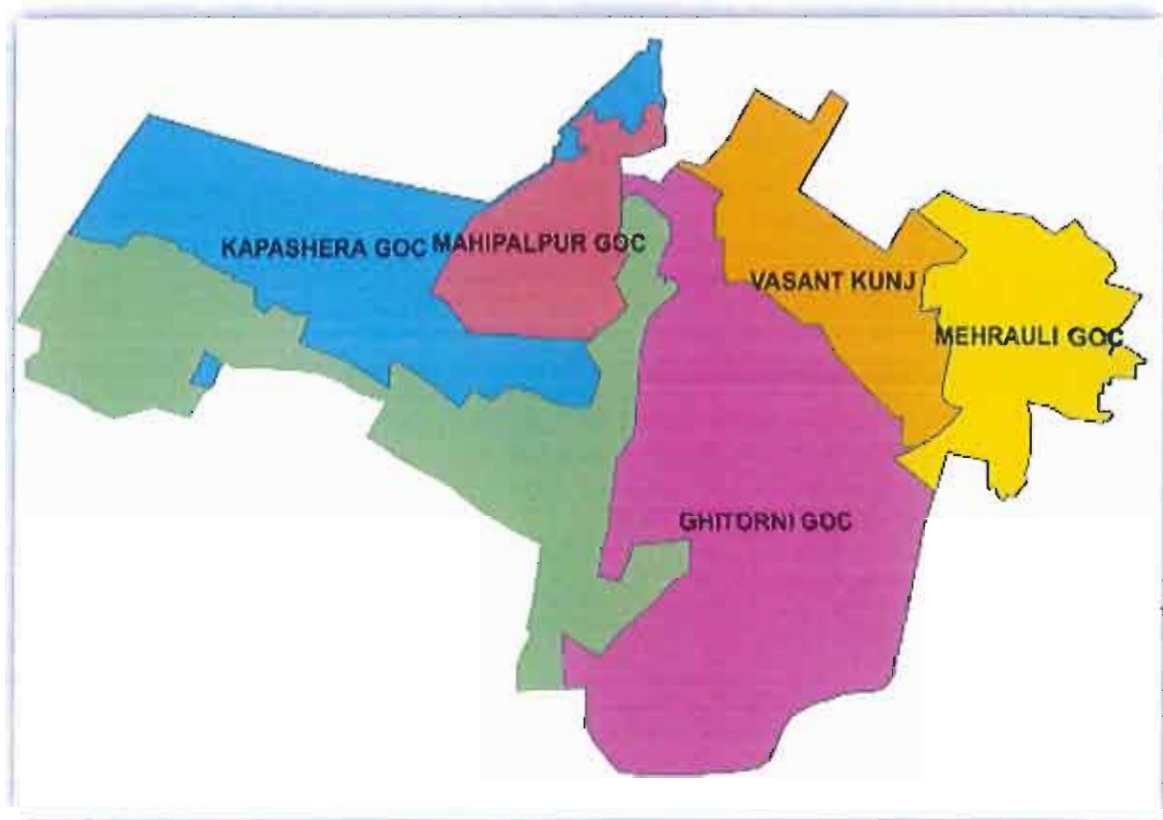


Figure 31: Various Group of Colonies of South Delhi Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 13: Implementation Schedule

Sl. No.	Scheme Details				Implementation Schedule			
	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Mehrauli	MH	SD-MH	Mehrauli				
2	Mehrauli	MH	SD-MH-CM	Chhatarpur Village and Manglapuri				
3	Ghitorni	GH	SD-GH	Ghitorni				
4	Mahipalpur	MP	SD-MP	Mahipalpur				
5	Ghitorni	GH	SD-GH-AN	Ayanagar GOC				
6	Kapashera	KH	SD-KH-BWE	Bijwasan				
7	Kapashera	KH	SD-KH	Kapashera GOC				
8	Vasant Kunj	VK	SD-VK	Kishangarh				

Table 14: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Colonies Name
1.	Kapashera	Saini Mohalla Extn B- Block Bijwasan Village New Delhi 61 Samalka Extn. Old Gurgaon Road, New Delhi-37 Samalka Extn.(East) Telephone Exchange Road Samalka, New Delhi. Samalka extn. Kapashera Chowk, Najafgarh Road Shalapur Khera, Bijwasan, New Delhi-61 Yawantika Colony Salapur, Khera, Bijwasan, New Delhi-61
2.	Mahipalpur	Rajokari Village Extn Abadi, New Delhi-38 Rajokari Harijan Basti, New Delhi- 38 Rajokri Rangpuri Mahipalpur Extn., K-II Block, New Delhi-37 Mahipalpur Ext., K-II Block, New Delhi-7 Defence Enclave Mahipalpur Extn. New Delhi Mahipal Pur Extended, Abadi, New Delhi-37 Ruchi Vihar, Rang Puri Abutting Block Delhi 37 Mahipal Pur Mahipalpur K-Block, West Vasant Kunj, New Delhi Mahipal Pur Amaltas Avenue (Samalka), Colony Rajokari, Delhi Mahipalpur Block A Extn., Delhi Mahipalpur Extn., L-Block, New Delhi Rangpuri Ext. B-Block, Vasant Kunj Rangpuri Extn. A-Block, Vasant Kunj Difence Enclave, Mahipalpur extn-II, New Delhi-37 Samal Khan
3.	Vasant Kunj	Vasant Kunj Enclave, B-Block JNU Road Village, Kishangarh, New Delhi-70 Shanti Kunj, Behind Sect.-D, Pocket III & IV, Vasant Kunj Bhagat Enclave, Uttam Nagar, Delhi-70 Vasant Kunj Enclave, Delhi-70 Bhawani Kunj Near Vasant Kunj, Delhi-70 Pratap Gandas Colony-I Vill. Kishangarh Delhi-70 Shanti Kunj (Main) Near Church Vasant Kunj Delhi-70 Shanti Kunj Behind Deep Public School, Vasant Kunj) Delhi-70 Asha Kunj Vasant Kunj Delhi-70 Kishangarh Harcharan Bagh, Andheria More, Vasant Kunj Road, Delhi-30 Bhawani Kunj behind Sector D-II, Vasant Kunj, New Delhi-70 Malikpur Kohi Aruna Asafali Road, Village Kishan Garh Village Pusteni Kishan Garh, Vasant Kunj, New Delhi-10
4.	Mehrauli	St. John Church Colony, Mehrauli, New Delhi-30 Sahurpur Extn. Satbari, Mehrauli Sambav Babu Colony, Jaunapur Mandi, Pahari Abadi, Mehrauli Kishan Garh Part Village, Mehrauli, Delhi Garhwal Colony, Mehrauli, New Delhi-30 Istam Colony Mehrauli

Sl. No.	Name of GOC	Colonies Name
		Green Meadows, Satbari Mehrauli, Delhi Andheri More Extn. Village Mehrauli, New Delhi 30 The Sunridge, Sunridge India Heritage Pvt. Ltd. Haveli Sarai No. 8, Kalka Das Marg Mehrauli, New Delhi 30 The Haven Athene Hospitality Services Pvt. Ltd, Property No. 4-1-14, Ward- I, Kalka Das Marg, Mehrauli New Delhi 30 The Sunridge, Sunridge India Heritage Pvt. Ltd. Haveli Sarai No. 6, Kalka Das Marg Mehrauli, New Delhi 30 The Qila, Sunridge Qila Resorts Pvt. Ltd. 4A, Ward -I, Kalka Das Marg Mehrauli New Delhi Qutab Enclave Village Mehrauli 4C Ward No. - New Delhi 30 Village Mehrauli 4B- Ward No. 1, New Delhi 30 Mehrauli Village Kishan Garh(Mehrauli) New Delhi-70 Shri Sai Kunj, Mehrauli, Delhi-70 Chhatar Pur, Near Durga Ashram, New Delhi-74 Mangla Puri Extended Colony, New Mangla Puri New Delhi 30 Lado Sarai Lado Sarai Extn.,Delhi Dr. Ambedkar Colony, Chhattarpur Dr. Ambedkar Colony, Andheria Morh, Chhattarpur Chhattarpur Enclave, D-Block Phase-I, New Delhi-68 Shanti Kunj, Chhattarpur, Delhi-30 Village Chhattarpur New Delhi Chatterpur Chatterpur Mini Farms Chatterpur main Road Mehrauli New Delhi-62
5.	Ghitorni	Ghitorni Extn Gitorni Village New Delhi Ghitorni Nangal Dewat Ghitorni Enclave Sultanpur Extn. Delhi 39 Sultan Pur Village Sultanpur New Delhi 30 Aaya Nagar Extn. Ph-I, New Delhi-47 Aya Nagar Extn. B-Block, New Delhi-47 C-4, C-5, & G1 Block Village Aya Nagar New Delhi B-1, Block Bandh Road Village, Aya Nagar New Delhi H1, Block Village Aya Nagar New Delhi Extended Abadi of Aya Nagar Village, New Delhi-47 Extended Lal Dora Abad Area, Village Aya Nagar, New Delhi-47 Phase -II, Aya Nagar New Delhi 47 Aya Nagar Adarsh Enclave Aya Nagar Extn. New Delhi Gadai Pur

ANNEXURE - 12
OUTER SOUTH DELHI DRAINAGE ZONE
(OSD)

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OUTER SOUTH DELHI DRAINAGE ZONE (OSD)

1. INTRODUCTION

Outer South Delhi is bounded by southern green buffer known as ridge area at southern boundary of NCT Delhi and South Delhi & Okhla Drainage Zones on northern side. Area is mainly residential; most of the area consists of farm houses, open land, cultivation, green buffer and ridge area with scattered habitation and villages. Location of Outer South Delhi is as shown in **Figure 1**:

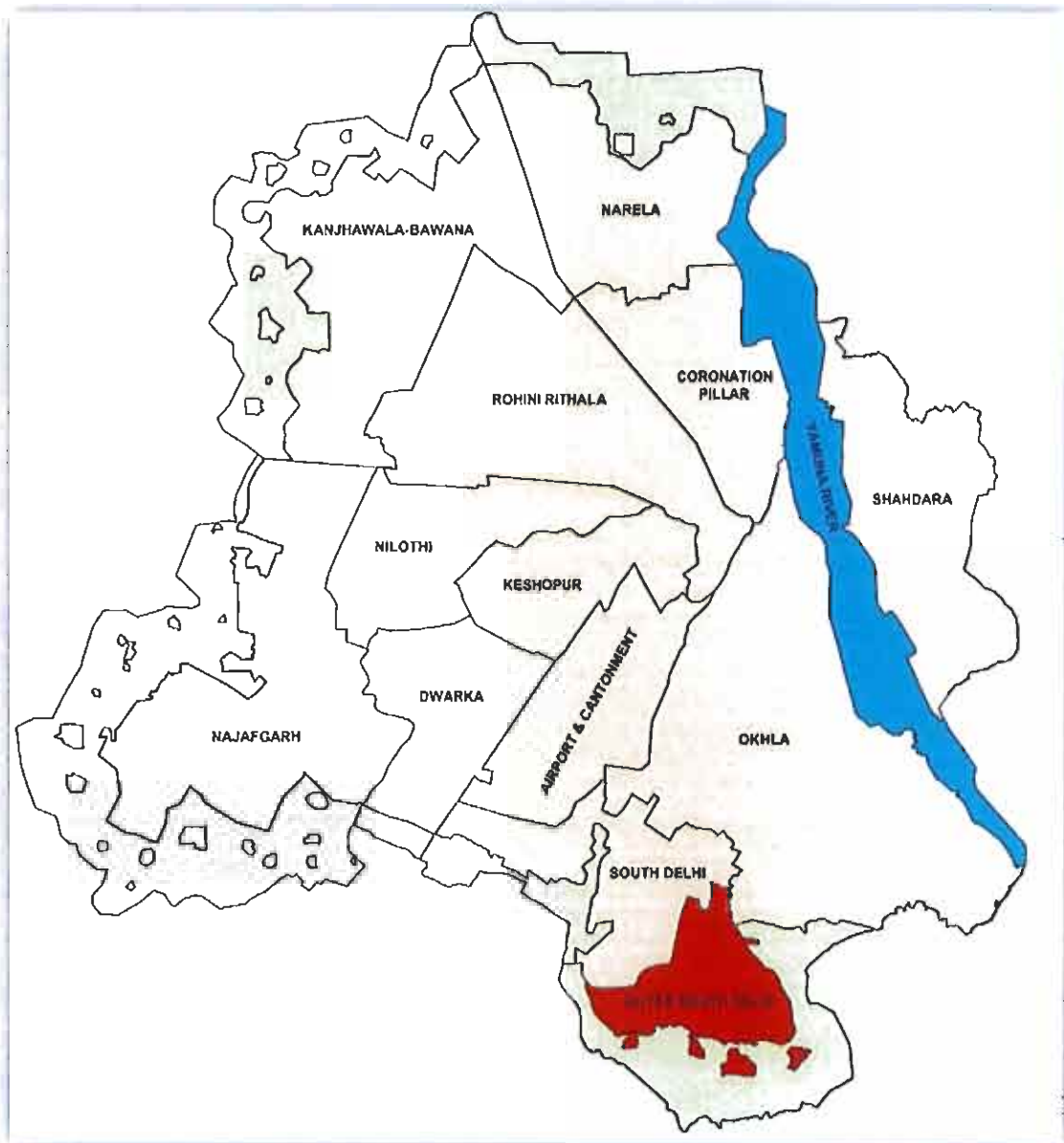


Figure 1: Outer South Delhi Drainage Zone

Outer South Delhi Drainage Zone comprises of major areas like Chhatarpur ext., Rajpurkhurd, Jaunapur, Mandi Village, Dera Mandi, Sanjay Nagar, Fatehpurberi and Chandanhola etc. This drainage zone falls under the DDA Zone J as shown in the **Figure 2**.

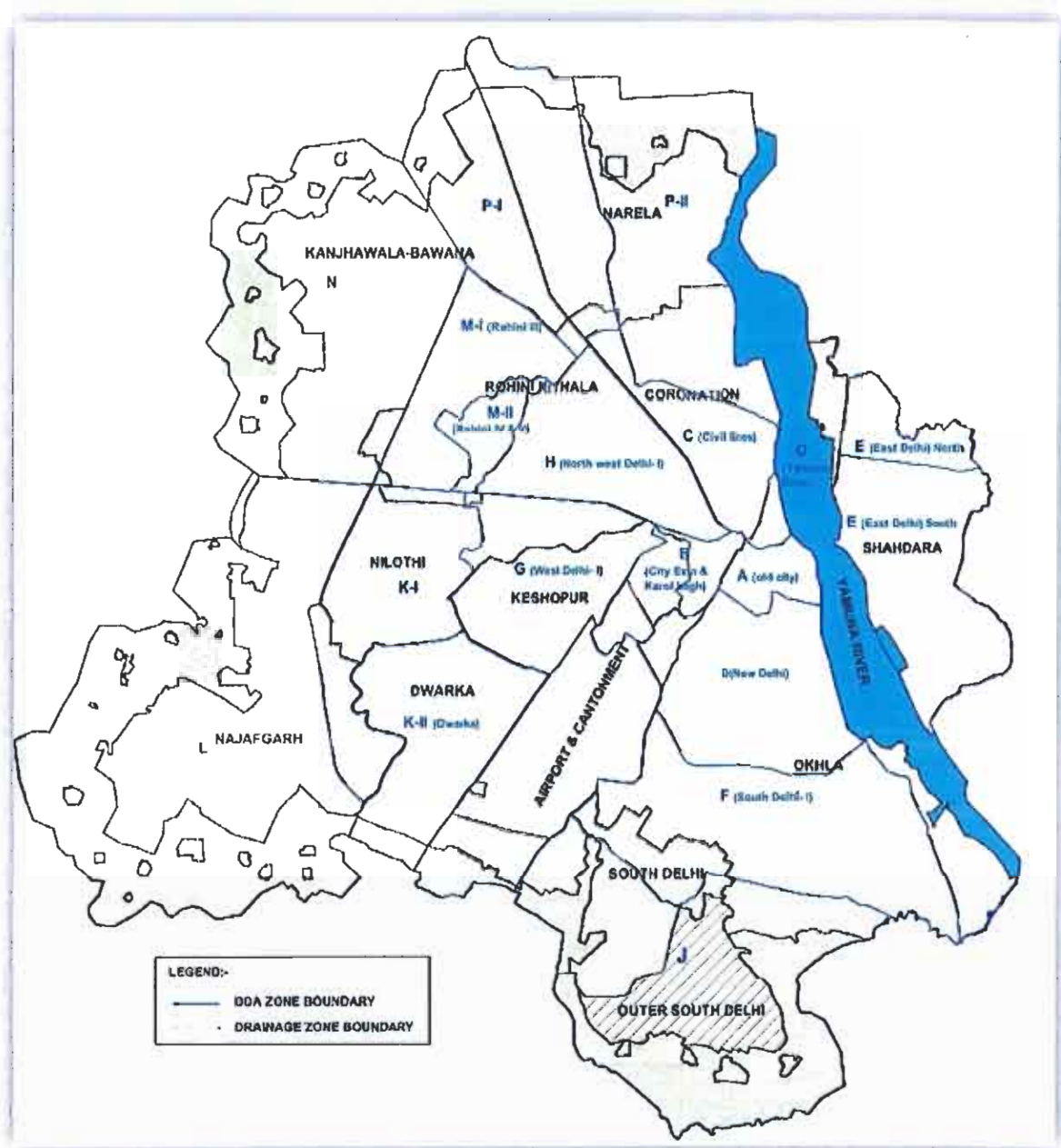


Figure 2: DDA Zones and Outer South Delhi Pillar Drainage Zone

Soil Description of Outer South Delhi

This zone is fully covered with Aeolian deposits. Outer South Delhi zone is fully coming under high Hazard category due to basin effect. This hazard factor is due to Chhatarpur basin. Dera Mandi farm and Banjor Johar areas are having water depth at 20-40m, whereas rest of this drainage zone covering ChatarPur, Sulatnpur, Rajpur khurd etc. is having water depth ranging from 40-60m. In this zone 70 % of the portion is covered with kochi soil (Dera Mandi, Bhatti kalan etc.) & 30 % of the portion with Khadar soil (ChattarPur, Sultanpur, Rajpur khurd etc.).

