9 Sewerage, Solid Waste Management, Drainage and Irrigation

9.1 SEWERAGE

9.1.1 Background

Sewerage is a core element of the physical infrastructure that determines the environmental status of any settlement. Planning and development of appropriate sewage carriage system with efficient treatment and cost recovery is the key component of urban physical infrastructure. Rehabilitation of old sewers, augmentation of existing sewerage system and sewage treatment capacities, extending sewerage system to uncovered areas, adoption of new technologies of waste treatment for higher degree of treatment to facilitate reuse and developing feasible and cost effective treatment for small and marginal settlements and rural areas is a huge task.

Low coverage of towns with sewerage system coupled with large and increasing gap in treated sewage and sewage generation also leads to degradation of the environment. The rivers (mainly Yamuna, Hindon and Kali Nadi) and various seasonal streams and drains in the NCR are under severe water quality threat due to untreated sewage polluting downstream areas. The surface water bodies and rivers receiving untreated wastewater are becoming unfit for bathing & unsuitable for drinking water.

The crisis in sewerage and sanitation has clear links to the imbalanced urban development and poor provision of wastewater infrastructure. Also, increased disease incidence, health risks and associated economic burdens have disproportionate impacts on the poor and vulnerable. This situation is aggravated by the on-going densification in the CNCR, the impact of climate change and the increasing groundwater pollution due to sewage infiltration. To address the problem of lack of sewerage system, a number of actions are immediately needed, such as (i) substantial investment in the construction of sewer network, conveying system and STPs, (ii) reuse of effluent (iii) energy generation in STPs and (iv) Institutional and financial management reforms to ensure that growth is environmentally sustainable and inclusive.

9.1.2 Existing Situation

A) Coverage of Sewage Network Services

In NCR out of 108 towns only 33 towns have sewerage system and even in these 33 towns, the coverage can at best be classified as partial. In Uttar Pradesh sub-region only 6 towns are partially covered out of 63 towns, in Haryana sub-region 24 towns are partially covered out of 35 towns, in Rajasthan sub-region 2 towns are partially covered out of 9 towns. The population covered with sewer network is only 51% which is 2% less than the percentage of population covered in year 2001. NCR lags behind the MoUD bench mark of 100% coverage but it is far better than national average of 12.2% in terms of sewer network services. In absolute terms urban population in NCR during the decade 2001-11 has increased by 78.69 Lakh (37.6%) whereas the population covered with sewer network service has increased by 36.31 Lakh (33%). Thus the pace of sewer coverage is lagging far behind the increasing population. The city wise coverage is given in Annexure 9/I. The Sub-region wise coverage is given in Table 9.1.

Table 9.1: Sub-Region wise Coverage of Towns and Population with Sewerage in 2001 and 2011

Sub Region	Total Towns	Towns Covered		Urban Population		Urban Population Covered		Percentage Covered	
		2001	2011	2001	2011	2001	2011	2001	2011
NCT Delhi	1	1	1	12,905,780	16,334,000	8,388,757	8,983,700	65	55
Haryana	35	15	24	2,964,678	4,755,000	1,591,968	3,391,748	54	71
Rajasthan	9	2	2	4,34,939	6,54,000	14,326	76,100	3	12
Uttar Pradesh	63	2	6	4,614,677	7,046,000	1,110,956	2,285,860	24	32
Total	**108**	**20**	**33**	**20,920,074**	**28,789,000**	**11,106,007**	**14,737,408**	**53**	**51**

Source: Analysis by NCRPB

The network coverage in some of the important cities in NCR and service providers are given in Table 9.2. The problem of low coverage and lack of sewerage system gets compounded by the multiplicity of authorities/utility/service providers even within the same city.

Table 9.2: Sewer Network Coverage in Important Cities & Service Providers

Name of City	Percentage Covered 2001	Percentage covered 2011	Service Providers
NCT Delhi	55	55	Delhi Jal Board
Meerut	30	31	MDA, UPJN, MNN, Cantonment Board, Housing Board
Ghaziabad-Loni	70	60	GDA, UPJN, GNN, NPPL,UPSIDC
Noida	0	72	NOIDA
Greater Noida	0	79	Greater NOIDA
Faridabad	65	70	PHED, MCF, HSIIDC, HUDA
Gurgaon	60	79	PHED, HUDA, HSIIDC, MCG
Panipat	50	92	PHED, HUDA
Rohtak	65	90	PHED, HUDA, HSIIDC
Sonepat	40	80	PHED, HUDA
Alwar	5	10	PHED, UIT

Source: Compiled by NCRPB

B) Estimate for Sewage Generation

Sewage generation in 2021 for NCT Delhi has been estimated based on water supply rate of 202 lpcd (as provided by DJB). The sewage generation for other sub regions has been estimated at water supply rate of 180 lpcd for towns with population of more than 10 lakh and at the rate of 135 lpcd for other towns as per CPHEEO norms. Sewage generation has been estimated at 80% of water supply. The city wise wastewater generation has been worked out in Annexure 9/II and sub region wise details are given in Table 9.3.

Table 9.3: Estimate for Sewage Generation

Sub Region	Urban Population			Sewage Generation in MLD		
	2001	2011	2021	2001	2011	2021
Delhi	12,905,780	16,334,000	19,856,000	2,540	2,996	3,275
Haryana	2,964,678	4,755,000	10,504,000	374	599	1,342
Rajasthan	4,34,939	6,54,000	1,475,000	47	71	216
UP	4,614,677	7,046,000	12,339,000	600	862	1,555
NCR Urban	**20,920,074**	**28,789,000**	**44,174,000**	**3,560**	**4,528**	**6,387**

Source: Analysis by NCRPB

C) Sewage Treatment Capacity

At present the sewage generation in NCR urban is 4,528 MLD. NCR has 64 STP's of 3,349 MLD design capacity and the sewage treated is 2,248 MLD. Therefore, the sewage treated is 50% of sewage generation. The increase in sewage treatment capacity during the decade 2001-11 has been 53% whereas the increase in treated sewage quantity has been much less at 33%. The gap in the sewage generation over the sewage treatment is as high as 2,280 MLD. Sub-Region wise existing details of STPs, treatment capacity and treated quantity are given in Table 9.4.

Table 9.4: Sewage Treatment Plants in NCR

Sub Region	No. of Towns having STP's	No. of STP's	Treatment Capacity (MLD)		Actual Sewage Treated (MLD)		Gap in Sewage Treatment (MLD)	
			2001	2011	2001	2011	2001	2011
NCT Delhi	1	19	1,828	2,475	1,500	1,589	1,040	1,407
Haryana	24	25	236	406	164	199	209	400
Rajasthan	2	2	0	24	0	10	47	61
Uttar Pradesh	6	18	129	445	30	450	570	412
Total	**33**	**64**	**2,193**	**3,349**	**1,694**	**2,248**	**1,866**	**2,280**

Source: PHED Haryana, Rajasthan Sub-Regional Plan 2021, UP Sub-Regional Plan 2021 and Delhi Jal Board

Table 9.4 shows that in Delhi the quantity of sewage treated is 53% of sewage generated, in Haryana sub-region it is 33%, in Rajasthan sub-region it is 14% and in UP sub-region it is 52%. Also, thirty five sewage treatment plants of capacity 1,030 MLD are under construction in NCR, Table 9.5.

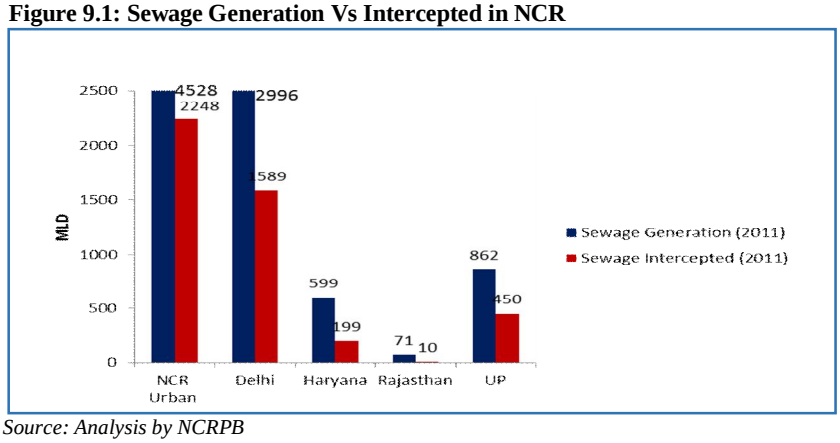
Table 9.5: Details of Sewage Treatment Plants Under Construction

Sub-Region	No. of STPs Under Construction	Capacity (MLD)
NCT of Delhi	06	564.00
Haryana	18	368.40
Rajasthan	2	25.00
UP	09	72.30
NCR	**35**	**1029.70**

Source: Data received from Respective Sub-regions

The utilization of the installed capacity of STPs in Delhi is 64%, in Haryana Sub Region it is 49%, in Rajasthan Sub Region it is 41%, in UP sub region it is 101%. The overall utilization figure for NCR is 67%. Figure 9.1 shows the comparison of Sewage Generation and Intercepted in NCR.