2. MASTER PLANNING FOR OUTER SOUTH DELHI DRAINAGE ZONE

The boundaries of zones have been decided on the basis of topography, location of existing sewer network, WWPSs, WWTPs and the direction of gravity flow of sewage to arrive at the most economical and feasible sewer network alignment.

re-framed and optimized based on the subsequent design iterations, site visits, and constraints. The proposed sewers have either been connected to the existing sewers/WWPS's or planned trunk sewers/WWPS's as appropriate based on techno-economical solution.

Utilization of Existing Sewerage Infrastructure

This zone is completely unsewered.

Sewerage Scheme Formulation

For the design of sewerage system the key decisive parameters are location, size, slope and depth of proposed sewers and other appurtenances. The aim of design is not only to make the sewer system functional but also to build the system at optimum cost ensuring durability throughout its life.

The hydraulic model built up and analysis/simulation has been carried out for different scenarios and alternatives. All the design parameters have been checked for the guidelines provided in Chapter 6 of Main Report.

Additional Sewage Treatment Capacity Requirements

No WWTP exists in the Drainage Zone. Feasibility of new location or alternative locations have been studied and proposed in this report. It is important to mention here that Outer Delhi Drainage Zone earlier covered area of Ayanagar, Part of Chhatarpur, Sultanpuri and Gadaipur, however, in order to better utilize capacities of existing WWTPs, this area has been routed to existing Ghitorni and Mehrauli WWTP. Same area has been included in South Delhi Drainage Zone now and is excluded from this area. For undeveloped areas, location and capacity of WWTP is proposed in phased manner as per DDA Master Plan 2021 and population projections for year 2031. However location and capacity may vary according to phase wise implementation and policy level decisions in future.

3. SUB DRAINAGE ZONES

Outer South Delhi Drainage Zone has been divided into 2 Sub Drainage Zones as below:

- **Rajpur Khurd (OSD-RK)**
- **Fatehpur Beri & Chandanhola (OSD-FC)**

Sub Drainage Zone Map and Contour Map are shown in the **Figures 4 & 5**.

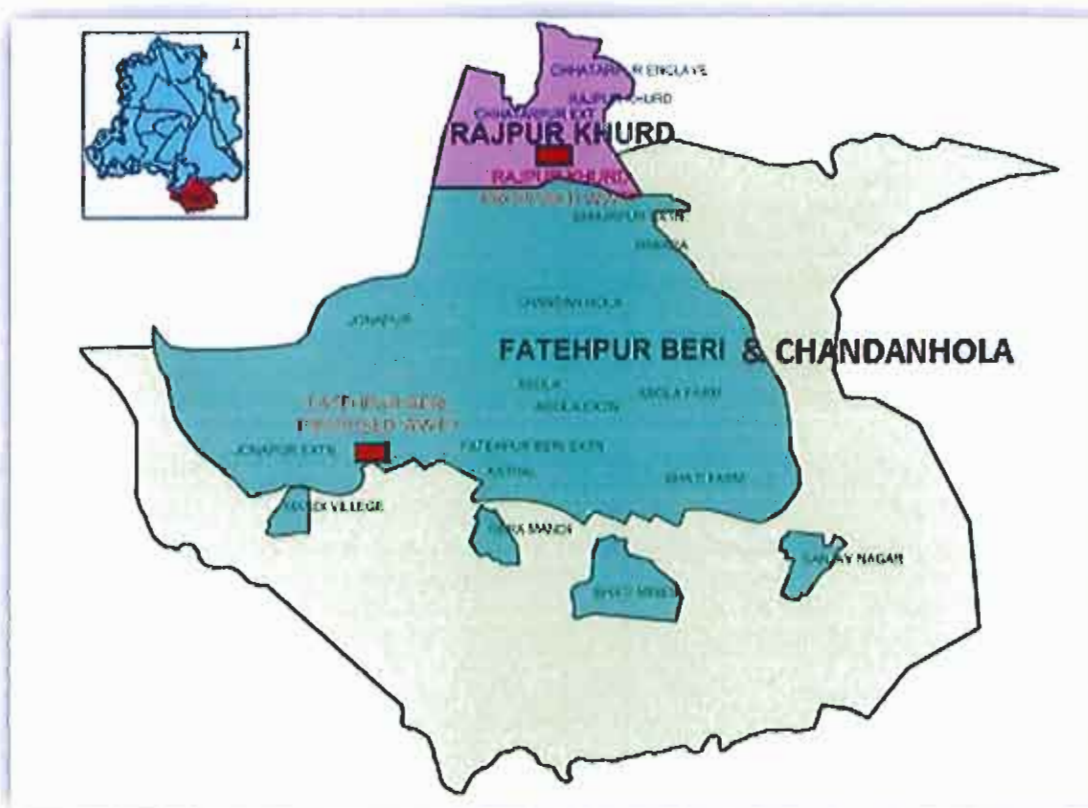


Figure 4: Sub Drainage Zone Map of Outer South Delhi Drainage Zone (OSD)

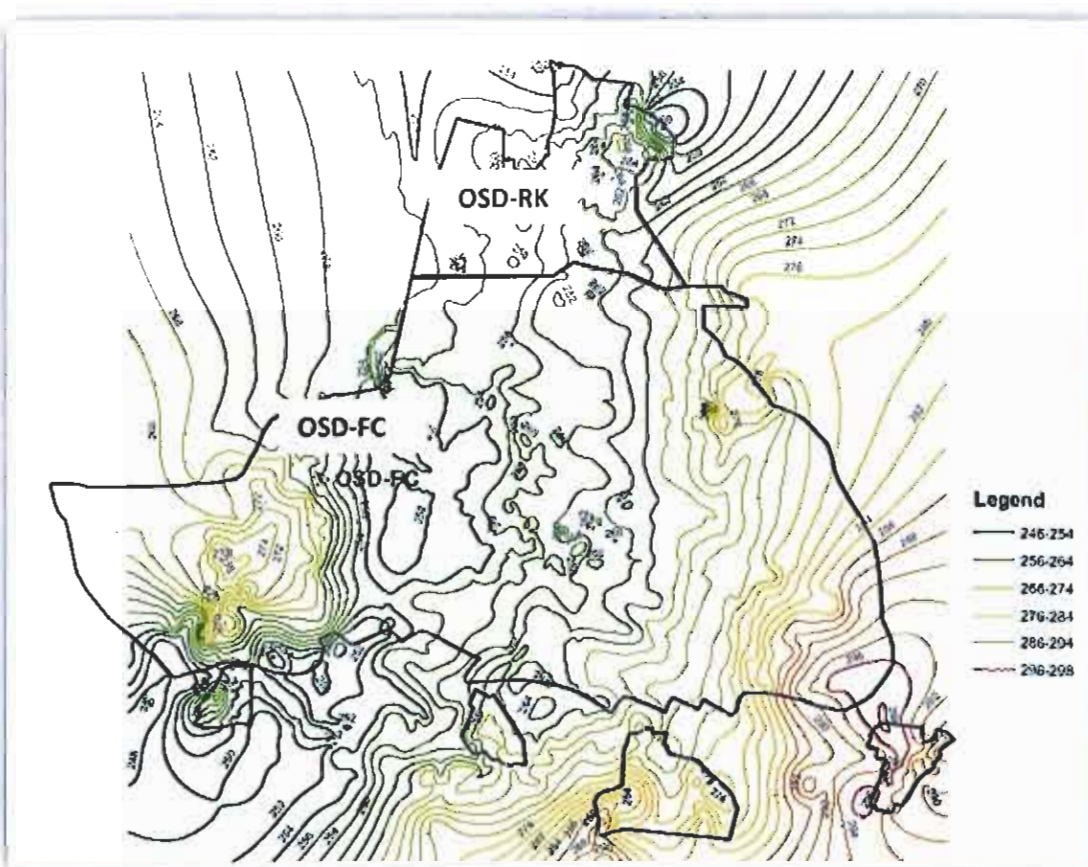


Figure 5: Contour Map of Outer South Delhi Drainage Zone (OSD)

Based on population projections Sub Drainage Zone wise estimated sewage generation is presented in the **Table 1**.

Table 1: Estimated Sewage Generation of Outer South Delhi Drainage Zone

Sub Drainage Zone	Waste Water Generation (MLD)			Waste Water Generation (MGD)		
	2011	2021	2031	2011	2021	2031
OSD-RK	9.23	18.46	45.40	2.00	4.10	10.00
OSD-FC	36.17	72.34	177.97	8.00	15.90	39.20
Total	45.40	90.80	223.37	10.00	20.00	49.20

3.1 Sub Drainage Zone: Rajpur Khurd (RK)

This Sub Drainage Zone spread across Rajpur Khurd, part of Maidangarhi, Chhatarpur Extn and nearby area. Land use map is as shown in the **Figure 6**.

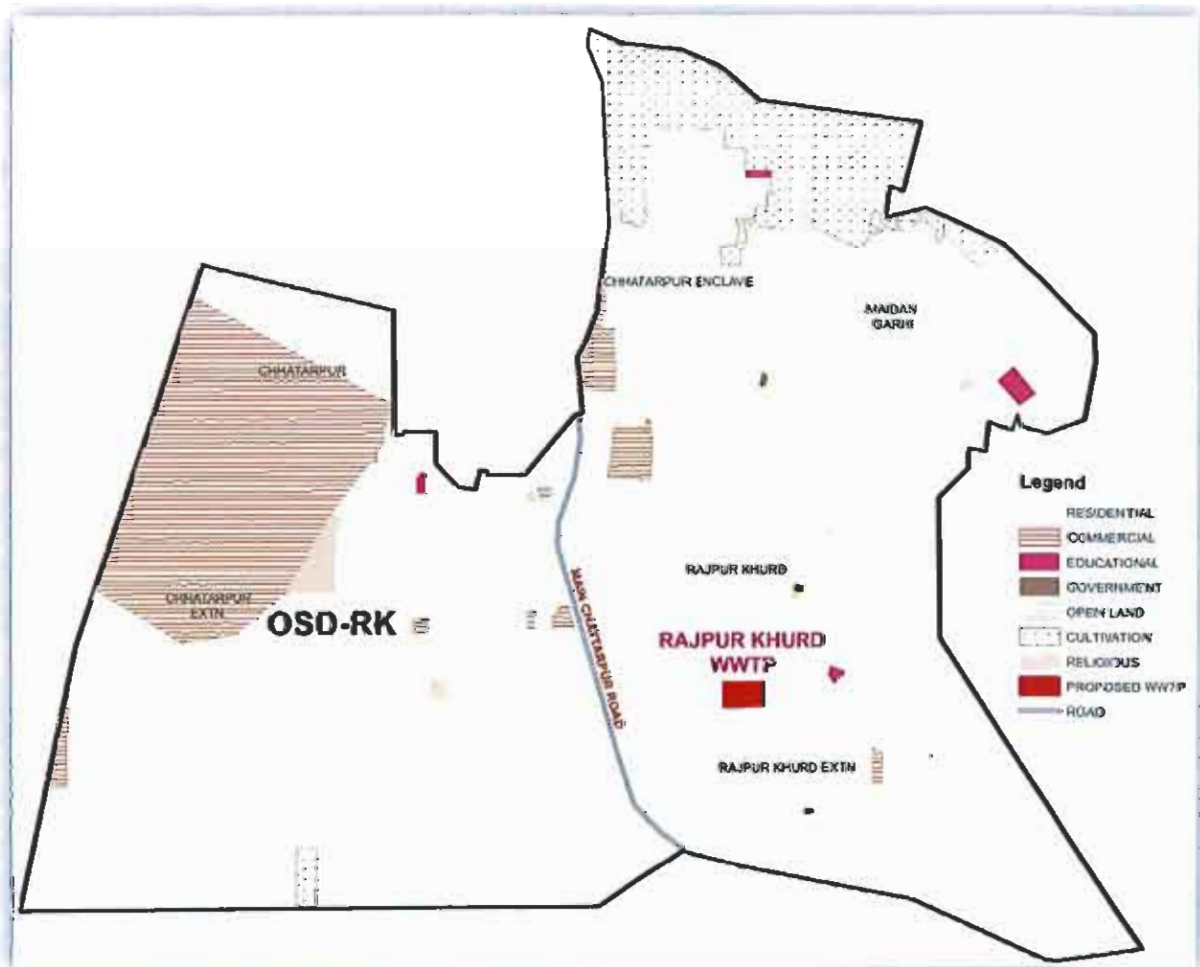


Figure 6: Land Use Map of Rajpur Khurd Sub Drainage Zone (OSD-RK)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage schemes has been represented and shown in **Figure 7**.

- The area is unsewered and no sewage treatment facility exists.
- One WWTP is proposed at Rajpur Khurd.
- Sewage from part of Maidangarhi, Chhatarpur Enclave, Rajpur Khurd and nearby area is routed to proposed WWPS at Chhatarpur Enclave and then via rising main to proposed WWTP at Rajpur Khurd.
- Sewage from Chhatarpur Extn, Rajpur Khurd Extn and nearby area is routed to proposed WWPS at Rajpur Khurd and then via rising main to proposed WWTP at Rajpur Khurd.

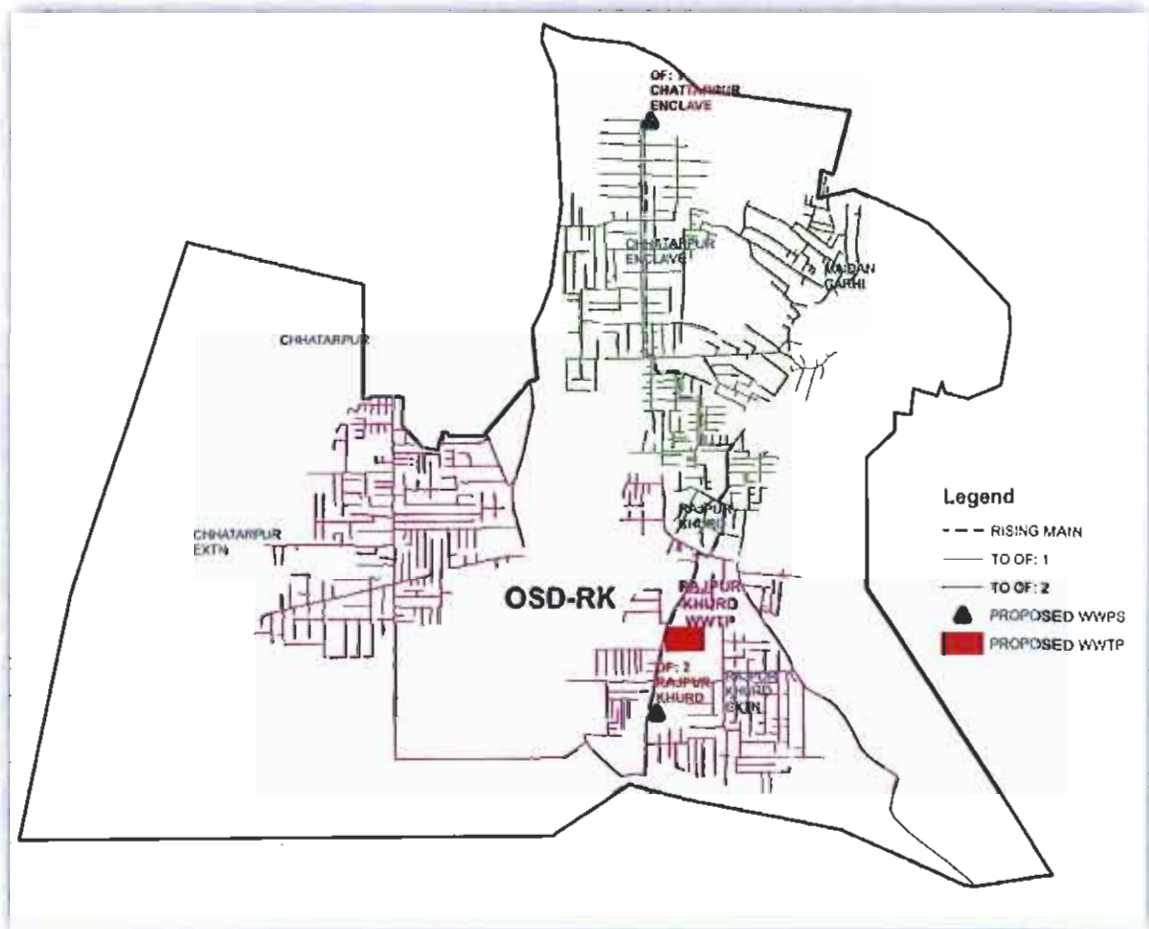


Figure 7: Scheme Map of Rajpur Khurd Sub Drainage Zone (OSD-RK)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Rajpur Khurd Sub Drainage Zone is shown in the **Figure 7**.

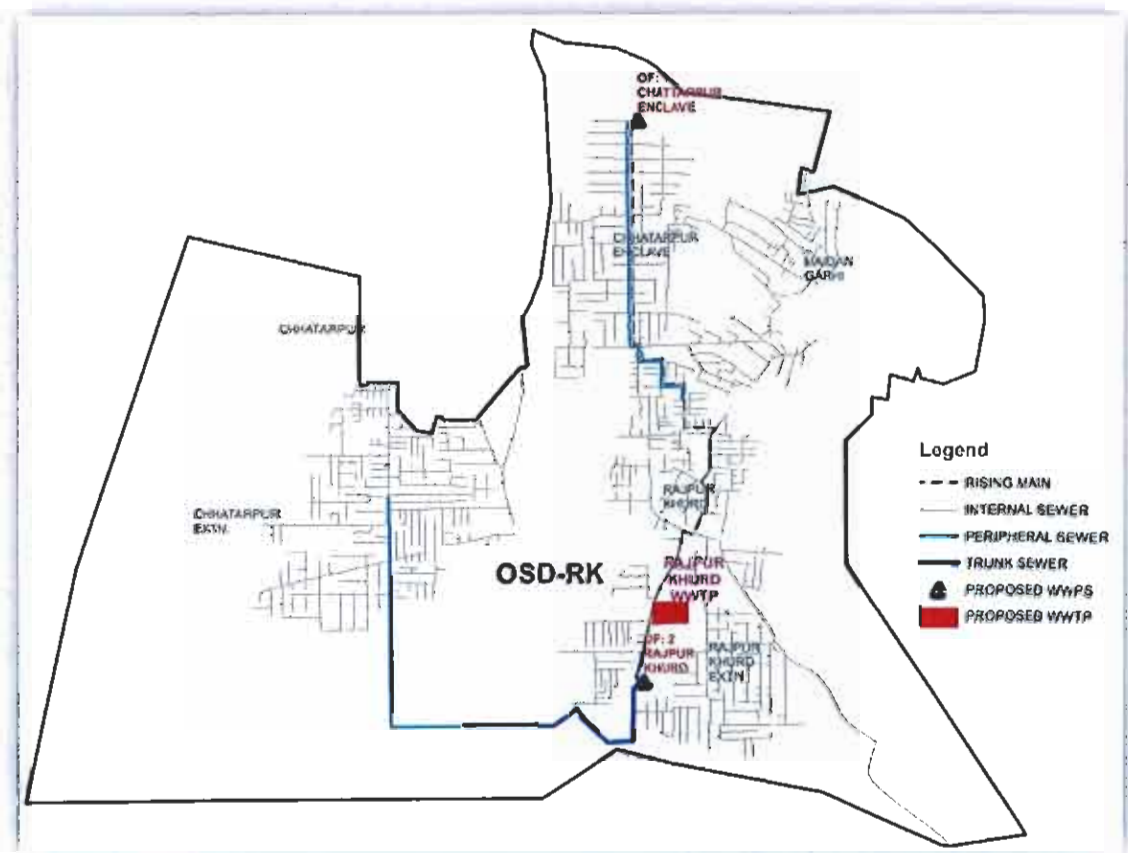
Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 2**.

Table 2: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	54083
300	HDPE/DWC	758
400	HDPE/DWC	2747
500	HDPE/DWC	1756
563.6	HDPE	553
635.2	HDPE	350
700	RCC NP3/NP4	217
800	RCC NP3/NP4	470
900	RCC NP3/NP4	1723
1000	RCC NP3/NP4	343
Total		63000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 8**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

**Figure 8: Proposed Sewerage Infrastructure of Rajpur Khurd Sub Drainage Zone (OSD-RK)**

Waste Water Pumping Requirements

Considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; however necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 3**.

Table 3: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Chattarpur Enclave	WWPS	8.00	700	1	2500	Proposed WWTP
2	Rajpurkhurd	WWPS	10.00	600	1	50	Proposed WWTP

Waste Water Treatment Requirements

One WWTP is proposed at Rajpur Khurd (10 MGD) in phased manner. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

3.2 Sub Drainage Zone: Fatehpur Beri & Chandanhola (OSD-FC)

This Sub Drainage Zone spread across part of Satberi, Chandanhola, Asola, Fatehpurberi, Sanjay Nagar Bhati Kalan, Dera Mandi, Mandi Village, Jonapur extn. and nearby area. A peripheral green belt exists on Southern boundary of the zone. The area is unsewered and no sewage treatment facility exists. Land use map is as shown in the **Figure 9**.

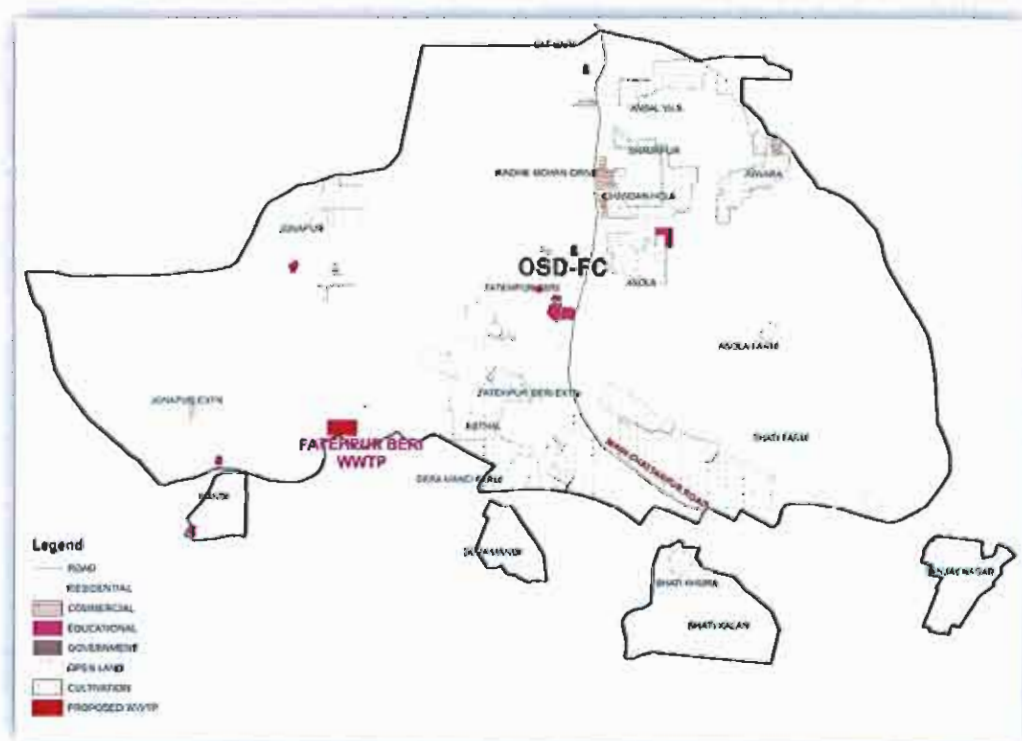


Figure 9: Land Use Map of Fatehpur Beri & Chandanhola Sub Drainage Zone (OSD-FC)

Existing Sewerage Infrastructure

No sewerage infrastructure exists in the Sub Drainage Zone.

Proposed Sewerage Scheme

The details of proposed sewerage scheme has been represented and shown in **Figure 10**:

- The sub drainage zone is unsewered and no sewerage infrastructure exists.
- One WWTP is proposed at Fatehpurberi.
- Sewage from Asola and nearby area is routed to Proposed WWPS at Asola and then via rising main to Proposed Fatehpurberi WWTP. Sewage from WWPS's at Jaunapur, Sanjay Nagar, Chandanhola and Bhati Mines are planned to discharge into Asola WWPS for planning purposes. Alternatively, decentralized WWTP's may be proposed at these locations.
- Sewage from Satberi, Riwara, Chandanhola, Fatehpurberi and nearby area is routed to Proposed WWPS at Chandanhola and then via rising main to Proposed WWPS at Asola.
- Sewage from Sanjay Nagar is routed to Proposed WWPS at Sanjay Nagar and then via rising main to Proposed WWPS at Asola. One intermediate Lift Station is proposed.
- Sewage from Sanjay Nagar is routed to Proposed WWPS at Sanjay Nagar and then via rising main to Proposed WWPS at Asola. One intermediate Lift Station is proposed.
- Sewage from Bhim Basti, Jaunapur and nearby area is routed to Proposed WWPS at Jaunapur and then via rising main to Proposed Fatehpurberi WWTP. One intermediate Lift Station is proposed.
- Sewage from Jaunapur Extn, Ambedkar Colony, Mandi and nearby area is routed to Proposed WWPS at Mandi and then via rising main to Proposed Fatehpurberi WWTP. Two intermediate Lift Stations are proposed.
- Sewage from Dera Mandi and nearby area is routed to Proposed WWPS at Dera Mandi and then via rising main to Proposed Fatehpurberi WWTP.

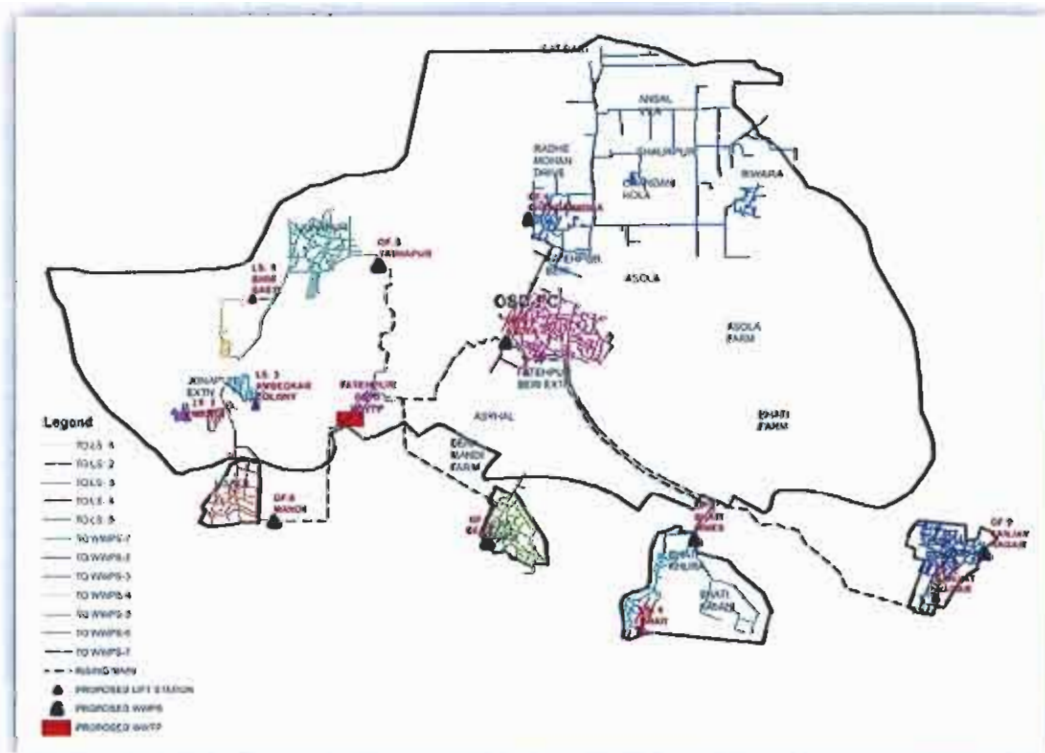


Figure 10: Scheme Map of Fatehpur Beri & Chandanhola Sub Drainage Zone (OSD-FC)

Proposed Sewerage Infrastructure

The proposed sewerage infrastructure is classified under Proposed Gravity Sewerage Network, Waste Water Pumping and Waste Water Treatment requirements Scheme map for Fatehpur Beri & Chandanhola Sub Drainage Zone is shown in the **Figure 10**.

Proposed Gravity Sewerage Network

SewerGEMS sanitary has been used to develop, design and optimize the hydraulic model of proposed sewerage network. The proposed sewer network details are shown in **Table 4**.

Table 4: Proposed Gravity Sewerage Network- Diameter wise

Diameter (mm)	Material	Length (m)
Upto 250	HDPE/DWC	248527
300	HDPE/DWC	3025
400	HDPE/DWC	6755
500	HDPE/DWC	5215
563.6	HDPE	1663
635.2	HDPE	892
900	RCC NP3/NP4	923
Total		267000

The proposed sewerage network in unsewered area is tentatively categorised as Trunk, Peripheral and Internal Sewers and represented in **Figure 11**. However actual categorization with respective details, such as length, diameter and invert levels shall be done based on as-built drawings.

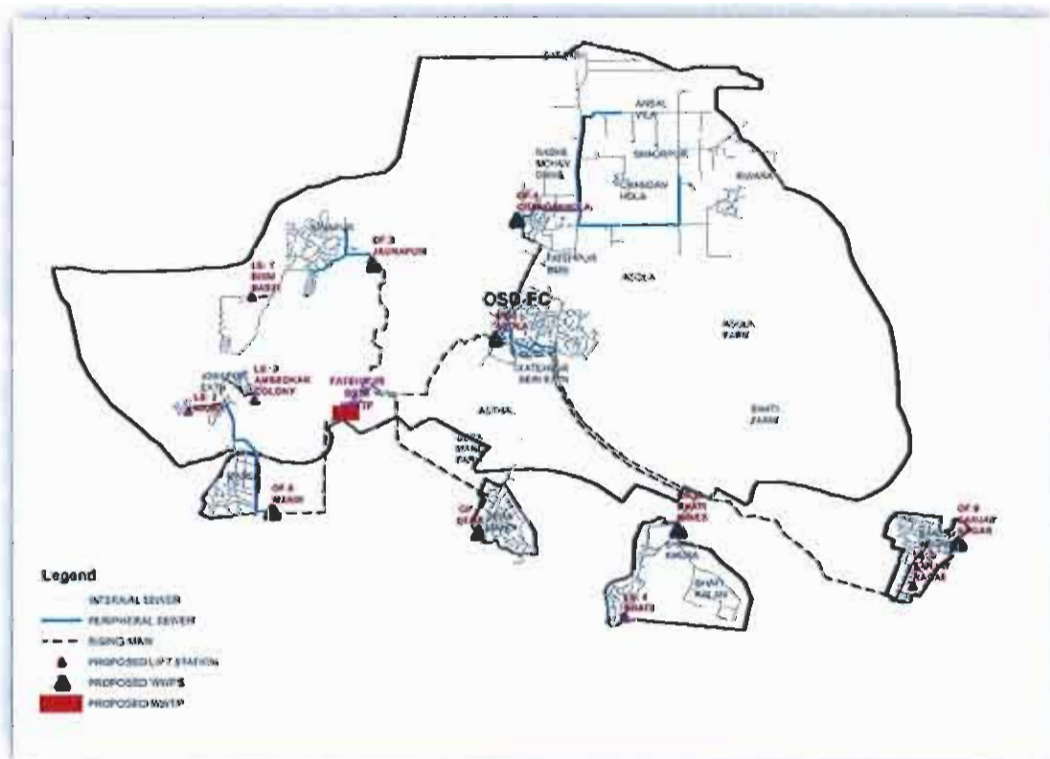


Figure 11: Proposed Sewerage Infrastructure of Fatehpur Beri and Chandanhola Sub Drainage Zone (OSD-FC)

Waste Water Pumping Requirements

Though considerable efforts have been made during feasibility study and site visits in finalizing the location of pumping stations and rising mains; yet necessary modifications may be required during land acquisition based on discussions with concerned stakeholders. The capacities of proposed WWPSs and details of proposed Rising Mains are listed in the **Table 5**.

Table 5: Proposed Waste Water Pumping Stations

Pumping Station				Rising Main			
Sl. No.	Location	Type	Design Capacity (MGD)	Diameter (mm)	No. of rising main	Length (m)	Outfall To
1	Jaunapur	LS	0.50	200	1	200	Nearest Manhole
2	Ambedkar Colony	LS	0.50	200	1	500	Nearest Manhole
3	Mandi	LS	0.50	200	1	850	Nearest Manhole
4	Bhati Mines	LS	0.20	100	1	120	Nearest Manhole
5	Sanjay Nagar	LS	0.20	100	1	120	Nearest Manhole
6	Jaunapur	WWPS	3.00	400	1	2800	Proposed WWTP
7	Chandanholia	WWPS	7.00	700	1	7400	Nearest Manhole
8	Asola	WWPS	6.00	500	1	3000	Nearest Manhole
9	Mandi- 1	WWPS	2.00	400	1	2200	Dera WWPS 5
10	Dera	WWPS	3.50	400	1	3500	Proposed WWTP
11	Bhati Mines	WWPS	1.50	400	1	7500	Proposed WWTP
12	Sanjay Nagar	WWPS	1.00	250	1	4900	Bhati Mines WWPS 6

Waste Water Treatment Requirements

One WWTP is proposed at Fatehpurberi (39.2 MGD) in phased manner. However location and capacity may vary according to phase wise implementation and policy level decisions in future. Phase wise implementation plan for WWTPs is given in Chapter 8 of Main Report.

4. SUMMARY OF PROPOSED SEWERAGE INFRASTRUCTURE

The proposed sewerage infrastructure for unsewered areas within the drainage zone is summarized in the **Table 6**.