Figure 9.1: Sewage Generation Vs Intercepted in NCR



Source: Analysis by NCRPB

In NCR urban areas, as much as 50% of the sewage generated is not intercepted, implying that 2280 MLD goes untreated into Water bodies/Drains/Rivers.

D) Reuse and Recycle

In NCT Delhi, 645 MLD of treated effluent is reported to be used in Horticulture/Irrigation/Power plant, against present sewage generation of 2996 MLD which works out to be 21%. In Haryana, 20-30% of the treated sewage of the STPs in Gurgaon is utilized for irrigation and the balance is discharged into Najafgarh drain which ultimately meets river Yamuna. 25-30 % of the treated sewage of the STPs in Faridabad is utilized for irrigation and the balance is discharged into Buria nala, Agra canal and Gaunchi drain. For the STPs in Panipat, 30-40% is utilized and the balance is discharged into Nohra drain and Panipat drain which ultimately meets river Yamuna.

E) Treated Sewage Quality

DJB/DPCC monitors the effluent quality of all STPs and in most of the cases the quality is within the acceptable standards. Data on quality of treated sewage of STPs in other sub regions is not available.

F) Preparation of Sewerage Master Plans

Regional Plan 2021 recommended preparation of Master Plans for Sewerage system in all the towns of NCR in order to have integrated Sewerage schemes and to avoid piece meal approach which ultimately increases number of intermediate sewage pumping stations. Out of 108 towns in NCR, only 32 towns have sewerage master plan. In Haryana sub-region, 27 towns have Sewerage Master Plans out of 35 towns. In UP sub-region, only 4 towns have Sewerage Master Plans out of 63 towns. In Rajasthan sub-region, no Sewerage Master Plan has been prepared. Table 9.6 gives the details of sub region wise towns for which Sewerage Master Plans have been prepared.

Table 9.6: Sewerage Master Plan Preparation

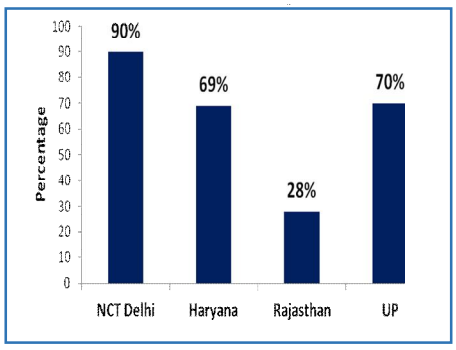
S. No	Sub-Region	Total No. of Towns in Sub-region	No. of Towns having Sewerage Master Plans
1	Haryana	35	27
2	Uttar Pradesh	63	04
3	Rajasthan	09	0
4	NCT Delhi	01	01
	Total	**108**	**32**

Source: Compiled by NCRPB

G) Toilet Facilities

According to Census of India 2011 data, 74.3% of the total households in NCR have toilet facilities within the premises in comparison to all India average of 46.9%. In Haryana sub-region, it is 69.0%; in Rajasthan sub-region, it is 27.5%; in Uttar Pradesh sub-region, it is 70.3% and in NCT Delhi, it is 89.5%. If we consider only urban areas in the NCR, the coverage of toilet facility within the premises is 90.3% in comparison to national coverage of 81.4%. In terms of coverage in rural areas, it is 43.9% against national coverage of 30.7%. In rural areas the sewage is carried through open kuccha drains and disposed off in fields and nearby ponds. Sub-Region wise details of availability of toilet facilities in urban and rural areas are given in Annexure 9/III. Figure 9.2 shows the percentage of households having toilets within premises.

Figure 9.2: Percentage of Households having Toilets within Premises



Source: Census of India, 2011

The coverage of toilets in metro centres in NCR is 94% in Gurgaon, 91% in Faridabad, 95% in Sonepat Kundli, 97% in Ghaziabad Loni, 97% in Meerut, 96% in NOIDA and Greater NOIDA against MOUD bench mark of 100%. The national average in terms of coverage of toilets is 69.5%.

9.1.3 Government of India Schemes

A) Flagship Schemes of Govt. of India

Total Sanitation Campaign

Total Sanitation Campaign (TSC) is a flagship scheme of Government of India with an aim to ensure sanitation facilities in rural areas, to eradicate the practice of open defecation by 2017. Communities are facilitated to conduct their own appraisal and analysis of open defecation (OD) and take their own action to become ODF (open defecation free). CLTS (Community-Led Total Sanitation) focuses on the behavioural change needed to ensure real and sustainable improvements.

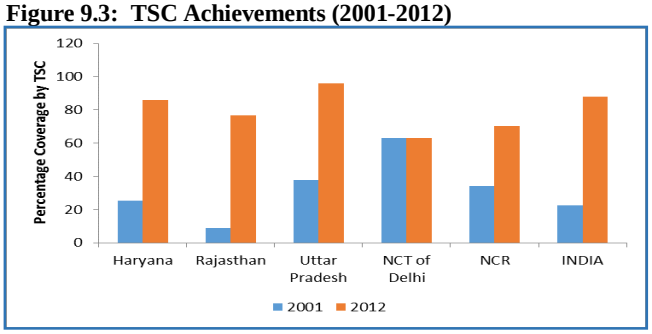
As per the information provided by Ministry of Drinking Water and Sanitation, the coverage of rural households for providing Toilet facility through Total Sanitation Campaign in India increased from 22.38 % in 2001 to 87.76 % in 2011-12. It increased from 34.28% (2001-02) to 70.32% (2011-12) in NCR. In Haryana sub-region, it increased from 25.24% (2001-02) to 85.83% (2011-12); in Rajasthan sub-region, it increased from 8.82% (2001-02) to 76.77% (2011-12); in UP sub-region, it increased from 37.80% (2001-02) to 95.81% (2011-12). Table 9.7 provides Sub-Region wise details of achievements of TSC in NCR and Figure 9.3 provides graphical comparison.

Table 9.7: Sub-Region wise Achievements

Region/Sub-region	TSC Percentage Coverage	
	2001-02	2011-12
NCT of Delhi	62.89	62.89
Haryana	25.24	85.83
Rajasthan	8.82	76.77
Uttar Pradesh	37.80	95.81
NCR	**34.28**	**70.32**
INDIA	**22.38**	**87.76**

Source: Census of India, 2011

Figure 9.3: TSC Achievements (2001-2012)



B) Project Financing by NCR Planning Board

NCRPB has financed 277 projects of which 38 projects are in the Sewerage, Sanitation and Drainage sector at an estimated cost of Rs 756 Crore for which a loan amount of Rs.453 Crore has been sanctioned. Out of these 38 projects, 20 projects are ongoing and 18 projects have been completed. Sub-region wise details are given in Table 9.8.

Table 9.8: NCRPB Assisted Sub-Region wise Sewerage, Sanitation and Drainage Projects (March 2013)

Sub-Region	Number of Sewerage, Sanitation and Drainage Schemes			Estimated Cost (Rs. in Crore)		
	Total	Completed	On Going	Total	Completed	On Going
Haryana	33	13	20	644	231	512
Rajasthan	0	0	0	0	0	0
UP	5	5	0	12	12	0
NCT of Delhi	0	0	0	0	0	0
NCR	**38**	**18**	**20**	**756**	**243**	**512**

Source: NCRPB

NCRPB assisted completed projects from sewer sector have already augmented the sewage treated capacity by more than 36 MLD and sewerage network by 261 km in various small and medium towns. In addition, the ongoing projects are proposed to augment the treatment capacity by another 171 MLD and the sewerage network by 468 km in various towns of NCR.

9.1.4 Issues

Analysis of information provided by the NCR participating States as given in Tables 9.1 to 9.3 and Annexure 9/I and 9/II indicates that there is a substantial gap between demand and availability of sewer network and sewage treatment facility in NCR. The issues related to the sewerage system in NCR are given below:

A) Sewage Network Services

In NCR 75 cities out of 108 total numbers of cities are not covered with sewerage system. The remaining 33 cities also have partial sewerage system. The expansion of sewerage network has lagged behind the growth of population resulting in overflow of sewage into drains causing river pollution or creation of cess pools in low lying areas of the towns/settlements. The goal of coverage with 100% Sewerage system of all towns is reiterated not only in the revised Regional Plan 2021, but also in service level delivery benchmark of Ministry of Urban Development.