Table 6: Summary of Proposed Sewerage Infrastructure

SubZone		Proposed Infrastructure			
		Sewerage Network (km)	WWPS (No.)	Lift Stations (No.)	New WWTP (No.)
Rajpur Khurd	(OSD-RK)	49	2	-	1
Fatehpur Beri & Chandanholia	(OSD-FC)	267	7	5	1
Total		316	9	5	2

The capacity and anticipated area requirements for proposed Pumping and Sewage Treatment facilities are summarized in the **Table 7**.

Table 7: Capacity and Anticipated Area Requirements for Proposed Pumping and Sewage Treatment Facilities

SubZone	WWTP			Pumping Station			
	Location	Design Capacity (MGD)	Area Req'd. (ha)	Location	Type	Design Capacity (MGD)	Area Req'd. (sq.mt.)
Fatehpur Beri & Chandanhola	Fatehpur Beri	39.2	22.2 - 28.5	Jaunapur	LS	0.5	36.2
				Ambedkar Colony	LS	0.5	36.2
				Mandi	LS	0.5	36.2
				Bhati Mines	LS	0.2	30.2
				Sanjay Nagar	LS	0.2	30.2
				Jaunapur	WWPS	3.0	36.2
				Chandanhola	WWPS	7.0	2710.5
				Asola	WWPS	6.0	2095.1
				Mnadi-1	WWPS	2.0	1107.4
				Dera	WWPS	3.5	2033.6
				Bhati Mines	WWPS	1.5	1076.9
				Sanjay Colony	WWPS	1.0	1054.2
Rajpur Khurd	Rajpur Khurd	10	5.7 - 7.3	Chhaterpur Enclave	WWPS	8.0	2676.8
				Rajpurkhurd	WWPS	10.0	2847.0

Line Diagram for Proposed WWPS and WWTP for Fatehpur Beri sub drainage zone is shown in **Figure 12**:

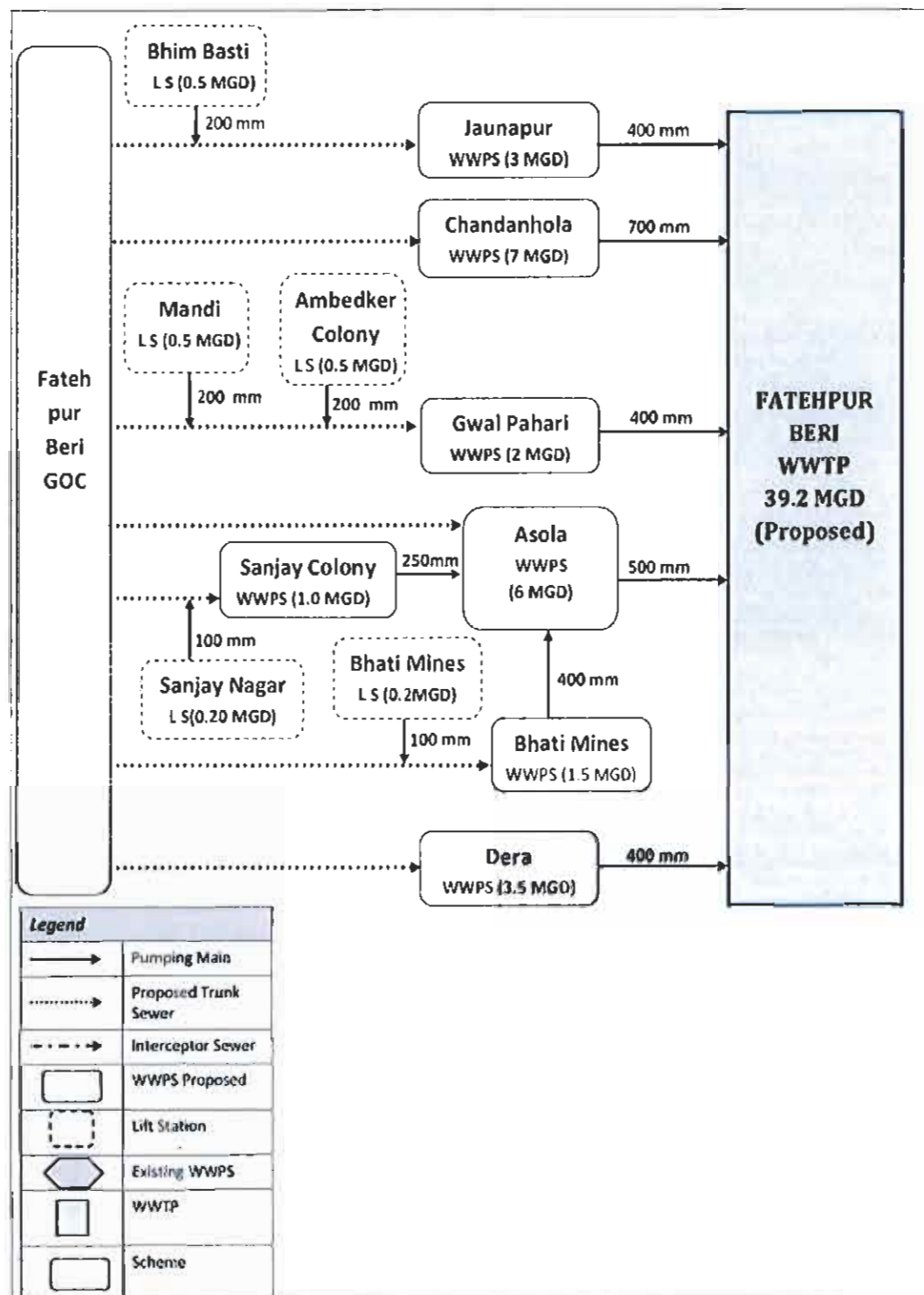


Figure 12: Line Diagram for Proposed WWPS and WWTP for Fatehpur Beri and Chandanhola Sub Drainage Zone

Line Diagram for Proposed WWPS and WWTP for Rajpur Khurd sub drainage zone is shown in **Figure 13**:

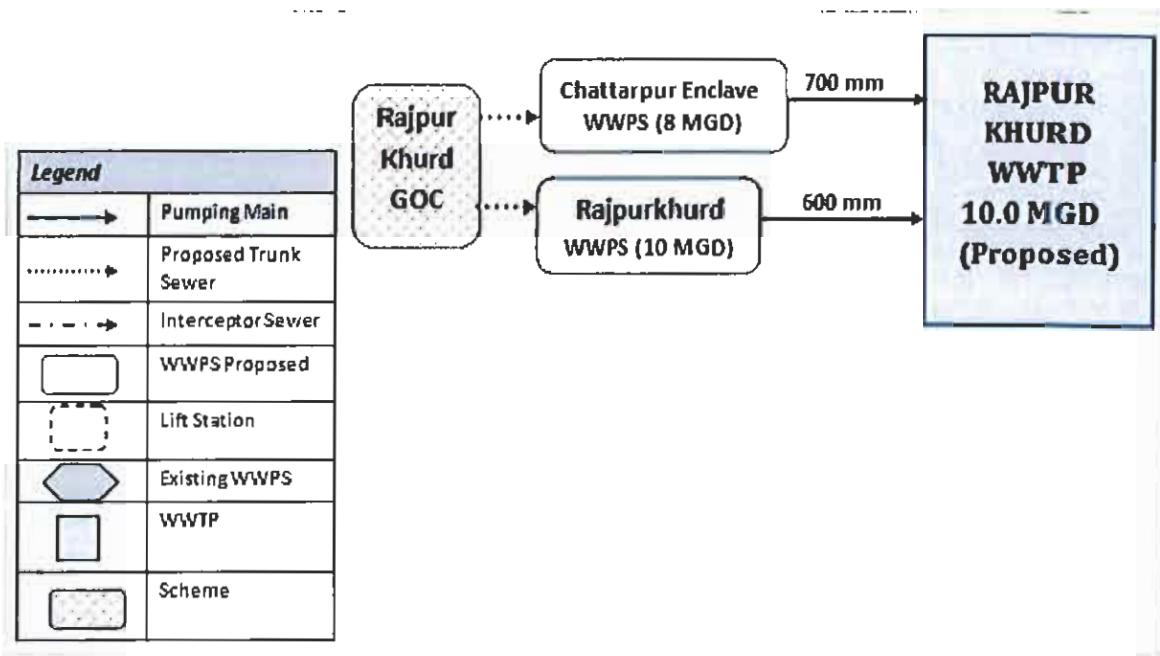


Figure 13: Line Diagram for Proposed WWPS and WWTP for Rajpur Khurd Sub Drainage Zone

Disposal of Treated Effluent

Treated effluent of high grade quality can be utilized for non-potable uses. Likely users of Treated Effluent may be MCD, DMRC and DDA. The Treated waste water can also be used for horticulture in the nearby area.

The proposed sewerage scheme for Outer South Delhi Drainage Zone including trunk sewers, proposed WWPSs and WWTPs is shown in the **Figure 14**.

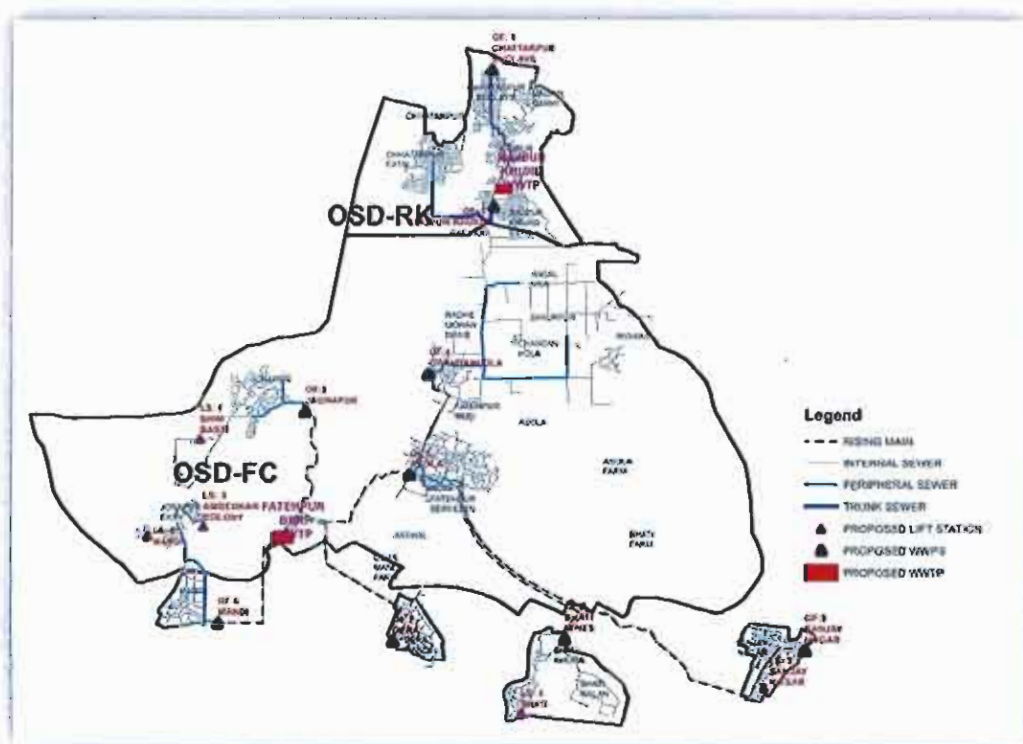


Figure 14: Proposed Sewerage Scheme for Outer South Delhi Drainage Zone

Various Group of Colonies (GOCs) – wise sewerage schemes have been prepared for the drainage zone and represented in the **Figure 15**:

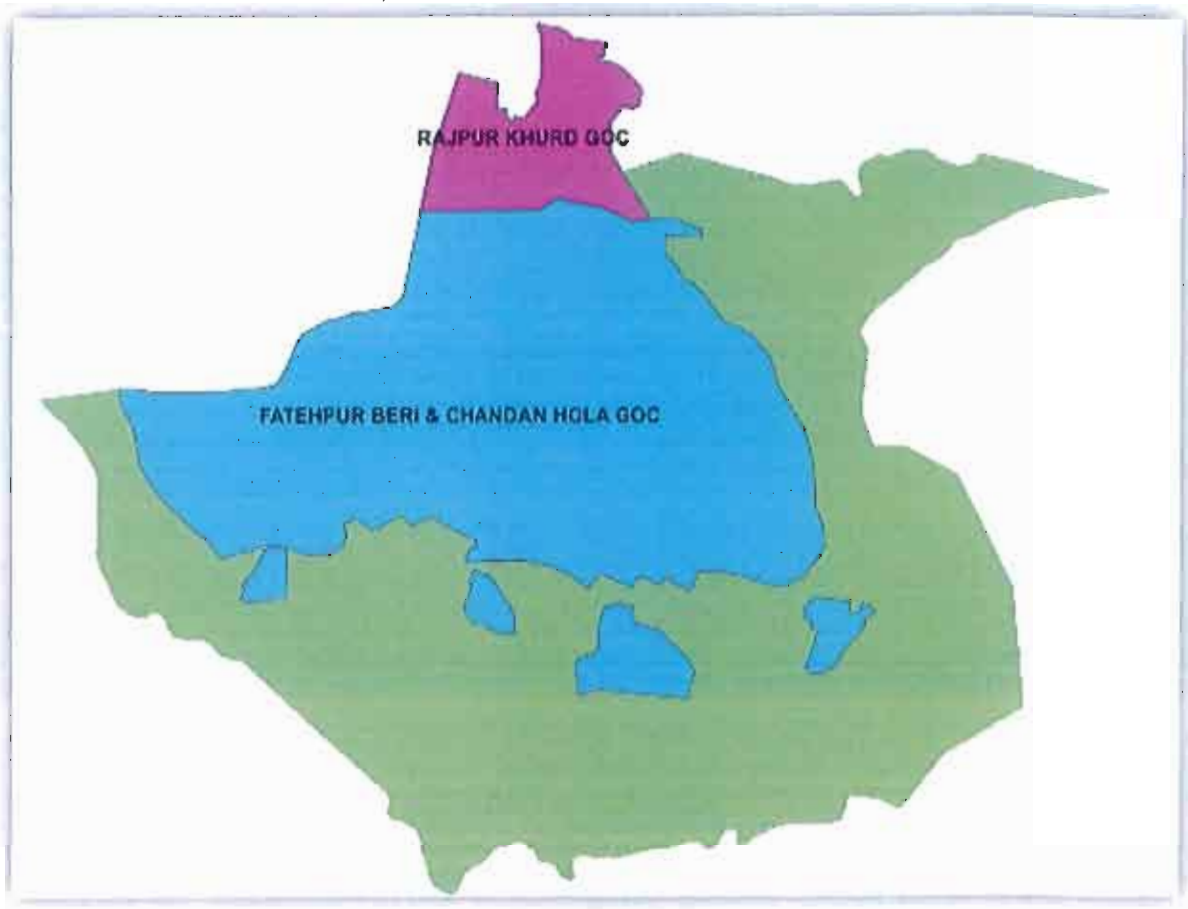


Figure 15: GOC-wise Sewerage Schemes – Outer South Delhi Drainage Zone

5. IMPLEMENTATION PLAN

Scheme-wise tentative Implementation Plan for the drainage zone has been represented below:

Table 8: Implementation Schedule

Scheme Details					Implementation Schedule			
Sl. No.	WWTP Catchment	SubZone	Scheme Code	Scheme Name	Upto Yr 2016	2016-21	2022-2027	2027-31
1	Fatehpurberi	FC	OSD-FB	Fatehpurberi GOC				
2	Rajpurkhurd	RK	OSD-RK	Rajpur Khurd GOC				

Table 9: List of colonies falling under respective GOCs

Sl. No.	Name of GOC	Colonies Name
1.	Rajpur Khurd	Mahavir Campus Rajpur Khurd Extn. Maidangarhi, Delhi-68 Raj Pur Khurd Extn. Mehrauli Delhi-68 Rajpur Chhawani Village Rajpur Khurd Madian Gari New Delhi Chhatarpur Enclave Ph-I, Block-A, Maidan Garhi, Village Road Rajpur Khurd Har Govind Enclave Rajpur Khurd Delhi-68 Rajpur Khurd Colony, North Extn., Maidan Garhi, New Delhi-68 Rajpur Khurd Extn (South) Rajpur Extn., New Delhi-68 Satbari Dr. Ambedkar Colony Ansal Road, Satbari Delhi-54 Chattarpur Enclave, Mehrauli Chattarpur, Road, Delhi-68 Chattarpur Extn., A-1, New Delhi Chatter Pur Extn. Mehrauli New Delhi-74 Maidan Garhi Extn. Chatterpur Road Delhi-68
2.	Fatehpur Beri & Chandan Hola	Gadai Pur Club Drive Colony, M.G. Road, Gadaipur (Opp. Ghitorni) Gadai Pur Extn., 26- A, Club Drive, Gadai Pur Extn., Mehruuli, Gurgaon Road, Gadai Pur, Delhi-30 Sanskriti Aur Vikas Sanstha OSHO Drive Gadipur Extn., Of Village Gadaipur Mehrauli New Delhi Silver OAK Enclave, Village Jonapur Gadaipur Mandi Road New Delhi-47 Jonapur Bhim Basti Pahari, Delhi-42 Silver OAK Enclave, Village Jonapur Gadai Pur, Mandi Road, New Delhi-47 Jona Pur Mandi Pahari Abadi, Shanti Camp-I, Delhi-47 Fatehpur Beri Fatehpur Beri Extn. Mehrauli Delhi-74 Mandi Bhati Dera Mandi Dera Gaon Asola Ashola Extn., Part-I Ashola Extension, Delhi. Chandan Hola Chandan Haula Extn. East Chattarpur Bhati, Sahurpur, Delhi-74 Sanjay Colony, Bhatti Mines, Bhagirath Nagar, New Delhi-74

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS (MoEF)

SEWERAGE MASTER PLAN FOR DELHI - 2031

FINAL REPORT

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VOLUME – II	MAIN REPORT
VOLUME – III	ANNEXURES (1 TO 4)
VOLUME – IV	ANNEXURES (5 TO 8)
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JUNE 2014

DELHI JAL BOARD
Govt. of NCT of Delhi

AECOM
WAPCOS

FINAL REPORT
ON
SEWERAGE MASTER PLAN FOR DELHI - 2031
JUNE 2014

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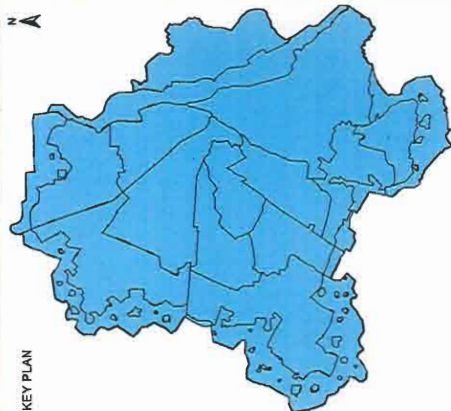
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- LEGEND**
- SHAHDARA
 - OKHLA
 - KESHOPUR
 - ROHINI-RITHALA
 - CORONATION PILLAR
 - DWARKA
 - NAJAFGARH
 - NILOTHI
 - NARELA
 - SOUTH DELHI
 - OUTER SOUTH DELHI
 - KANJAWALA-BAWANA
 - OUTER GREEN BELT
 - YAMUNA RIVER



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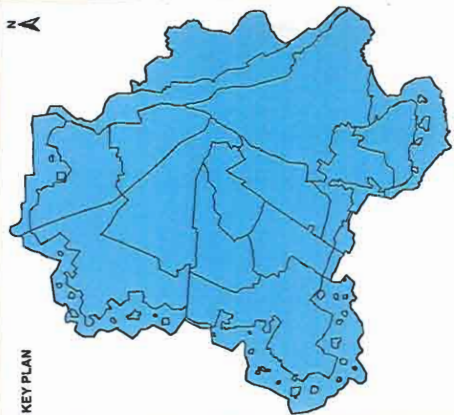
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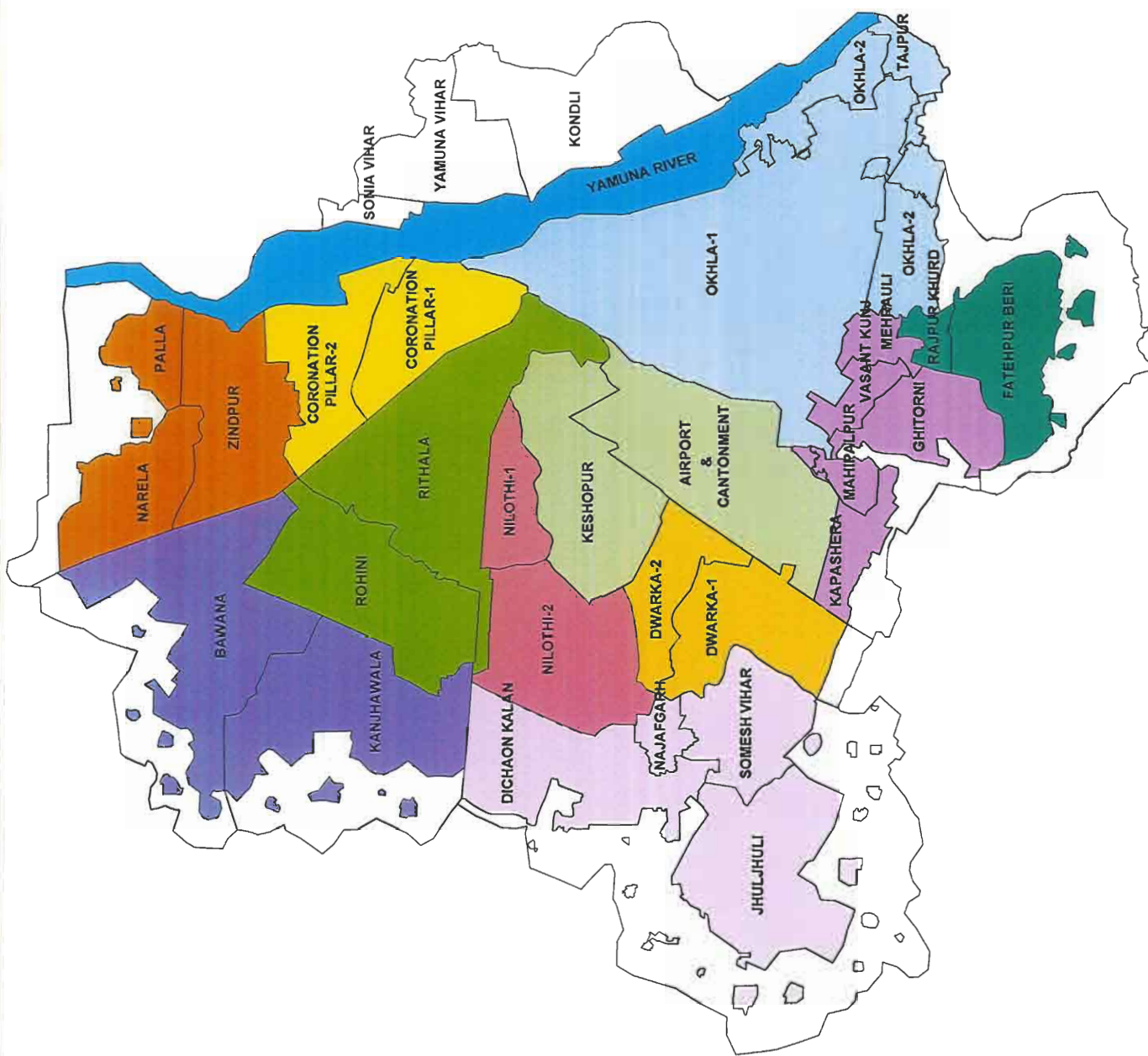
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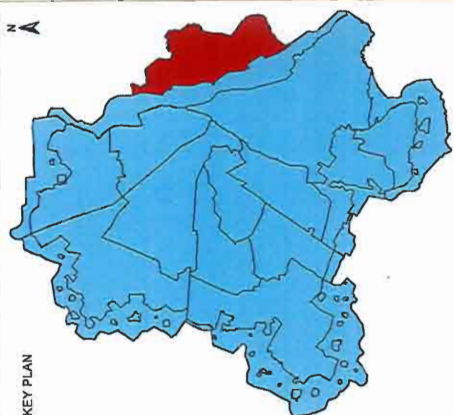
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Approved By

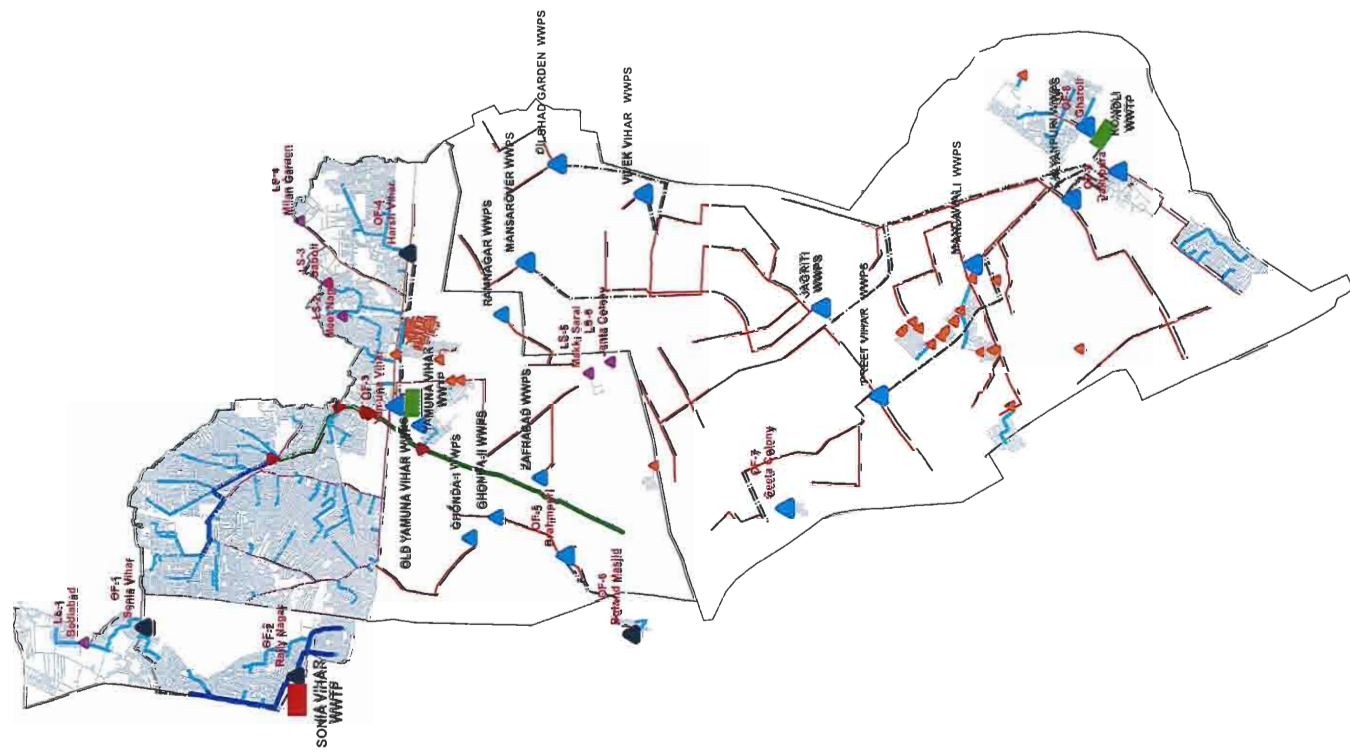
THE SHOWN OF THIS SITE BLOCK COULD BE THE DESIGN AND DRAWING OF THIS PROJECT
AND BEING THE PROPERTY OF THE CLIENT AND NOT BEING THE PROPERTY OF THE CONSULTANT

PLANNED	DESIGN	DESIGNED	DESIGNED	DATE
DATE	DATE	DATE	DATE	DATE
DATE	DATE	DATE	DATE	DATE



LEGEND:-

- Rising main
- Internal Sewer
- Existing Sewer
- Peripheral Sewer
- Trunk Sewer
- Wazirabad Road Sewer
- Interceptor Sewer
- Integration with Existing Sewer
- To Interceptor Sewer
- Existing WWPS
- Proposed Lift Station
- Proposed WWPS
- Existing WWTP
- Proposed WWTP



THE SIGNING OF THIS BLOCK CONFIRMS THE DESIGN AND DRAWING OF THIS PROJECT HAVE BEEN PREPARED IN ACCORDANCE WITH THE REQUIREMENTS OF THE RECORD QUALITY ASSURANCE SYSTEM TO PART 10 OF BS 5896:1999.

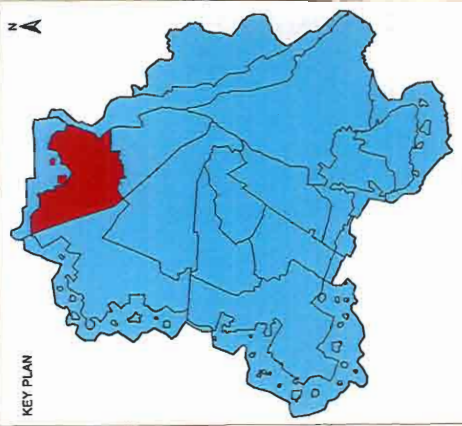
MANOJ KUMAR	DESIGNED	MANOJ KUMAR
MANOJ KUMAR	APPROVED	15.10.20
MANOJ KUMAR	DATE	15.10.20



AECOM
WAPCOS
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DLF Cyber City,
Gurgaon, Haryana,
India
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www.aecom.com

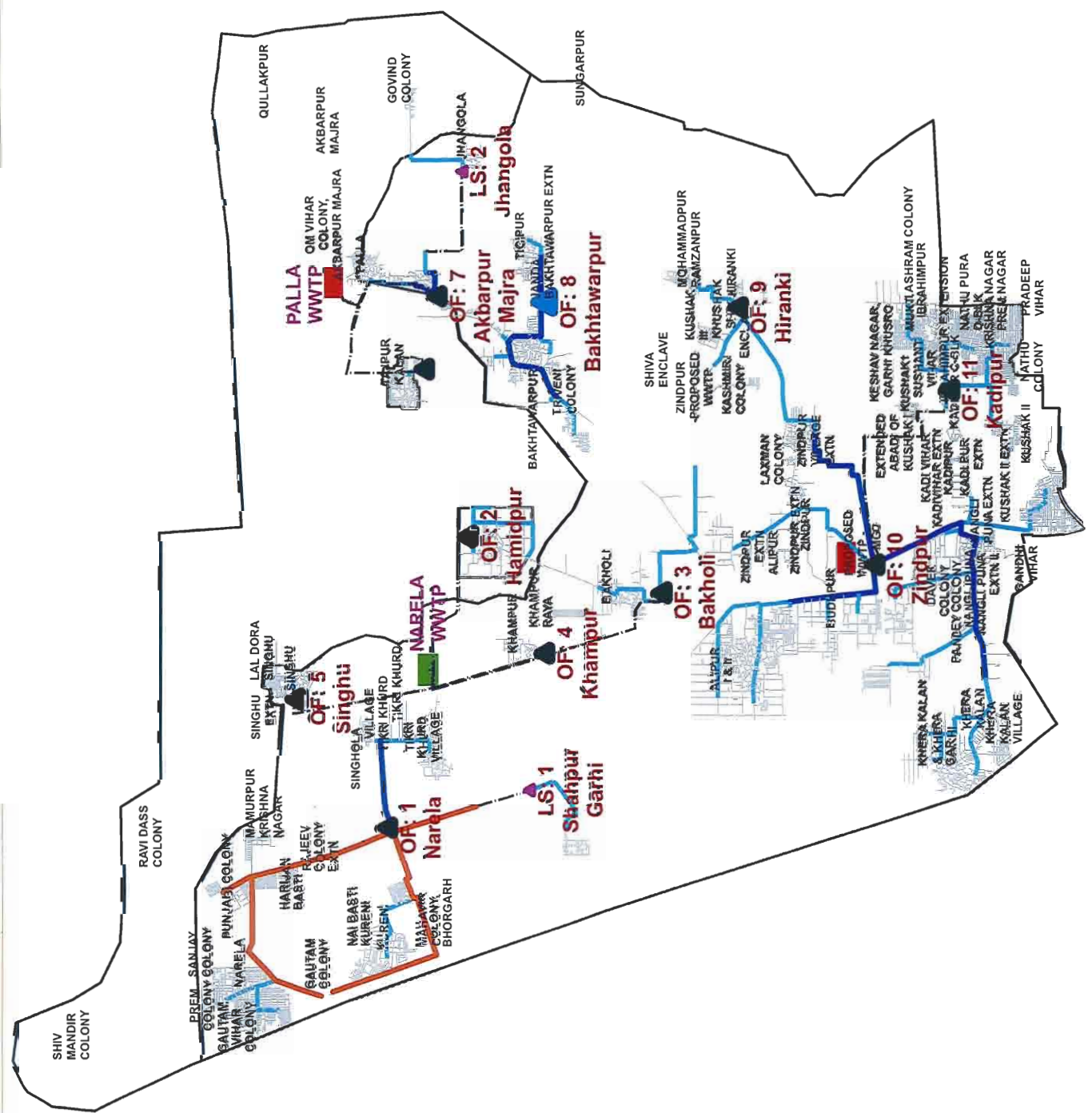
DELHI JAL BOARD

Project File	DJD SEWERAGE MASTER PLAN - 2031
Drawing Title	PROPOSED INFRASTRUCTURE FOR SHYAMSHAR DRAINAGE ZONE
Status	Design
Drawn By	
Checked By	
Approved By	



LEGEND:-

- Rising main
- Internal Sewer
- Existing Sewer
- Peripheral Sewer
- Trunk Sewer
- ▲ To Existing WWPS
- ▲ Proposed Lift Station
- ▲ Proposed WWPS
- Existing WWTP
- Proposed WWTP



THE CLIENTS OF THIS PROJECT ARE: **DELHI JAL BOARD**

THE PROJECT IS: **PROPOSED INFRASTRUCTURE FOR NARELA DRAINAGE ZONE**

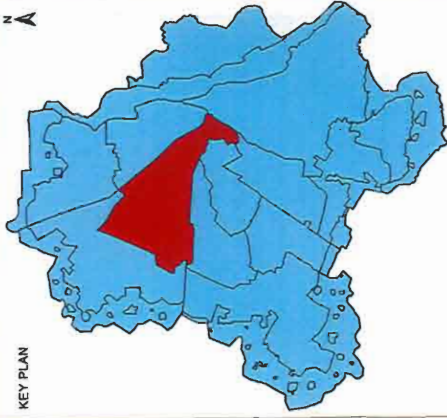
NO.	DESCRIPTION	DATE	BY	CHECKED	DATE	BY
1	PREPARED	15/05/2021	...	...	...	...
2	APPROVED	...	...	...	...	...
3	REVISION	...	...	...	...	...