B) Sewage Treatment Capacity

The sewage treatment at present is 2,248 MLD against generation of 4,528 MLD. The sewage generation in the year 2021 will be 6,387 MLD. Thirty five number of sewage treatment plants of capacity 1,030 MLD are under various stages of construction. After taking into account construction of all the on-going STPs, the gap in quantity of sewage treatment and generation will continue to remain 1,250 MLD (4528-2248-1030=1,250 MLD) at present and the gap will further increase to 3,109 MLD in the year 2021. Moreover the planned capacity (Design capacity) of the STPs will be more than the required capacities as the plants are designed for design period of 10-30 years. Considering average design period of 10 years the installed capacity requirement shall be about 30% more than today's requirement. The planning and implementation of STPs takes at least 5-6 years. It is also assumed that existing capacities of STPs will be utilised to full extent. Based on above assumptions NCR needs to plan and start implementation of STPs of capacity 2,491 MLD immediately. The requirement for UP sub region is of 1,350 MLD capacity, Haryana sub region needs addition of 617 MLD; Rajasthan sub region needs additional requirement of 218 MLD. NCT Delhi needs to use existing capacities of STPs and addition of 306 MLD new STPs apart from on-going work to reach a capacity of 564 MLD. The sub region wise details are given in Table 9.9.

Table 9.9: Additional STPs Required

Sub –region	Estimated Sewage Generation (MLD)		Treatment Capacity	Sewage Treated at Present	STPs Under Construction	Gap considering Installed Capacity 30% more
	Year 2011	Year 2021	(MLD)	(MLD)	(MLD)	(MLD)
	A	B	C	D	E	(B-C-E)*1.3
NCT of Delhi	2,996	3,275	2,475	1,589	564.00	306
Haryana	599	1,342	405	199	368.40	617
Rajasthan	71	216	24	10	25.00	218
Uttar Pradesh	862	1,555	445	450	72.30	1,350
NCR –Urban	**4,528**	**6,387**	**3,349**	**2,248**	**1,029.70**	**2,491**

Source: Analysis by NCRPB

C) Reuse and Recycle

Recycling/Reuse of treated sewage is insufficient at present as reuse system/network are not developed. Planning for prospective users is not done at the time of conceiving STPs.

Sewage generation in NCR is estimated to be 6,387 MLD by the year 2021. Assuming that 80% of generated sewage after treatment will be available for recycling or reuse, 5,101 MLD treated sewage effluent will be available for reuse in NCR by 2021. The treated sewage available for reuse shall be 2,620

MLD in Delhi, 1,074 MLD in Haryana sub region, 1,244 MLD in UP sub region and 173 MLD in Rajasthan sub region.

D) Operation and Maintenance

The lack of proper maintenance of the sewerage system results in blockage and overflowing of sewers, opens manholes and back-flows. Throwing street sweepings and garbage into manholes/open drains results in blocking of sewers and creates cess pools resulting in environmental degradation and diseases. Age old system of manual cleaning of sewers is still followed instead of use of modern machines like jetting cum suction machines, which are quick and do not damage the inner surface of the sewers.

The upper reaches of sewerage system, where flow mostly remains below the self-cleansing velocity, are silted up as they have no system of regular flushing. There is need for a comprehensive maintenance plan for de-silting of the entire sewer system of a city.

The operation and maintenance of STPs has been neglected. Often sewage is bypassed from STPs. At many places the condition of mechanical and electrical equipment is poor and pumps are old which consume more power. Renewals are not done timely. Preventive maintenance is generally not done.

Cost recovery and collection efficiencies are poor. Revenue generation through recovery of resources viz. recycled water, manure and waste to energy plans; should be added for recovery of the expenditure in operation & maintenance. Proper and adequate maintenance is not possible in case of less cost recovery.

E) Imbalances in the Coverage

There are imbalances in the coverage of municipal sewerage system in various parts of the cities. Significant portion of the city population particularly living in marginal settlements, unauthorized colonies and urban villages do not have sewerage system.

F) Rehabilitation & Phasing out Existing Sewer Network & STPs

In older parts of cities the sewerage system is old, silted and overloaded, requiring phased replacement or rehabilitation. Development authorities associated with development of new areas in various towns/cities take care of sewerage system in newly developed sectors only. Provision of sewerage system and treatment facilities in the existing areas is considered as the sole responsibility of the local bodies which have neither sufficient financial resources nor appropriate technical staff to provide such facilities. ULBs are generally dependent upon the State Governments.

G) Sewerage Facilities in Rural Areas

Analysis of Census 2011 data (Table 9.7) indicates that the coverage of households in rural areas in NCR with the toilet facilities within premises is 44%. About 15.8% of the households are having toilets in the form of Pit Toilets which directly pollute the ground water and about 3.3% households have toilets in the form of either service toilets or directly dispose of night soil into the open drains. In Haryana Sub-Region, percentage of households with pit toilets is highest i.e 24.6 % and in UP Sub-Region, the percentage of households having Toilets in the form of either service Toilets or directly dispose of night soil into the open drains is highest i.e. 4.3%. Sub-region wise details are given in Table 9.7.

H) Treatment of Industrial & Hotel Waste

Industrial wastes are sometimes not treated and are disposed in public sewers or in streams/drains. This waste is highly concentrated and needs separate and special treatment before disposal in public sewer or in drains. The legislations to prevent this are in place but administration and monitoring mechanisms are weak and ineffective. Industrial areas should have common effluent treatment plants. Also, restaurants should discharge their waste water after primary treatment through grease interceptors and larger hotels should have independent sewage treatment facility.

I) Land Availability for STPs

The land for construction of new STPs is a major constraint in all sub-regions and therefore it is imperative to earmark land for STPs in the Master Plans.

J) Availability of Data

Data pertaining to network service area, inflow in STPs, treated quantity, influent and effluent characteristics of sewage reuse quantity, expenditures, revenues, cost recovery, collection efficiency, sewer connections etc. are generally not available. It is difficult to evaluate performance of STPs and sewage service and understand gaps. This data is necessary for future planning of sewerage facilities.

9.1.5 Policies and Proposals

In order to improve the sewerage system in the NCR for the harmonized and balanced development by the perspective year 2021, following policies and strategies are proposed:

A) Preparation of Master Plan for Sewerage System

Each participating State with the help of the specialized agencies and experts should prepare detailed and integrated Sewerage Master Plans for each city integrated with Land Use Plan of the city. The Master Plan be for atleast 20 year horizon period and must cover the extended boundary of the city as per proposed land use. Plan should address area for onsite sanitation and area for offsite sanitation (sewerage system). It should identify land required for STPs and their locations. The plan should provide rehabilitation of the existing network, STPs and Sewage Pumping Stations; extension of the sewer network, increase in treatment capacity, effluent requirements, disposal system, recycling the treated effluent for irrigation, 'peri-urban agriculture', urban agriculture, gardening, flushing of sewers and cooling in industries/hotels etc. Individual and/or common effluent treatment plants in industrial estates, grey water treatment and its recycling in residential apartments, hospitals, schools, hotels, etc. be promoted. The plan should prioritize works and propose phased investments. Associated environmental, social, financial, institutional & technical issues should be addressed.

B) Allocation of Land for Sewerage Schemes

Master/Development Plans of the towns and cities should notify and incorporate land allocations at appropriate locations for following components of the sewerage schemes:

i. Adequate corridor should be provided for laying of sewerage network and treated waste water recycling pipe lines along roads as per standard cross sections.

ii. Depending upon quantity of sewage to be pumped, land area for sewage pumping stations needs to be allocated (on an average, area of 0.25 hectare should be reserved for each pumping station).

iii. Adequate land area (0.2-1.0 hectare/MLD) should be reserved for sewage treatment plant as per the technology adopted.

C) Service Level Bench Marking

It is suggested that in order to focus on service delivery in the 7 metro centres, NCRPB may get a study conducted on the present status and improvements that could be carried out in respect of sewage service level benchmarks developed by MoUD.

D) Network Coverage

All towns should be covered such that 100% population is served by sewerage system or by on site sanitation. The implementation of sewerage system in towns should be prioritized based on higher population, less per capita investment, financial sustainability, reuse potential and O&M capacity. Piecemeal approach for laying of sewers should be avoided.