AECOM
WAPCOS

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Metro Tower C,
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New Delhi - 110028
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F: +91 (0)11 26102201
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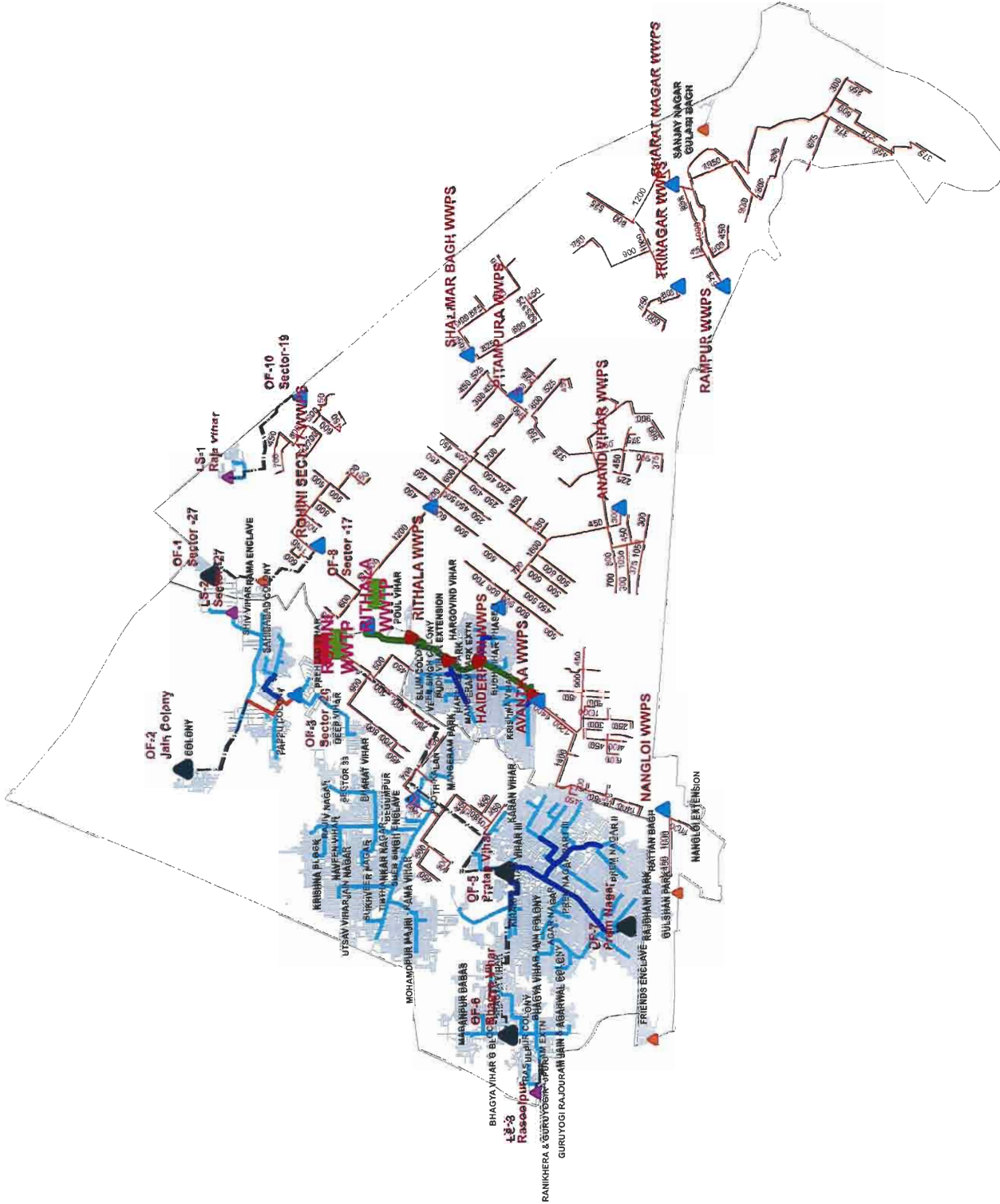
DELHI JAL BOARD

Client

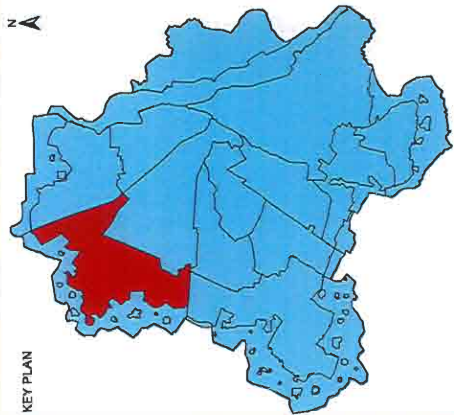


Rising again

Legend	Feature
	Risingmain
	Internal Sewer
	Existing Sewer
	Peripheral Sewer
	Trunk Sewer
	Interceptor Sewer
	Integration with Existing Sewer
	Existing WWPS
	Proposed Lift Station
	Proposed WWPS
	To Interceptor Sewer
	Existing WWTP
	Proposed WWTP

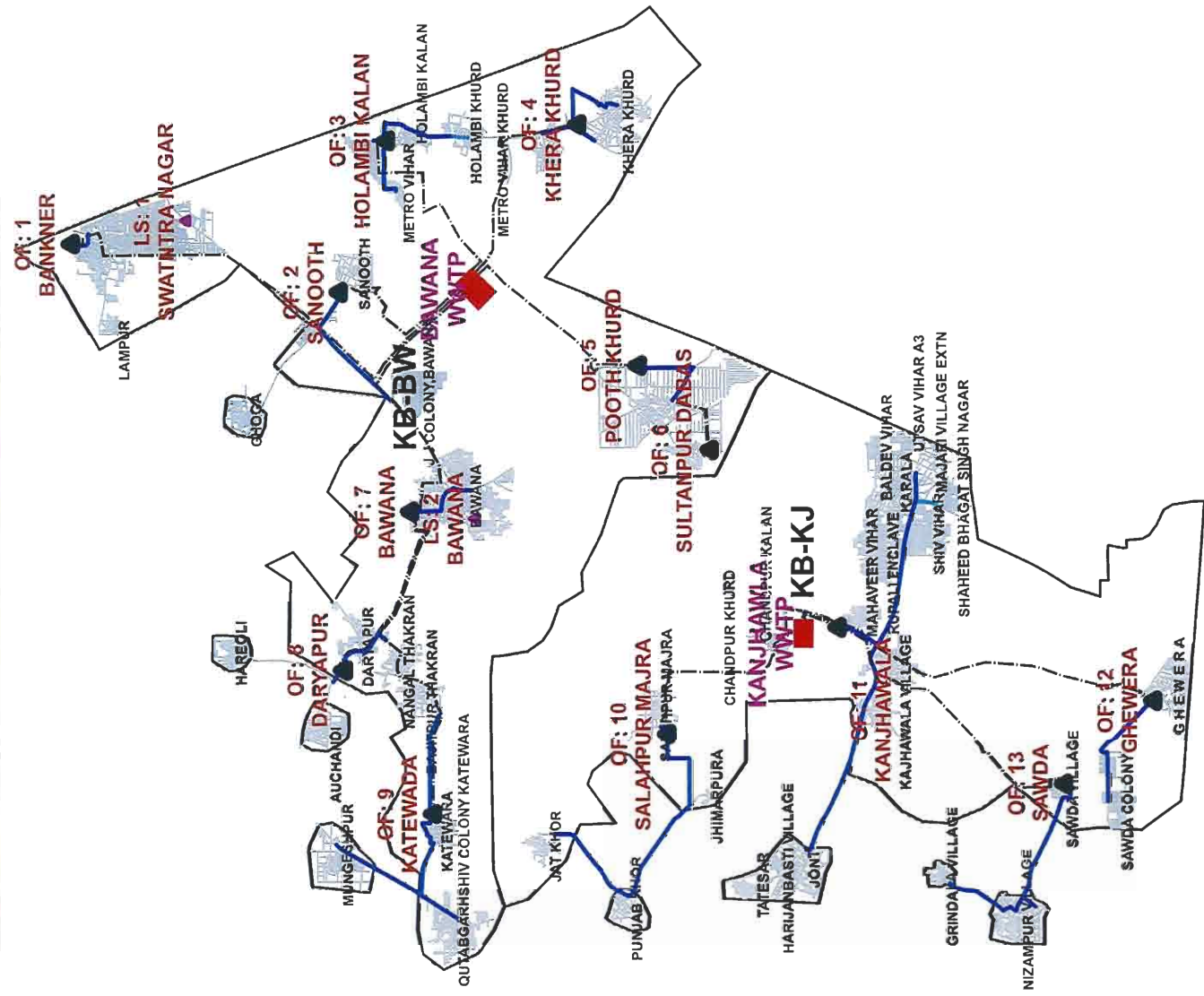


KEY PLAN



LEGEND:-

- Risingmain
- Internal Sewer
- Peripheral Sewer
- Trunk Sewer
- ▲ Proposed Lift Station
- ▲ Proposed WWPS
- Proposed WWTP



THE DRAWING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAINING OF THIS PROJECT SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE ACT AND RULES.

PLANNED	DESIGNED	APPROVED	DATE
REVIEWED & CHECKED	DESIGNED	APPROVED	DATE
REVIEWED & CHECKED	DESIGNED	APPROVED	DATE

AECOM
WAPCOS

W.P. No. 1
Bawana, New Delhi
D.P. No. 124/4830250
F. No. 124/4830250
Hyderabad, India

DELHI JAL BOARD

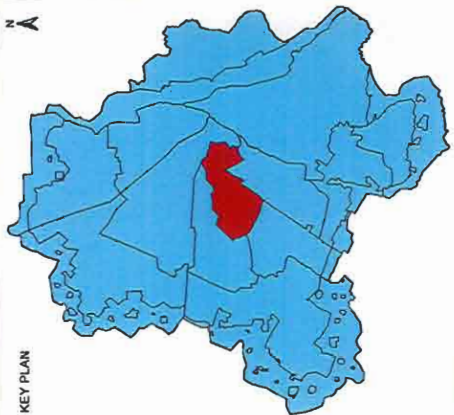
Project Title: **DJB SEWERAGE MASTER PLAN - 2031**

Drawing Title: **PROPOSED INFRASTRUCTURE FOR KANJHAWALA-BAWANA DRAINAGE ZONE**

Scale: _____

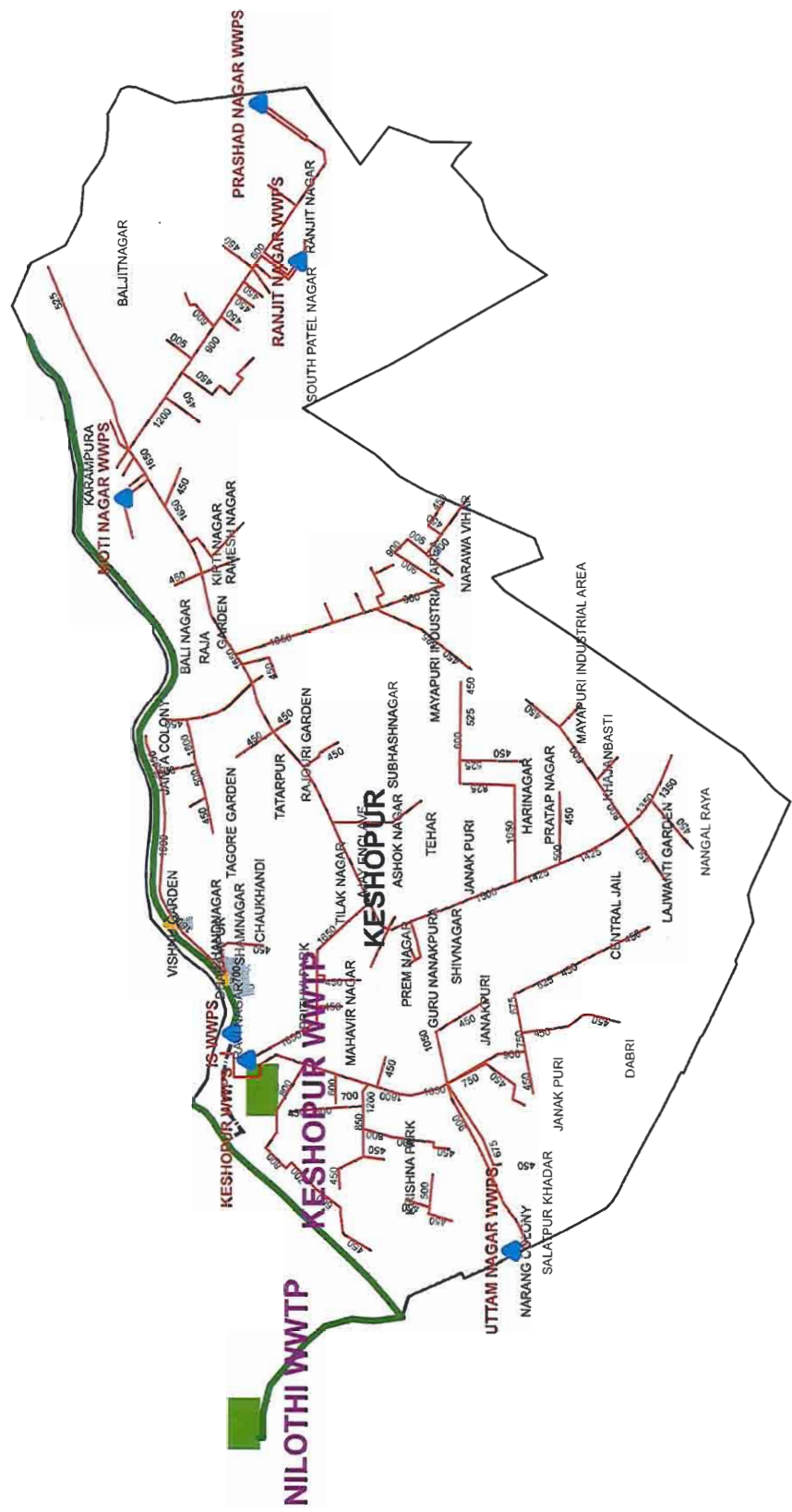
Sheet No: _____

KEY PLAN



LEGEND:-

- Risingmain
- Internal Sewer
- Existing Sewer
- Interceptor Sewer
- Integration with Existing Sewer
- Existing WWPS
- Existing WWTP



THE DESIGN OF THIS PROJECT HAS BEEN PREPARED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATIONS OF THE PROJECT HAS BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM FOR PROJECTS ISO 9001:2000

PLANNED	DESIGNED	APPROVED	DATE
REVIEWED & CHECKED	DATE	DATE	DATE



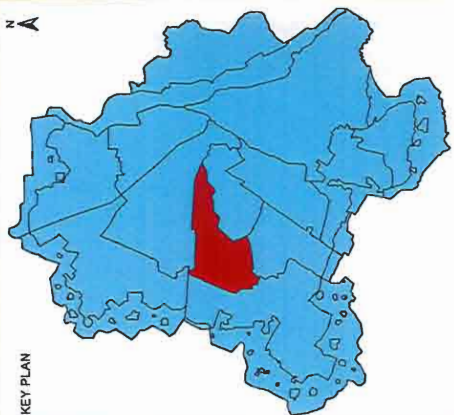
9th Floor,
Building Tower C
D-2, Connaught Place,
New Delhi 110028
T: +91 124 4830250
F: +91 124 4830108
www.aecom.com



DELHI JAL BOARD

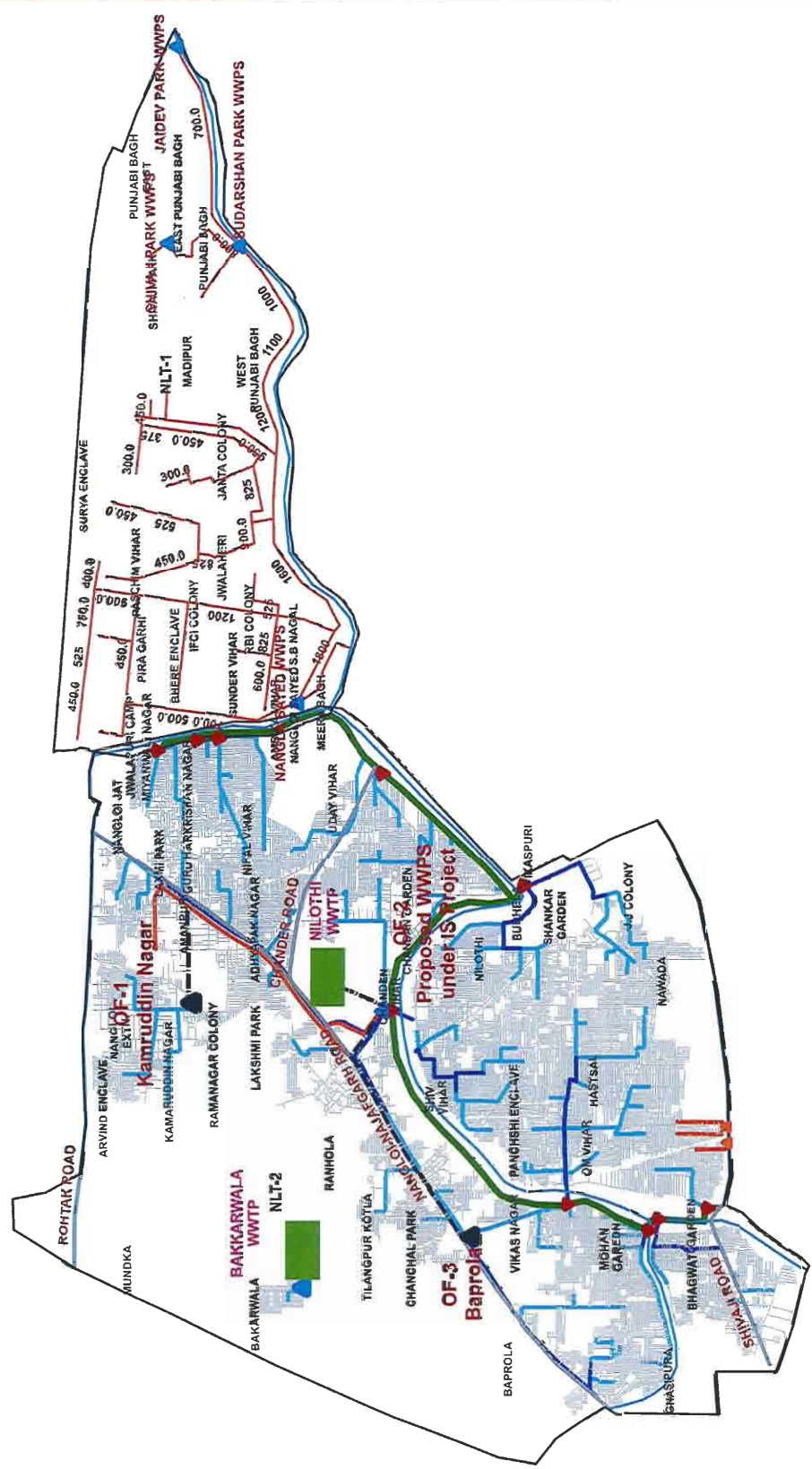
Project Title	DJB SEWERAGE MASTER PLAN - 2031
Drawing Title	PROPOSED INFRASTRUCTURE FOR KESHOPUR DRAINAGE ZONE
Status	Rev

KEY PLAN



LEGEND:-

- Risingmain
- Internal Sewer
- Existing Sewer
- Peripheral Sewer
- Trunk Sewer
- Interceptor Sewer
- Drain
- To Interceptor Sewer
- Existing WWPS
- Proposed WWPS
- Existing WWTP



THE SIGNED OF THIS TITLE BLOCK CONFIRMS THE CDR HAS DRAWN THIS PROJECT
HENCE BELONGS TO THE CDR'S RESPONSIBILITY

DESIGNED	REVIEWED	APPROVED	DATE
CHANDAN GUPTA	CHANDAN GUPTA	CHANDAN GUPTA	15/08/2024

REVIEWED & CHECKED

ATCOM
WAPCOS

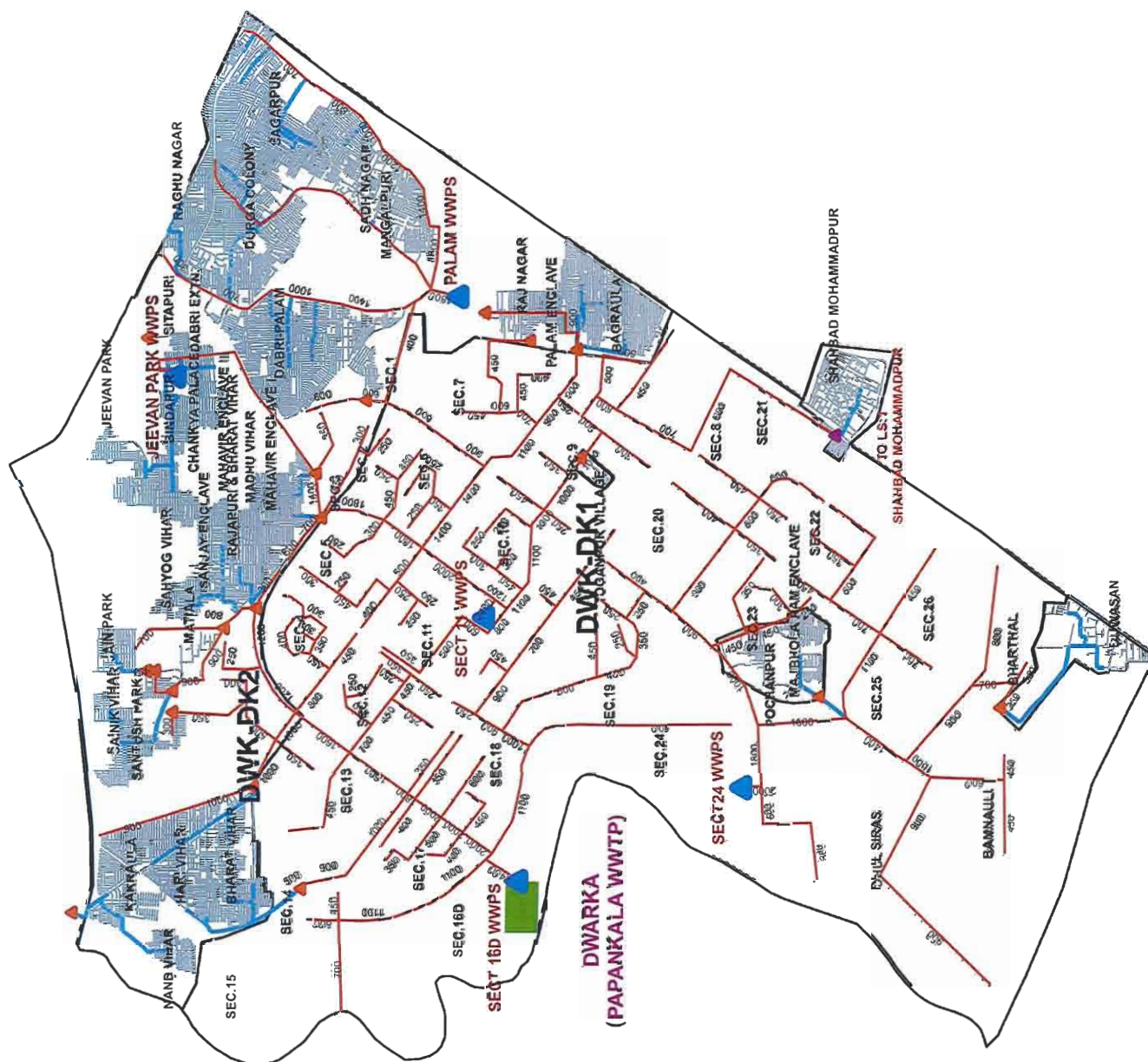
Wh. Floor
Indira Tower C
15, Connaught Place
New Delhi - 110028
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F: +91 124 4830108
www.atcom.com

DELHI JAL BOARD

DJB SEWERAGE MASTER PLAN - 2031

PROPOSED INFRASTRUCTURE FOR NILOTHI DRAINAGE ZONE

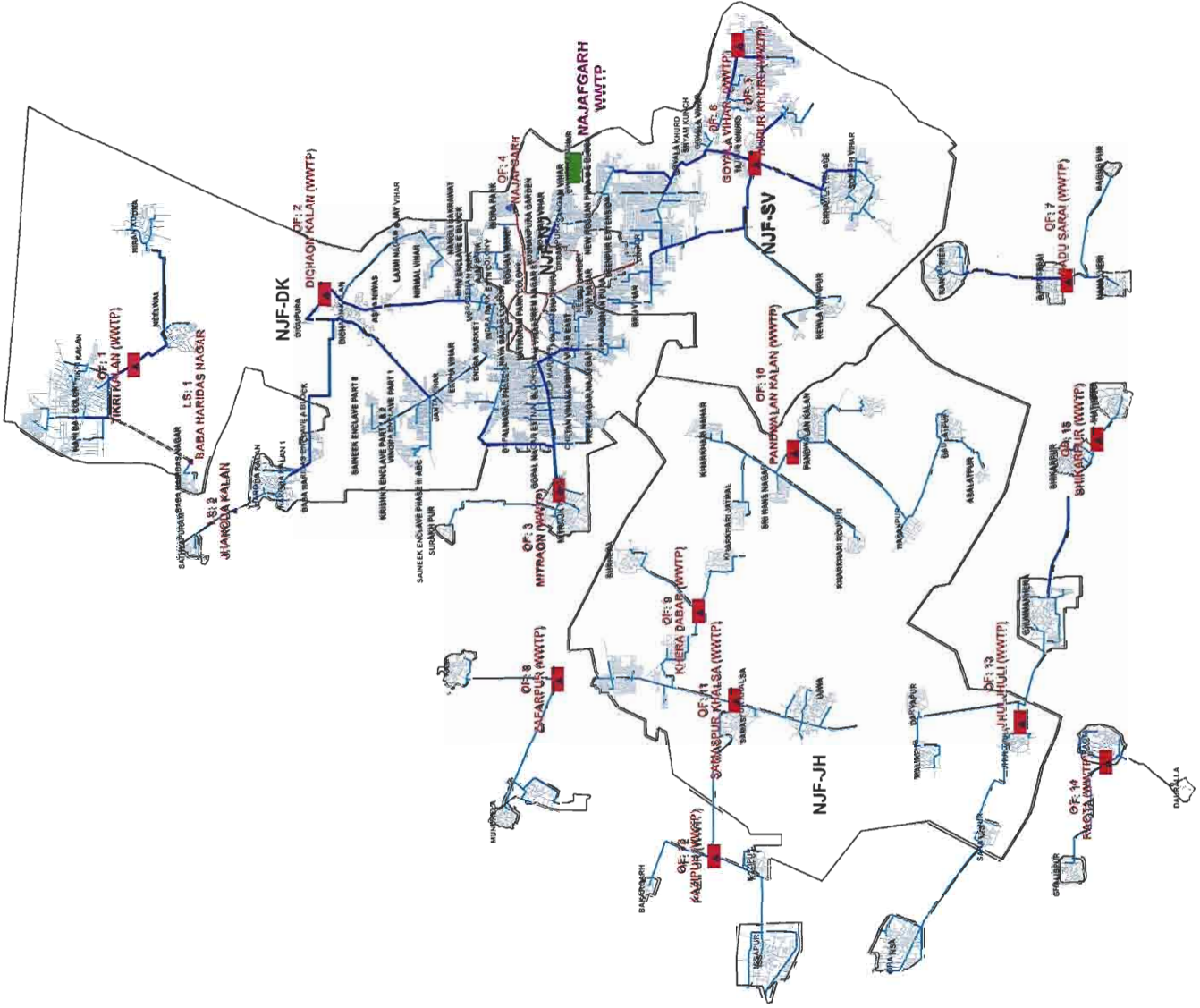
Project No. _____
Drawing No. _____
Scale _____

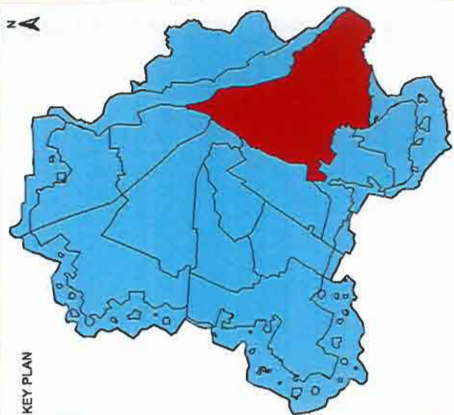




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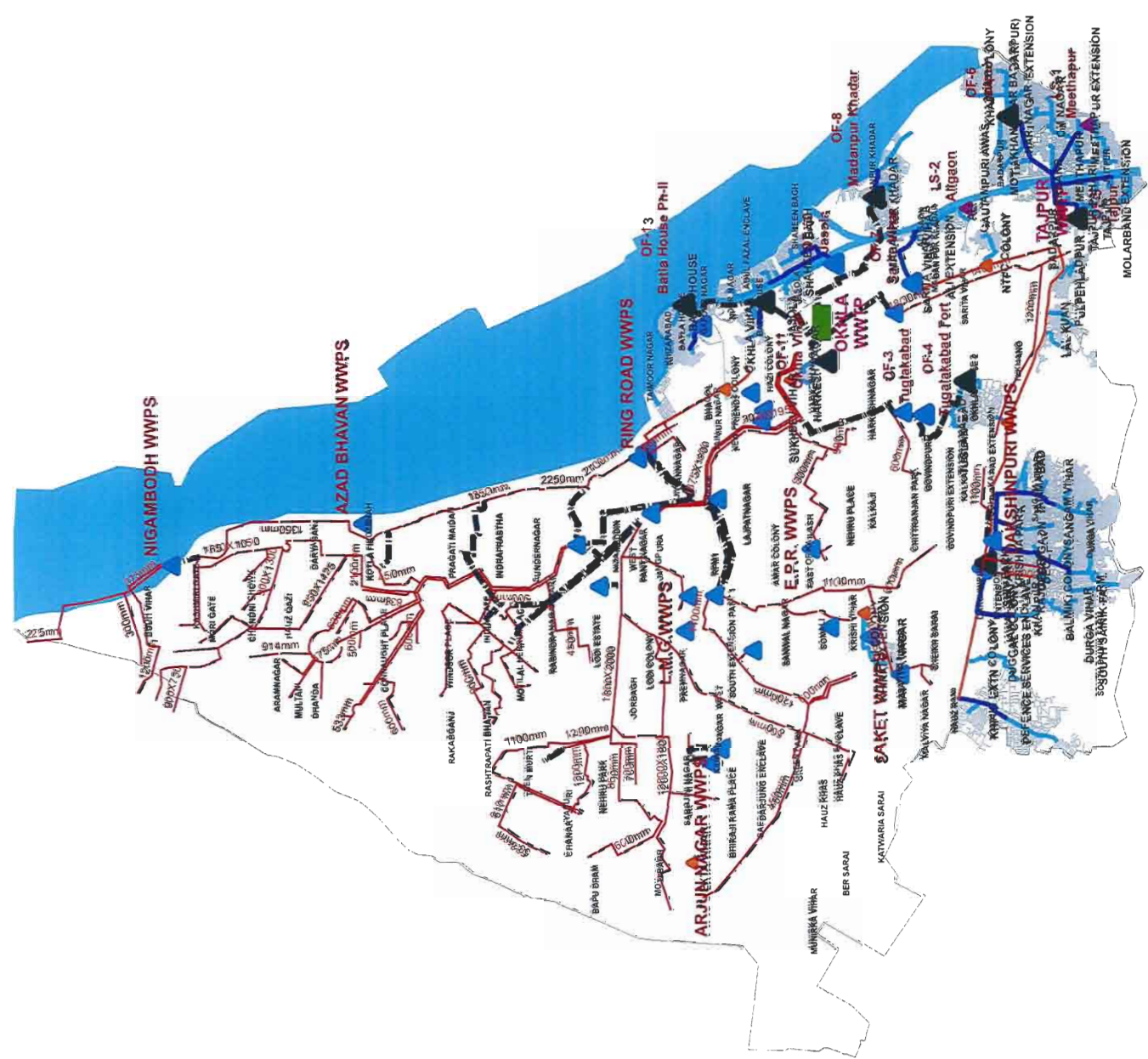
Line Style	Line Color	Line Shape	Line Color
Rising main	Black dashed		
Internal Sewer	Grey solid		
Existing Sewer	Brown solid		
Peripheral Sewer	Blue solid		
Trunk Sewer	Dark blue solid		
Existing WWPS	Blue triangle		
Proposed Lift Station	Purple triangle		
Proposed WWPS	Black triangle		
Existing WWTP	Green rectangle		
Proposed WWTP	Red rectangle		





LEGEND:-

- Rising main
- Internal Sewer
- Existing Sewer
- Peripheral Sewer
- Trunk Sewer
- Integration with Existing Sewer
- To Existing WWPS
- Proposed Lift Station
- Proposed WWPS
- Existing WWTP



THE ENGINEER OF THIS PROJECT CERTIFIES THAT THE DESIGN AND CONSTRUCTION OF THIS PROJECT HAVE BEEN PREPARED AND CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE DELHI MUNICIPAL CORPORATION ACT, 1957 AND THE DELHI MUNICIPAL CORPORATION (AMENDMENT) ACT, 1978.