E) Sewage Treatment Capacity & Effluent Quality

STPs should be constructed of modular design so that the large capacities do not remain unutilized. Sewage should be treated as per standards laid down by MoEF/CPCB under the Environmental Protection Act, 1986 before it is discharged on land for irrigation, plantation, gardening etc. or into the water bodies. The grey water treatment and its recycling in residential apartments, hospitals, schools, hotels etc should also be encouraged. Sewage treatment facilities should be provided simultaneously in a phased manner

while developing the new areas in a town. No untreated sewage should be allowed to flow into water bodies/drains/rivers.

E) Decentralized Wastewater Treatment

In case of centralized wastewater treatment plant the network sizes are larger and pumping costs are more as compared to centralized wastewater treatment plants. Also long pipelines are required to be laid for reuse of treated effluent in case of centralized wastewater treatment as the users are situated upstream of the WWTP. The pumping costs for reuse increases due to higher head pumping. Therefore the decentralized wastewater management systems should be encouraged.

F) Recycling of Waste Water for Non Drinking Water Use

Recycled waste water should be promoted for non-drinking purposes and necessary infrastructure should be developed to facilitate reuse and recycling of treated waste water. The reuse of water recovered from grey waste water treatment at low cost needs to be promoted in multi storied apartments, schools, Hotels, industrial units and large installations. Fiscal measures such as quantum based taxation for waste water for institutions and commercial establishments be taken up which will not only reduce the cost of treatment for the municipalities but will ultimately help in improving the overall environment of the cities.

About 5101 MLD of treated waste water will be available for recycling and reuse. All new development areas may have two distribution lines, one for drinking water and other for non-drinking water/recycled treated waste water for reuse. Water requirements for non-drinking purpose in big hotels, industrial units, central air-conditioning of large buildings/institutions, large installations, irrigation of parks/green areas and other non-potable/ non- human contact demands should be met with through treated recycled waste water. Proper and adequate infrastructure should be planned and implemented for the reuse of treated sewage. Individual grey water treatment and recycling units should be promoted in small communities, schools and Institutions.

Almost 80% of the treated waste water can be recycled on whole. State Government may consider providing liberal tax rebates for institutions/industries adopting recycled waste water to compensate for the cost involved in treating waste water for recycling. If required, enabling provisions in the respective Acts of the local bodies may be made by the respective State Governments.

G) Rehabilitation/Augmentation of Sewerage System and Treatment Facilities

Poor condition of existing sewerage system in townships/cities should be rehabilitated and wherever, sewerage facility in part of town is not available or is not up to the desired level, augmentation schemes, should be taken up. Since treatment facilities in most of the townships are less, emphasis should also be given to provide the same, as per the requirement.

H) Adoption of Energy Efficient Treatment Processes and Energy Generation from Sludge

The wastewater treatment plants with energy efficient mechanized treatment processes including energy generation from sludge digestion or gasification be encouraged. To mitigate the problem of intermittent and unreliable power supply, dedicated power supply from the national grid and standby diesel generator sets to ensure continuous power supply for the STPs be taken up. The STPs will also include proper measures for automation with supervisory control and data acquisition (SCADA) systems.

I) O&M Embedded Construction Contracts for Operational Sustainability

To mitigate O&M capacity of ULBs and ensure operational sustainability, O&M embedded construction contracts combining design, construction and O&M for wastewater treatment plants shall be taken up. This will encourage the contractors to improve quality of construction and provide continuity in system operation.

J) Operation and Maintenance

Operation and maintenance of sewerage system should be done in a planned manner and should be given priority by the local bodies. The maintenance of sewerage system should be carried out by using modern

technology/equipment. Technical and financial resources of local bodies for proper O&M of sewerage system and STP's should be considered for enhancing their capacity. Technical resources may be outsourced as required.

The O&M of the existing sewage treatment facilities should be done through expert and experienced reputed agencies on long term agreement (5-10 years), preferably on Public-Private-Partnership (PPP) model, and resource recovery and promotion of use of recycled water should be included in the agreement.

K) On site Sanitation

The towns within NCR, which do not have sufficient resources or have unsuitable terrain to provide proper sewerage system and treatment facilities, may initially be provided with low cost sanitation system which can be upgraded at later stages within the time frame of master plan. Densely populated parts of towns can be provided with sewerage system and thinly populated parts can be provided with onsite sanitation system. Pit Toilets which directly pollute the ground water, service Toilets and direct disposal of night soil into the open drains should be discouraged and the target should be to reduce this component from 15.8% in 2011 to 0% in 2021.

L) Septage Management

The evacuation of sludge from septic tanks should be institutionalised and its proper disposal should be planned.

M) Sewerage System in Villages

Urban villages should be provided with the facilities equivalent to the towns, within their controlled areas. Large villages may be provided with low cost sewage treatment facilities with appropriate sewerage system. Other rural areas should be provided with low cost sanitation measures such as sanitary toilets and septic tanks. The target should be that all the villages in NCR are provided with appropriate wastewater management system by 2021. Moreover the water supply should be strengthened to support sewerage system.

N) Institutional Reforms

Policy of having dual agencies for construction and operation & maintenance of these facilities in some of the constituent States should be discouraged. To have better environmental management and to avoid over-loading/under-loading of the system and for focused accountability, overall management of sewerage system and surface drains with its effluent treatment facilities should be entrusted to a single agency in a given town.

O) Creation of Mass Awareness

It is imperative to create mass awareness among public through mass media with regard to saving of water, waste minimization and utilization of treated waste water for non-drinking purposes. 'Public Participation and Awareness' programme should be made a mandatory component of each sewerage project and suitable provision of cost for the necessary activities may be made in the DPR.

P) Commercial Approach for Tariff

With the increased requirement of improved quality of life, Government should not be dependent upon to continue with the subsidies for improving the sewerage system in the times to come. Commercial approach should be adopted by the local bodies for revenue generation. Tariff should be fixed so as to meet at least the operation and maintenance cost of the sewerage system. Introduction of sewage tax and improved recovery of taxes may help in reducing the revenue-expenditure gap. Some state government departments/ULBs levy sewage charges as some % of water charges. Such system leave out the private/own water supply consumers although they may be disposing waste in public sewers. Such consumers should be surveyed and charged as per water used by them whether water is supplied by utility or not.

The structure of the sewage tax should be demand based and increased telescopically depending upon the monthly consumption of water and should be reviewed periodically as a built-in mechanism to make the service self-sustaining and a deterrent to wastage.

Q) Norms and Standards

Norms and standards provided in the CPHEEO Manual for sewerage and its treatment, 'Guidelines for Preparation of Project Reports under National River Conservation Plan and National Ganga River Basin Authority', Ministry of Environment and Forest (MoEF), CPCB Standards and relevant Bureau of Indian Standards should be followed while framing the DPRs for sewerage system, sewage treatment facility and recycling infrastructure. Efforts should be made to bring effluent of STP within stringent norms laid down by MoEF vide its order dated 03 February, 2010.

The 'National Urban Sanitation Policy' of MoUD, Govt. of India should be followed while framing the Sewerage DPRs.

R) Institutional Capacity Building

Institutional capacity building measures for management of sewerage system and sewage treatment plants in the towns should be done for efficient operation and maintenance of the system. Simultaneously, it should contribute towards improvement in the self-sustainability of the system.

9.1.6 Funding and Plan of Action

A) Funding of Sewerage and Sewage Treatment Schemes

Presently the utility and service infrastructure in the region is mainly funded by MoUD, MoEF, NCRPB and State Govt. with some share of local bodies.

The share of State Government should be provided in the state plan for NCR Sub-region of the respective States, while the Central Government grant could be a part of the NCR Planning Board's central budgetary provision. The loan component can be met by the NCR Planning Board through its Internal Extra Budgetary Resources (IEBR). Augmentation and upgradation of sewerage schemes/sewage treatment plants in older areas may be financed through this funding. External Development Charges (EDC) / Infrastructure Development Fund (IDF) collected by the development authorities from a town should be invested within the same town in proportion to the population of existing town proposed to be developed.

B) Plan of Action and Phasing of Implementation of Strategies/Policies/Proposals

In order to implement the policies of sewerage system in the region it is imperative to have a plan of action along with phasing so that the implementation of policies and proposals in the Regional Plan can be dovetailed in the State plans.

Industries/hotels/large institutions should be asked to use at least 50% of their waste water in their institutions itself and no fresh water should be allowed to be used for urban agriculture/ agriculture/horticulture purpose in the inhabited areas to promote use of treated waste water. Amendment in Act/statute, if required, should be carried out for the reuse and recycle of wastewater. Improvement/augmentation in the existing sewerage system and construction of sewage treatment plants in the region, should be carried out in a phased manner.