NAME	DESIGNER	DATE
DESIGNATION	SCALE	DATE
REVIEWED & CHECKED	NAME	DATE

AECOM
WAPCOS

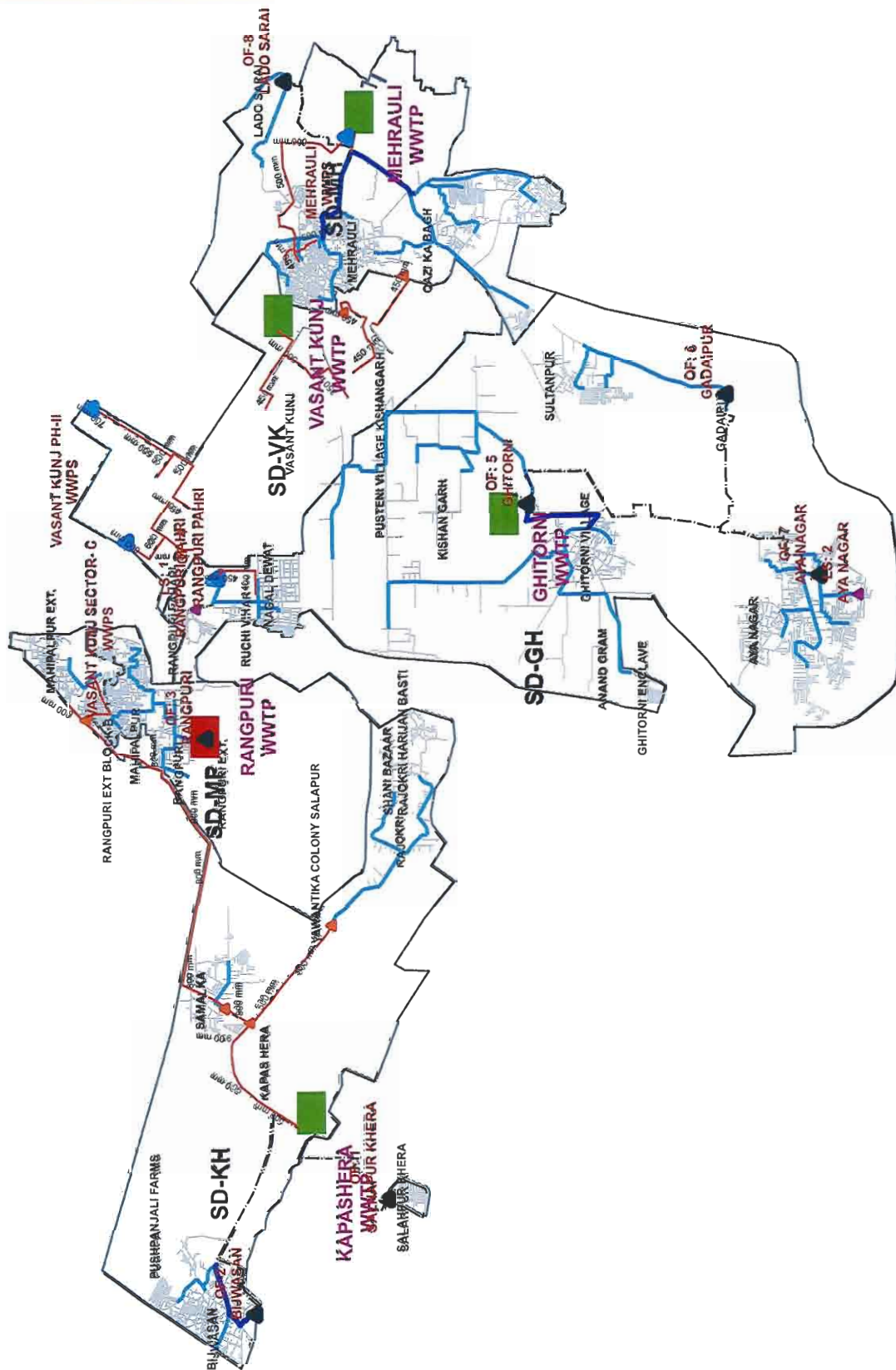
10th Floor,
Haryana House,
10, Connaught Place,
New Delhi - 110028
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F: +91 11 4610 4000
www.aecom.com

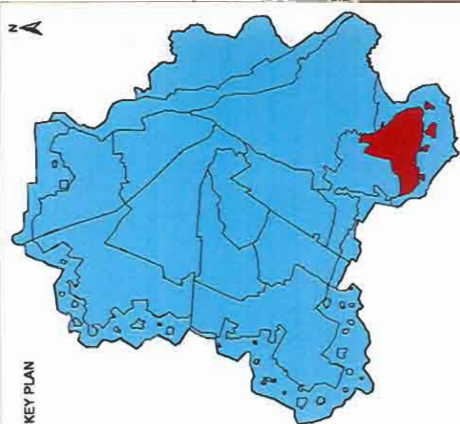
DELHI JAL BOARD

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Haryana House,
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New Delhi - 110028
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F: +91 11 4610 4000
www.djb.com

Project No.	DJB SEWERAGE MASTER PLAN - 2031
Drawing No.	PROPOSED INFRASTRUCTURE FOR OKHLA DRAINAGE ZONE
Scale	As per
Rev.	Rev.

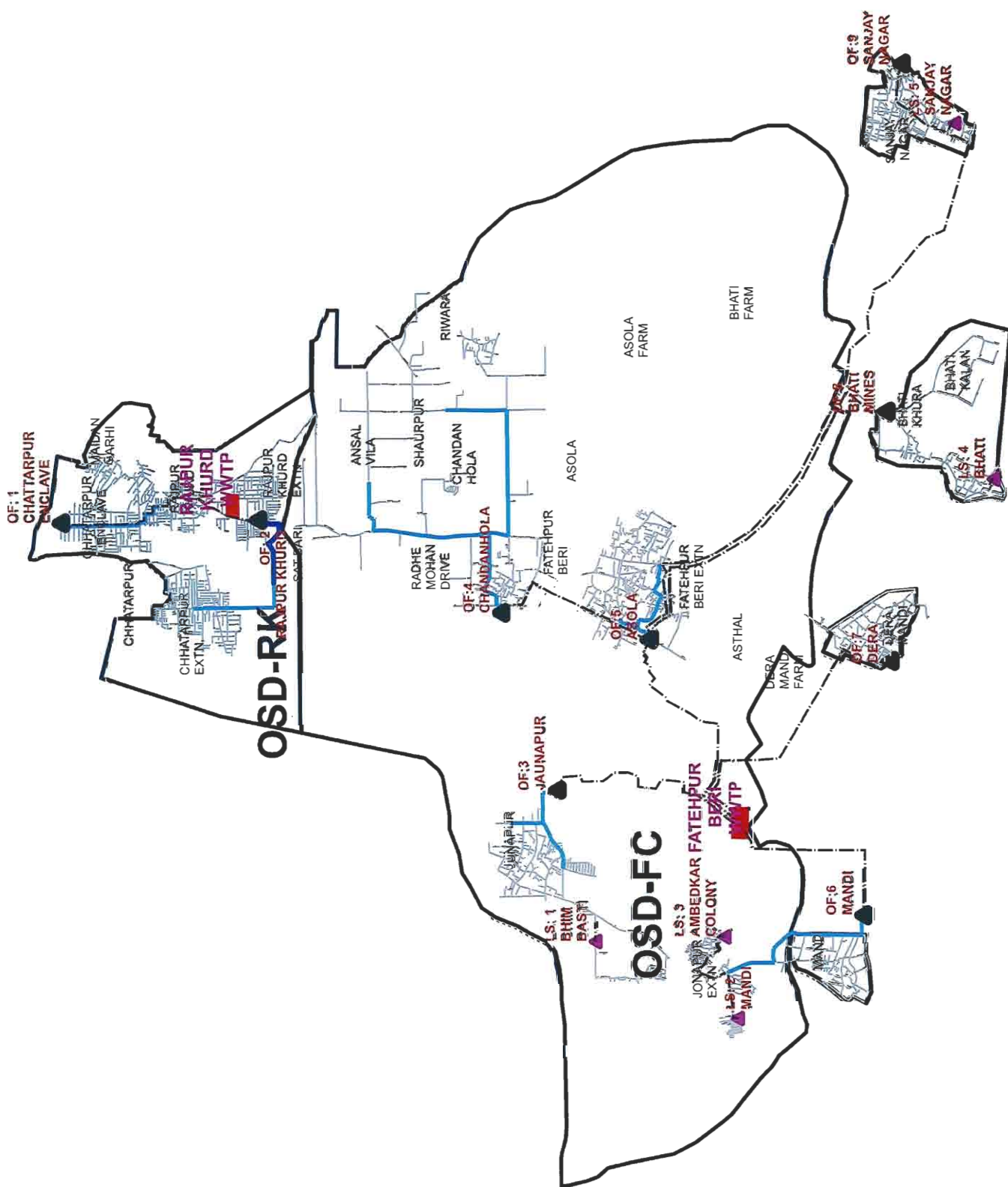
■ Risingmain
 ■ Internal Sewer
 ■ Existing Sewer
 ■ Peripheral Sewer
 ■ Trunk Sewer
 ▲ Integration with Existing Sewer
 ▲ To Existing WWPS
 ▲ Proposed Lift Station
 ▲ Proposed WWPS
 ■ Existing WWTP
 ■ Proposed WWTP

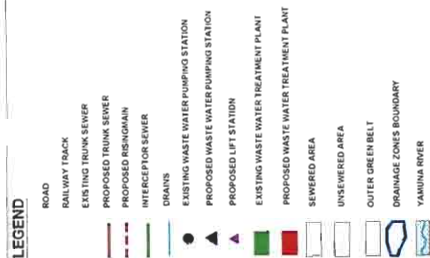
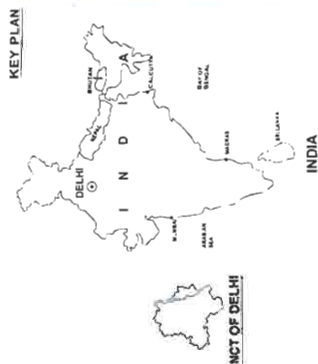
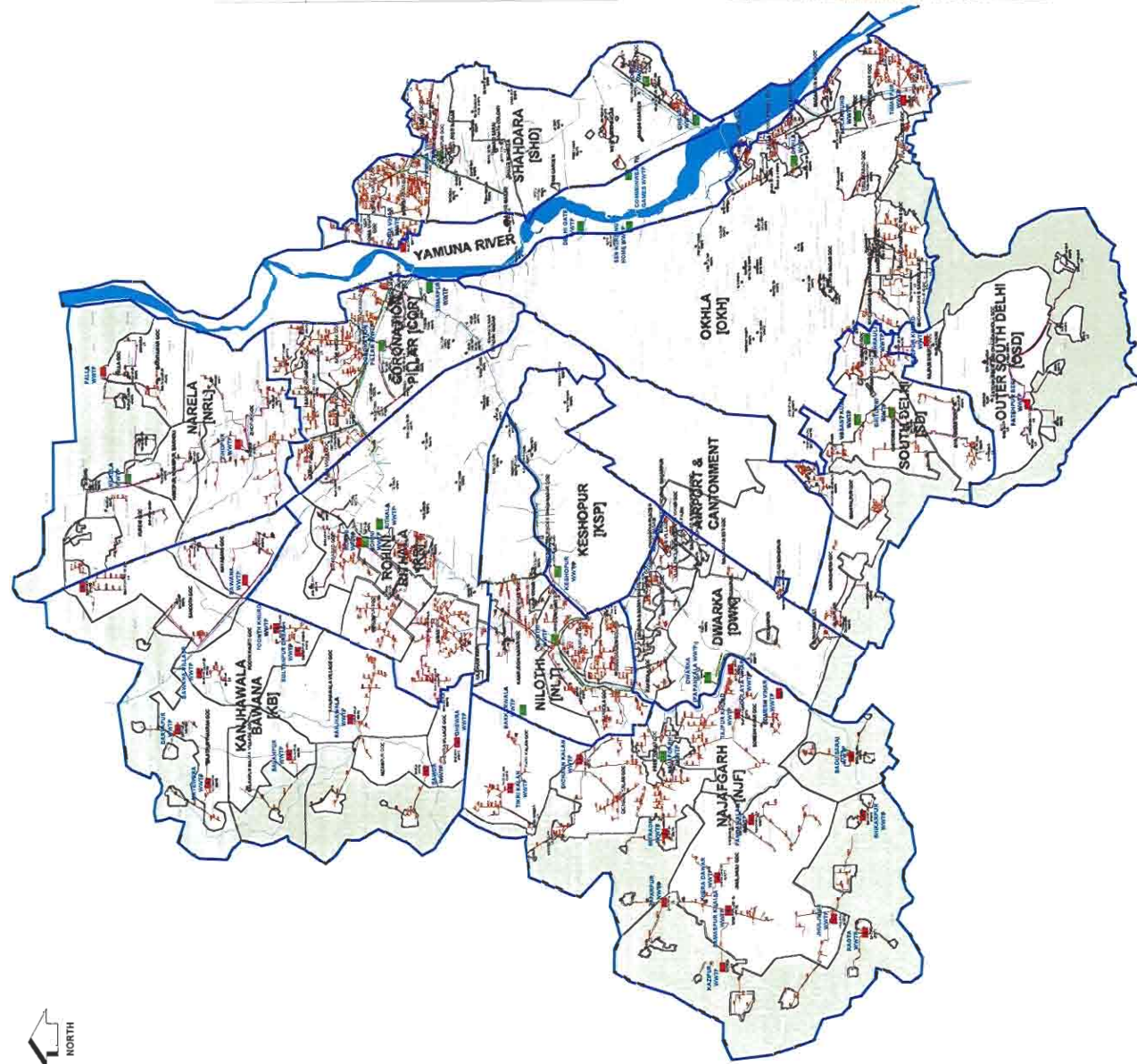




LEGEND:-

	Risingmain
	Internal Sewer
	Peripheral Sewer
	Trunk Sewer
	Proposed Lift Station
	Proposed WWPS
	Proposed WWTP





標号	産地	Project Age Years (age)	Construction Completed	Capacity after expansion (MW)
1	1. Shikoku	1970	1970	14.0
2	2. Hokkaido	1971	1971	21.0
3	3. Tohoku	1972	1972	10.0
4	4. Kanto	1972	1972	10.0
5	5. Chubu	1973	1973	10.0
6	6. Kansai	1973	1973	10.0
7	7. Chugoku	1973	1973	10.0
8	8. Shikoku	1973	1973	10.0
9	9. Kyushu	1973	1973	10.0
10	10. Hokkaido	1973	1973	10.0
11	11. Tohoku	1973	1973	10.0
12	12. Kanto	1973	1973	10.0
13	13. Chubu	1973	1973	10.0
14	14. Kansai	1973	1973	10.0
15	15. Chugoku	1973	1973	10.0
16	16. Shikoku	1973	1973	10.0
17	17. Kyushu	1973	1973	10.0
18	18. Hokkaido	1973	1973	10.0
19	19. Tohoku	1973	1973	10.0
20	20. Kanto	1973	1973	10.0
21	21. Chubu	1973	1973	10.0
22	22. Kansai	1973	1973	10.0
23	23. Chugoku	1973	1973	10.0
24	24. Shikoku	1973	1973	10.0
25	25. Kyushu	1973	1973	10.0
26	26. Hokkaido	1973	1973	10.0
27	27. Tohoku	1973	1973	10.0
28	28. Kanto	1973	1973	10.0
29	29. Chubu	1973	1973	10.0
30	30. Kansai	1973	1973	10.0
31	31. Chugoku	1973	1973	10.0
32	32. Shikoku	1973	1973	10.0
33	33. Kyushu	1973	1973	10.0
34	34. Hokkaido	1973	1973	10.0
35	35. Tohoku	1973	1973	10.0
36	36. Kanto	1973	1973	10.0
37	37. Chubu	1973	1973	10.0
38	38. Kansai	1973	1973	10.0
39	39. Chugoku	1973	1973	10.0
40	40. Shikoku	1973	1973	10.0
41	41. Kyushu	1973	1973	10.0
42	42. Hokkaido	1973	1973	10.0
43	43. Tohoku	1973	1973	10.0
44	44. Kanto	1973	1973	10.0
45	45. Chubu	1973	1973	10.0
46	46. Kansai	1973	1973	10.0
47	47. Chugoku	1973	1973	10.0
48	48. Shikoku	1973	1973	10.0
49	49. Kyushu	1973	1973	10.0
50	50. Hokkaido	1973	1973	10.0
51	51. Tohoku	1973	1973	10.0
52	52. Kanto	1973	1973	10.0
53	53. Chubu	1973	1973	10.0
54	54. Kansai	1973	1973	10.0
55	55. Chugoku	1973	1973	10.0
56	56. Shikoku	1973	1973	10.0
57	57. Kyushu	1973	1973	10.0
58	58. Hokkaido	1973	1973	10.0
59	59. Tohoku	1973	1973	10.0
60	60. Kanto	1973	1973	10.0
61	61. Chubu	1973	1973	10.0
62	62. Kansai	1973	1973	10.0
63	63. Chugoku	1973	1973	10.0
64	64. Shikoku	1973	1973	10.0
65	65. Kyushu	1973	1973	10.0
66	66. Hokkaido	1973	1973	10.0
67	67. Tohoku	1973	1973	10.0
68	68. Kanto	1973	1973	10.0
69	69. Chubu	1973	1973	10.0
70	70. Kansai	1973	1973	10.0
71	71. Chugoku	1973	1973	10.0
72	72. Shikoku	1973	1973	10.0
73	73. Kyushu	1973	1973	10.0
74	74. Hokkaido	1973	1973	10.0

[illegible]

THE SHOWNERS OF THIS TITLE BLOCK CONFIRM THE DESIGN AND LAYOUT OF THIS PROJECT

PLANNED	ISSUES	DESIGNED	CHANGES
THIS INTEGRATION	MANAGERIAL	APPROVED	18 MAY
REVIEWED & CHECKED	MANAGERIAL	DATE	18 MAY

Client



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DELHI JAL BOARD

Project Title

DELHI SEWERAGE MASTER PLAN - 2031