C) Investment Plan

Total estimated sewage generation in the urban areas of the region is estimated to be 6,387 MLD by the year 2021. Accordingly, there will be need to strengthen/expand the sewerage system and its treatment capacities. Total investment required for laying of sewerage system would be Rs.16,191 Crore by the year 2021 and for treatment of waste water, the investment would amount to Rs.2,989 Crore. It is based on the existing situation. Sub-region wise and Plan wise fund requirement for the NCR has been given in Table 9.10 & Table 9.11.

Table 9.10: Sub-Region wise Investment Requirement for Sewerage System (Rs. in Crore)

Sub-region	Gap in Treatment Capacity 2021 MLD	Sewerage System@ Rs. 6.5 Crore per MLD	STP @ Rs.1.2 Crore per MLD	Total Rs in Crore
NCT-Delhi	306	1,991	368	2,359
Haryana	617	4,012	741	4,753
Rajasthan	218	1,415	261	1,676
Uttar Pradesh	1,350	8,772	1,619	10,392
Total	**2,491**	**16,191**	**2,989**	**19,180**

Source: NCRPB

Note: Land Cost has not been considered in the Estimated cost of Sewerage System

Table 9.11: Plan wise Investment Requirement for Sewerage System

Plan Period	Percentage	Amount (Rs. in Crore)
2013-2017	40	7,672
2017-2021	60	11,508
Total	**100**	**19,180**

Source: NCRPB

9.2 SOLID WASTE MANAGEMENT

9.2.1 Background

Solid Waste Management (SWM) is increasingly becoming an important challenge in towns and cities. Over the years the amount of municipal solid waste generated in cities has been increasing due to rapid growth of urban population, improvements in economic conditions, change in lifestyles and consumption patterns. The amount of per capita generation of solid waste in India is estimated to have increased at a rate of 1% - 1.33 % annually[1]. Municipal solid waste is heterogeneous in nature and consists of a number of materials generated by various activities as indicated in Box 9.1.

Box 9.1

On the basis of source and degeneration characteristics solid waste can be classified as follows:

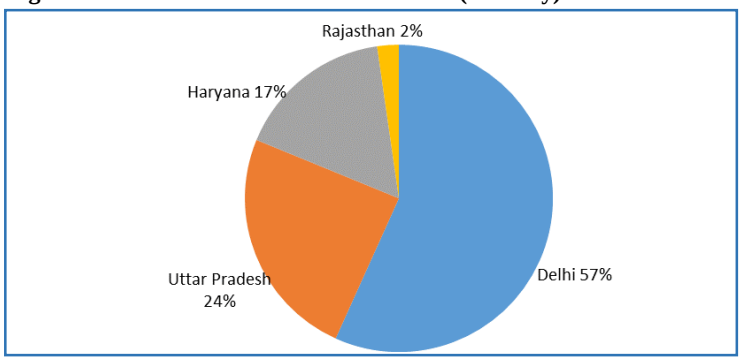
1. **Municipal Solid Waste:** As per the Municipal Solid Waste (Management & Handling) Rules 2000 garbage is defined as MSW which includes commercial and residential waste generated in a municipal or notified areas in either solid or semi-solid form.
2. **E- Waste:** As per the CPCB Guidelines (2008), "e-waste is defined as waste generated from used electronic devices and household appliances which are not fit for their originally intended use and are destined for recovery, recycling and disposal."
3. **Hazardous Waste:** Hazardous waste has been defined in Rule 3 of the Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008 came into force with effect from Sep. 24, 2008, as any waste, which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.
4. **Plastic Waste:** "Plastics are non-biodegradable, synthetic polymers derived primarily from petro-fossil feedstock and made-up of long chain hydrocarbons with additives and can be moulded into finished products CPCB, 2012). In India, approximately 8 Million tonnes plastic products are consumed every year (2008).
5. **Construction and Demolition Waste:** Construction and Demolition waste is generated whenever any construction/demolition activity takes place. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc.
6. **Biomedical Waste**: Bio-Medical Waste is generated during the diagnosis, treatment or immunisation of human beings or animals, or in research activities pertaining thereto, or in the production or testing of biological and including categories mentioned in Schedule-I of the Bio Medical Waste (Management and Handling) Rules 1998.

[1] *NEERI Report: Strategy paper on SWM in India, August 1995.*

9.2.2 Existing Situation

As per the NEERI study, solid waste generated in Indian cities has increased from 6 million tonnes in 1947 to 48 million tonnes in 1997 and is expected to increase to 130 million tonnes per annum by 2021[2] indicating that from 1947 to 1997, generation of solid waste increased by 8 times whereas urban population increased by 3 times.

Figure 9.4: Solid Waste Generation in NCR (MT/Day)



Source: Estimates by NCRPB Planning team based on population as per Census, 2011

As per NCRPB estimates based on population as per Census (2011), 13,199 MT solid waste is generated per day in NCR in the year 2011. Highest amount of solid waste was generated in Delhi i.e. 10,051 MT/day (76%) followed by UP sub-region 1,638 MT/day (12%), Haryana sub-region 1,373 MT/day (10%) and Rajasthan 137 MT/day (1.03%).

The methodology for estimating the MSW is based on the per capita generation of MSW in accordance with the norms prescribed by CPHEEO norms (Table 9.12).

Table 9.12: Solid Waste Generation in NCR

Sub-Region	Solid Waste Generation	
	2011 (in (MT/Day)	Percentage
NCT Delhi	10,051	76
Haryana	1,373	10
Rajasthan	137	1
Uttar Pradesh	1,638	12
Total	**13,199**	**100**

Source: Estimates by NCRPB based on Population based on Census, 2011

At present, there are inadequate numbers of landfill sites for disposal of solid waste generated in entire NCR. The available information on landfill sites in NCR is given in Table 9.13.

Table 9.13: Status of Landfill Sites in NCR

Location of Landfill Sites				
	Delhi	**Haryana**	**Uttar Pradesh**	**Rajasthan**
Existing	Bhalswa	**Village Bandhwari (Gurgaon)	Ghaziabad	Goleta (Alwar)
	Ghazipur	Pali* (Faridabad)	Pilkhuwa-Hapur	
	**Narela Bawana Okhla			
Proposed	Jaitpur	Rohtak	Astauli (Greater Noida), Noida, Loni, Khurja, Dasna,Meerut, Modinagar, Muradabad, Bulandshahr, Jahangirabad, Sikandrabad	Rundh Dhuninath Village
	Bhatti Mines			

Source: Master Plans and the Sub-regional Plans. **TSDF Facility* *** Scientific Engineered Landfill*

[2] *Municipal Solid Waste Management, SOER (2009)*

Most of the above existing landfill sites located in Delhi are brimming with solid waste and have already exhausted their lifespans.

9.2.3 Recycle and Reuse of Solid Waste

The Municipal Corporation/ Municipal Councils and other agencies responsible for managing the solid waste have made some efforts to recycle the waste and also to generate power from the waste. Sub-region wise picture is discussed below:

A) NCT-Delhi Sub-Region: Three Waste to Energy plants have been planned for Delhi at Okhla, Ghazipur & Bawana. These three 'Waste to Energy' plants will reduce the problem of disposal of biodegradable municipal solid waste. Timarpur - Okhla 'Waste to Energy' plant is operational and other two are under installation. Details are as under in Table 9.14.

Table 9.14: Details of Waste to Energy Plants in Delhi

S No	Name	Capacity of Electricity Generated (MW)	Capacity of Waste Processing (MTD)
1	Timarpur-Okhla Waste Processing Company Okhla Compost Site	16	1,300
2	East Delhi Waste Processing Company Pvt. Ltd. Ghazipur	10	1,300
3	Delhi MSW Solutions Ltd. Narela Bawana Road	24	3,000

Source: DPCC website (www.dpcc.delhigovt.nic.in)

A Construction and Demolition waste plant of capacity 500 Metric Tonnes Per Day has been installed by M/s IL&FS and is operational at Jahangirpuri for processing of construction and demolition waste in Delhi. Processed C&D material is used for tiles/pavement blocks and also in ready mix concrete.

Two new compost plants are planned for Delhi i.e. M/s IL&FS compost Plant at Okhla and M/s Delhi MSW Solutions Ltd., Narela Bawana Road of capacity 200 MTD & 1500 MTD respectively. APMC Tikri plant is not operational. Existing compost plant at Bhalswa is operational.

B) Rajasthan Sub-Region: In Rajasthan Sub-region, Awas Vikas Ltd has commissioned a landfill at Goleta and also planned a 25 MT/day compost plant, but yet to be executed. The present waste collected in Alwar city is being dumped in the landfill site at village Agyara. This 11 ha clay lined engineered landfill, situated on a site of 15 ha and is equipped with drains and ponds to collect and treat leachate. Another solid waste disposal site has also been planned at Rundh Dhuninath Village behind Ashok Leyland Ltd at MIA. Earlier, the proposal was to allot approx. 50 ha of land for this purpose. However, at present only 12.5 ha of land has been allotted for this purpose. This site will be used for solid waste disposal for Alwar city as well as bio-medical waste management, treatment and disposal. It is proposed to install a Waste to Energy plant at this site.

C) Uttar Pradesh Sub-Region: In Greater Noida, Greater Noida Authority has identified a land of 126 acre near village Astauli, 30 Km from Greater Noida. To reduce the expenditure on transferring of waste, Refuse Transfer station is proposed to be developed on 2 acre land. This Engineering Sanitary Landfill & Waste Processing Facility will have Material Recovery Facility (MRF) and Compost and Refuse Derived Fuel (RDF) facilities. This project will be operated on the basis of DBOOT (Design, Built, Own, Operate and Transfer) for minimum 25 years.

Noida Authority has identified a new site for establishing Integrated Municipal Solid Waste Treatment and disposal Facility in Sector 123.

D) Haryana Sub-Region: An integrated SWM project for Rohtak Municipal Corporation comprising 175 TPD MSW processing plant and a sanitary landfill is under implementation. Another project at Sonepat for 145 TPD MSW processing facility is under construction. In addition, a project to process 1000 TPD of MSW from Gurgoan and Faridabad cities was set up at Village Bandhwari on Gurgoan-Faridabad highway along with the sanitary landfill facility. MSW processing facilities for Panipat, Bahadurgarh, Hodel, Dharuhera, Ferozpur Jhirka and Farukhnagar are at various stages of planning/ implementation.

9.2.4 Projected Generation of Solid Waste

It is estimated that total solid waste generation in NCR would be 19,238 MT/day by the year 2021 and handling this quantity of waste need special efforts and funds. Sub-region wise details of solid waste generations are given in Table 9.15.

The methodology for estimating the MSW is based on the per capita generation of MSW in accordance with the norms prescribed by CPHEEO Manual on Municipal Solid Waste Management for cities with different population ranges.

Table 9.15: Solid Waste Generation in NCR

Sub-region	Solid Waste Generation	
	2021 (in MT/Day)	Percentage
NCT Delhi	12,158	63
Haryana	2,998	16
Rajasthan	491	03
Uttar Pradesh	3,591	19
Total	**19,238**	**100**

Source: Estimates by NCRPB Planning team based on population projection for 2021

Projections of solid waste generation have been made based on the revised population projections for 18 cities as shown in Table 9.16 below:

Table 9.16: Total Solid Waste Projections based on the Revised Population Projections

Name of Town	Proposed Population 2021 (Lakh)	Per Capita MSW Generation(Kg)	Total MSW Generation (MT/Day) 2021
NCT-Delhi	**202.64**	0.6	**12,158**
Haryana Sub-region			
Bahadurgarh	3	0.21	63
Faridabad-Ballabhgarh complex	25	0.35	875
Gurgaon-Manesar complex	21	0.35	735
Panipat	7	0.25	175
Rohtak	7.44	0.25	186
Palwal	4	0.21	84
Rewari-Dharuhera-Bawal	4	0.21	84
Sonepat-Kundli complex	10	0.27	270
Balance Urban	25.04	0.21	525.84
Sub-total	**106.48**		**2,997.84**
Rajasthan Sub-region			
Alwar	5.35	0.21	112.35
Greater Bhiwadi	8.09	0.21	169.89
SNB complex	5.35	0.25	133.75
Balance Urban	1.25	0.21	75
Sub-total	**20.04**		**490.99**
UP Sub-region			
Ghaziabad-Loni complex	30.19	0.35	1,056.65
Noida	17.4	0.27	469.8
Meerut –Daurala	26.5	0.35	927.5
Hapur-Pilkhua	7.5	0.25	187.5
Greater Noida	12	0.27	324
Bulandshahr-Khurja complex	4.8	0.21	100.8
Baghpat-Baraut	3	0.21	63
Balance Urban	22	0.21	462
Sub-total	**123.39**		**3,591.25**
NCR Urban	**452.55**		**19,238.48**

Source: Estimates by NCRPB based on Population Projection for 2021
**Per capita MSW Generation Estimates are based on CPHEEO Maunal.*

9.2.5 Provision of Landfill Sites in Master Plans: It is imperative that SWM sites are identified and marked in the Master Plans which are statutory documents. An analysis of Master Plans in NCR sub regions reveals the following:

A) Uttar Pradesh Sub-Region: Master plans of 4 towns namely Noida, Ghaziabad, Hapur and Meerut have earmarked sanitary landfill sites in the land use plans. However, in the Master Plans of Bulandshar and Khurja landfill sites are not located. Information on other towns in the sub-regions is not available.

B) Haryana Sub-Region: For Gurgoan and Faridabad, there is no separate landfill site and a common landfill site for both the towns is developed at Village Bandhwari.

In the Master plans of Sonepat, Palwal, Panipat and Bahadurgarh suitable provision for sanitary landfill sites have been made and also indicated in the respective land use plans.

In Rohtak, an area of about 20 hectares has been proposed in the master plan and in Rewari a site measuring 10.61 acres has been earmarked for disposal of solid waste at Village Bhagwanpur which is in the vicinity of the town.

C) Rajasthan Sub-Region: As per the master plan of Alwar, a site has been developed at village Agyara by Awas Vikas Ltd.

D) NCT Delhi: Presently solid waste is being dumped at three landfill sites, namely Bhalswa, Ghazipur and Okhla and three new sites have been identified at Jaitpur, Narela Bawana Road and Bhatti mines. DDA has yet to handover the land for the new sites to the Municipal Corporation.

In NCR, among the 18 metro & regional centres, 16 have earmarked sites for sanitary landfill in their respective master plans as shown in Table 9.17.

Table 9.17: Sites as Per the Master Plans

UP	Site(s) Earmarked	Rajasthan	Site(s) Earmarked	Haryana	Site(s) Earmarked	NCT-Delhi	Site(s) Earmarked
Ghaziabad-Loni complex	√	Alwar	√	Bahadurgarh	√	NCT-Delhi	√ (3 Nos)
Noida	√	Greater Bhiwadi	×	Faridabad-Ballabhgarh complex	√		
Meerut	√	SNB complex	√	Gurgaon-Manesar complex	√		
Hapur-Pilkhua	√			Panipat	√		
Greater Noida	√			Rohtak	√		
Bulandshahr-Khurja	×			Palwal	√		
Baghpat-Baraut	×			Rewari-Dharuhera-Bawal	√		
				Sonepat-Kundli complex	√		

Source: Analysis of Master Plans of NCR Cities

Highlights of the analysis of sub-regional plans, master plans and the zonal plans with regard to the disposal and landfill sites are as follows (Table 9.18).

Table 9.18: Analysis of Landfill Sites in Sub-Regional, Master and Zonal Plans

S.No	Plans	Delhi	Haryana	Uttar Pradesh	Rajasthan
1	**Sub-Regional Plan**	NA	Provision of solid waste not covered	Aspects of SWM partially Covered,	Provision for solid waste sites indicated
2	**Master Plan**	Requirement of SWM sites worked out indicating that location of the same would be shown in the respective zonal plan	Sanitary landfill sites shown in the respective master plans of the towns	Sanitary landfill sites in recent master plans of Noida, Ghaziabad, Hapur and Meerut indicated.	Sanitary landfill sites in the recent master plan of Alwar and SNB complex
3	**Zonal Plan**	As per requirement of the master plan out of 15 zonal plans, in 6 zonal plans landfill sites indicated, but not shown in the land use plans	NA	NA	NA

Source: Sub-Regional Plans, Master Plans and Zonal Plans

9.2.6 Issues in SWM:

A) Land Disposal Sites yet to be Developed Scientifically

Out of the 18 metro & regional centres in NCR, only 16 towns have earmarked sites for landfill in their respective land use plans but the same are yet to be developed on scientific lines. Presently, only one sanitary landfill site at Village Bandhwari (Gurgoan) and a TSDF site at Pali Faridabad is operational. In Delhi, Narela-Bawana is the only scientific engineered sanitary landfill, while other sites are primarily disposal sites. The location of landfill sites indicated in the master plans are required to be vetted as per the provision of MSW Management and Handling Rules, 2000.

B) Lack of Public Awareness and Need for Capacity Building

Awareness needs to be created regarding the dangers of unscientific solid waste management e.g health hazards, aesthetic damage and environmental issues. In this context, NGOs have taken up pilot projects in NCT-Delhi, Ghaziabad and Gurgoan for creating public awareness on the SWM issues which need to be emulated for wider awareness generation.

C) Inadequate Resources

While allocating resources, SWM gets low priority resulting in inadequate provision of funds, especially with regard to the O & M costs. It is observed that even O & M cost in solid waste management is not recovered fully.

D) Segregation of Waste at Source

Segregation of waste is a major problem in the NCR region. Due to lack of segregation of waste at source, most of the waste is dumped at landfill site which leads to spilling over of capacity of the existing sites.

E) Piecemeal Approach for Handling of Solid Waste

As per the CPCB report, in Delhi total quantity of waste generation is 7,384 MT/day (upto 31st July 2012) of which 6,796 MT/day is collected and 1,927 MT/day is treated[3]. Thus, only 26% of the total waste generated is treated. There is a need to have an integrated SWM plan for each town. As per the CPCB study the quantity of SWM is even larger and treatment gap will be even wider.

9.2.7 Policies and Proposals

In order to improve the overall situation in SWM in the National Capital Region following policies and strategies are suggested:

A) Preparation of Detailed Solid Waste Management Plan

All the towns in NCR should prepare a Solid Waste Management Plan on the basis of guidelines provided by the CPHEEO Manual for the solid waste management. It would be appropriate that the local bodies

[3] *CPCB: Status report on MSW,2007*

plan for the entire city indicating landfill sites in a decentralize manner for reducing the transportation cost and also for reducing carbon footprints. In UP Sub-Region, Greater Noida has prepared the Solid Waste Management Plan. Haryana is in the process of preparing SWM plans for its towns. Other towns may follow the pattern developed by Greater Noida.

B) Norms and Standards

Norms and standards provided in the CPHEEO Manual for solid waste management in terms of collection, transfer, transport and disposal may be followed by the constituent states while preparing the plans for handling the solid waste. In this regard, the notification of the Ministry of Environment and Forests under the Environmental Protection Act, 1986 should also be followed. In addition to the above norms and standards, there are Management and Handling Rules for each type of waste such as municipal solid waste, e-waste, hazardous waste, biomedical waste, plastic waste, construction and demolition waste. These regulations need to be complied and followed by the local bodies.

C) Identification of Land for Treatment/Disposal of Waste

While preparing the Master/Development Plan for various towns/cities, plans should earmark the land for treatment/disposal of solid waste. The acquisition of these sites, by the development authorities and municipalities, should form a compulsory element of the development programme and properly budgeted in their plan documents. A case for land requirement worked out by NCRPB in respect of Delhi may be referred. In NCT-Delhi, the land is scarce. Plan for solid waste management should consider this so as to utilize the land judiciously. It is estimated that in Delhi the quantum of solid waste per day would be 12,158 MT/day by the year 2021. Based on norms and standard about 11.74 sq. kms of land for disposal of solid waste through sanitary land filling will be required assuming that the depths of landfill will be 20 metres (4m below ground and 16m above ground), density of solid waste is 0.475 MT per cubic metre, life cycle of landfill site is 20 years and there are three landfill sites. Details of various options examined are in Annexure 9/IV.

The area required for solid waste disposal through various technologies including sanitary landfill sites should be reserved in the Zonal Plans. This should also include buffer zone of 'no development' around landfill sites. Keeping in view the fact that finding new sanitary landfill sites in Delhi is becoming extremely difficult, there is no option, but to resort to alternative and decentralized methods of waste treatment, reduction, recycle and reuse, which include vermin-culture, fossilization and composting. Pilot projects in this regard have been taken up by the MCD with the consultants.

D) Waste Minimization-Recycling/Recovery of Resources

In view of the limited availability of land for use as landfill sites, there is an urgent need to find other mechanical means of minimizing waste requiring disposal. In fact, we should aim at zero waste output. The practices of 4 R's i.e. Reduce, Reuse, Recycle and Recover should be adopted as a policy at the regional, sub-regional and the local body levels. The prevalent system of recycling/recovery of plastic, glass, metal, paper, etc. from the domestic waste is completely informal/unorganized. This should be done in more organized, scientific, cost effective and environmental friendly manner. The segregation of biodegradable waste from non-biodegradable waste such as plastics, glass, metal, paper etc. at the source should be made compulsory in all towns/cities. Closed bins and covered transportation vehicles should be adopted for collection and transportation of solid waste. The SWM system should be so designed such that not more than 20-25% of the MSW generated should be disposed off through sanitary landfill.

E) Public Awareness and Training

There is a need to create public awareness through mass media including television and newspapers regarding the harmful affects of littering and propagating measures to improve the overall sanitation in the surrounding areas. The informal training along with broad-based formal awareness through schools educational curriculum is also recommended. NGOs and Resident Welfare Associations (RWAs) should be actively involved in the public awareness campaigns.

F) Institutional Improvements and Resource Mobilization

Institutional capacity building measures are required to be taken in order to improve the efficiency and effectiveness of solid waste management at each stage such as waste collection, transfer/transportation,

treatment and disposal. There is a need to associate NGOs/private sector in this regard. This can be ideally achieved through the PPP mechanism. Local bodies should improve their financial conditions through better management and improvement in the revenue generation capacities. NGOs and private sectors in collection and disposal of solid waste management as well as in recycling process may be involved as is being followed in PPP mode for disposal of waste at the landfill site viz Bhandhwari (Haryana), Okhla, Narela-Bawana, Bhalaswa, Ghazipur (Delhi).

G) Cluster Approach

The smaller cities located in close proximity in the region, could follow a cluster approach for a more effective SWM by implementing common processing facility as well as common sanitary landfill. Three to four adjoining cities could have such common facility at a centralized location which would result in better utilization of resources as well as economies of scale while complying with the MSW Management & Handling Rules (2000). A similar project has been implemented at Village Bandhwari as a common site for Gurgaon- Faridabad.

H) Inclusion of Informal Sector in the SWM Planning Process

The informal sector consisting of rag pickers, door to door collectors, Kabariwallas, etc. play a vital role in the SWM process by substantially reducing the quantum of waste being transported for processing and land filling. The SWM plans should duly recognize their role and treat them as an integral part of the system. This is also included in the National Sanitation Policy, prepared by MoUD, GoI.

I) Service Level Benchmark

A service level benchmark has been developed and released by the MoUD, which seeks to identify a minimum set of standard performance parameters for the sanitation sector that are commonly understood and used by all stakeholders across the country. The local bodies need to make efforts to attain the benchmarks for the 8 SWM indicators (www.urbanindia.nic.in).

J) Provision in Bye-laws

Proper location of sites for SWM in Master plans, Zonal plans and Sub-regional plans should be earmarked and provision for the same may be made in the planning legislation, zoning regulation in building bye –law indicating requirement of area and other provisions for refuse storage.

K) Appropriate Technology

The equipment and machinery presently used in the system are usually those which have been developed for general purpose or those which have been adopted from other industries. This results in underutilization of existing resources and reduced efficiency in collection. A few attempts have been made to adopt the technology from developed countries like highly mechanized compost plants, incinerator-cum-power plants, compactor vehicles etc. However, these attempts have met with little success, since, the solid waste characteristics and local conditions in India are much different from those from where the technology is adopted. For example, a case in Timarpur WTE plant which was put up in late 1990s in Delhi and had to close down because of the incorrect waste characterization and inappropriate technology selected for the project.

L) Decentralized Waste Management

Decentralized Solid Waste Management Systems (DSWMS) needs to be implemented as a strategy, which aims at providing solutions to a large number of problems and issues mentioned above. This strategy endeavors to bring together various stakeholders for achieving sustainable, environment friendly and economically viable solutions whereby the citizens gradually begin to look at wastes as a resource rather than refuse. For example, a DSWMS was launched in 2009 at Rashtrapati Bhawan by the residents of President Estate. The door-to-door collection of waste was done from the households but segregation of waste was not happening in the Estate. The total collected waste from the households as well as the canteen was being disposed of in the landfill sites by NDMC (New Delhi Municipal Corporation). With the concept of the ‘Zero Waste Management’ i.e., total waste except inert waste should be managed with in the estate with an active participation of the residents, the community based composting was initiated.

9.2.7 Investment Plan

Total solid waste generation in the urban areas of the region would be about 19,238 MT/day by the year 2021 and accordingly, there will be need to develop appropriate system for collection, transportation and disposal of solid waste in environmental friendly manner either through properly designed sanitary land filling or through other treatment methods. Total investment required for this would be about Rs.961 Crore by 2021. Sub-region wise and Plan wise fund requirement for the region is given in Table 9.19.

Table 9.19: Sub-Region wise Investment Required in Urban Areas for SWM

Sub-region	Investment Required @ Rs. 0.05 Crore Per MT* (Rs. in Crore)
NCT Delhi	607.8
Haryana	149.9
Rajasthan	24.5
Uttar Pradesh	179.6
Total	**961.8**

Source: NCRPB **RP-2021*

Assuming investment at the rate of Rs. 5 Lakh Per MT, total fund requirement within NCR is estimated to be Rs.961 Crore. Sub region wise it will be Rs.150 Crore in Haryana, Rs.25 Crore in Rajasthan and Rs.180 Crore in Uttar Pradesh while NCT-Delhi would requires Rs.608 Crore excluding the cost of land.

Table 9.20: Plan wise Investment Required for SWM

Plan Period	Percentage	Amount (Rs. in Crore)
2013-2017	40	384
2018-2021	60	577

Source: NCRPB

Plan wise investment requirement of fund is estimated at Rs. 384 Crore in the 12th Plan and 577 Crore in the 13th Plan (Table 9.20).

9.3 DRAINAGE

9.3.1 Background

Drainage is an important element of physical infrastructure and constitutes removal and disposal of surplus rain/irrigation water from the land. It has two aspects namely flood protection and removal of storm water. National Capital Region in general, is a part of well integrated drainage system of the Ganga basin. The extremely gentle gradient prevalent almost all over the region restricts the degradation activities of the streams/drains. The storm water discharge in any basin/sub-basin of NCR is not local but has regional bearing covering areas of Haryana, Rajasthan, Uttar Pradesh and NCT of Delhi. It is, therefore, necessary to plan the drainage system at regional level in an integrated manner with adjoining States. Topography, rainfall intensity, soil characteristics, irrigation methods, crops and vegetation cover are important factors for deciding the type and design of drainage system. Since urban expansion is inevitable, increased run off would require remodeling of the existing drains as well as provisions of new/supplementary drains, implementation of appropriate flood protection measures, protection of natural drainage course, improved ground water recharge, and other environmental improvement measures such as prevention of sewer flows into the storm drains, pollution of river Yamuna etc. Provision of appropriate drainage in marginal settlements consisting of JJ clusters, resettlement colonies, informal/unauthorized colonies, etc, also requires due attention.

Regional Plan-2001 proposed that open drains, which are by and large the sources of nuisance and pollution, should be discouraged and discontinued. Major drains should be covered but are generally found open and road side smaller drains are also sometimes found open. Some of the towns have combined system of disposal for sewage and storm water. However generally it is not designed as such but by default in absence of sewerage system, the drains actually act as combined system both for sewage and drainage. The disposal of storm water is generally not planned properly and takes natural course on land, depressions, ponds etc. Separate systems for sewage and storm water disposal are recommended in NCR.

9.3.2 Existing Situation and Issues

Studies have revealed that there is lack of integrated planning in the drainage for storm water which is not local but has got regional bearing covering areas in Haryana, Rajasthan, U.P. and NCT-Delhi Sub-regions. Untreated sewage continues to flow in most of the drains in the region and ultimately falls into the rivers Ganga and Yamuna. Encroachment by slums along the drains cause choking of drains and flooding in the upstream areas due to reduced carrying capacity. Dumping of solid waste in the drains also causes blockage. Drainage Master Plans have not been prepared district wise and city wise. Ideally, the hydraulic survey should be carried out regularly to assess the conditions of the drains.

Lack of Regional Approach

There is a need to adopt integrated regional approach for drainage planning. Each major drainage system under basins/sub-basins of NCR at micro level should be critically examined by each constituent State Government to assess the deficiencies in planning, design, maintenance and to suggest remedial measures including remodeling/improvement work wherever necessary.

9.3.3 Policies and Proposals

In order to improve the regional and local drainage system in NCR, following strategies and policies are proposed:

A) Regional Approach to Drainage

Integrated Regional Drainage Plan at the regional level and sub-regional level; Drainage Master Plans at the district level and city level should be prepared after critically examining each major drainage system under basins/sub-basins of NCR at micro level by the State Governments and ULBs incorporating the improvement proposals for enhancing the quality of Sub-regional and local drains taking into account the present/future development and settlement pattern in the region. The area drainage plan should be considered as an integrated part of the Master Plan of the area and this drainage plan should take into account the land development planning for the region. There is a need to conceptualize a drainage system before any area development programme is taken up. No area development project/new town/colonies/industrial complex should be sanctioned/allowed to be started or implemented unless integrated drainage plan is conceptualized and cleared by the designated authority. All developments in controlled areas falling in dark and over exploited block declared or to be declared in future by CGWB should aim towards zero run off within the controlled areas. The ponds/lakes/wetlands (existing and proposed), bunds/check dams etc. should be developed/protected to increase the run off time of storm water in order to help in ground water recharging.

B) Norms and Standards

The urban drainage system should be designed as per norms and standards stipulated in CPHEEO manual for Sewerage for internal as well as peripheral drains. The likely time of concentration for each case may be worked out and corresponding storm values adopted.

i. The rural drainage system may be designed for three days rainfall of five years frequency to be drained in three days. An appropriate area dispersal factor should be adopted for computing the run off.
ii. The coefficient of run off may be calculated for areas with composite land use pattern on the basis of anticipated land use in the new areas and existing land use pattern for the areas already developed.
iii. Where it is not possible to work out the run off coefficient due to land use policies not indicated, run off coefficient not less than 0.2 may be adopted for rural areas with flat to moderate slopes and 0.4 for steeper slopes. For urban area, run off coefficient not less than 0.6 may be adopted in absence of adequate details of the areas.

C) Prevention of Storm Water Drains from Pollution

Measures should be taken to prevent the use of storm water drains for conveying sewage and dumping of solid wastes and sludge in open drains. Enforcement should be done under the Environment Protection Act, 1986. Unauthorized development/encroachment/slum dwellings in the drainage system should be prohibited.

D) Irrigation Water

Where irrigation canal escapes including the tail escapes outfall into the drains or in the neighbouring ponds, provision for efficient draining of surplus irrigation water by enhancing their capacity should be made while planning for improvement in the integrated Regional Drainage System.

E) Provision of Funds

Provision of adequate funds should be made for upgradation and regular maintenance of the drains on the same lines as for the irrigation channels.

F) Avoid Piecemeal Approach

In cities sometimes drains are constructed to drain water from some road/locality without considering final disposal of storm water. This only leads to a shift of the problem. As such first master plan of drain should be prepared and only then drains should be provided so as to integrate with master plan proposals.

G) Other Measures

i. Drainage system which requires pumping should be avoided as far as possible
ii. Planning of drainage system should be based on the concept of retention of rain water where it is received as much as possible, by ponding, retardation dams, grass waterways, pavements with interspaces, rain water harvesting structures, etc.
iii. Follow the principle that the drains should carry only rain water.
iv. Develop land around drain as public recreation place.
v. Protect drainage area from pollution
vi. The operation and maintenance of drains should be done regularly and properly. The growth of grass and plants need to be removed to maintain the carrying capacity of the channels.
vii. The drains have become dumping grounds of solid waste and carriers of sewage due to absence of Solid Waste Management and absence of sewerage system in the cities. This is blocking drains, reducing flow capacity and making drains to emanate foul smell. The natural gravity flows are restricted and require O & M at high cost in removal of debris and silt deposits. As such cities should be covered with solid waste management system and sewerage system to make drainage system effective and functional.
viii. Industrial waste disposal in drains to be stopped.

9.3.4 Plan of Action and Phasing of Implementation of Strategies/Policies/Proposals

In order to implement the policies of drainage in the region, it is imperative to have a phase wise plan of action so that the implementation of policies and proposals in the Regional Plan can be dovetailed with the five-year plans. In view of this, each recommendation has been phased plan-wise where certain activities are to be completed within first five-year of the implementation of the Regional Plan whereas some activities will span over to all the four five-year plans.

Some of the activities which need to be implemented include preparation of Integrated Regional Drainage Plan at the regional level and Drainage Master Plans at the District level to manage regional and local drains, avert mixing of sewage and solid waste in storm water drains, creation of mass awareness, waste minimization through recycling of waste, regular maintenance and upgradation of drains etc. Investment requirement in this sector will depend upon the District Level drainage Master Plans to be prepared by the respective State Governments and the Integrated Regional Drainage Plan, therefore, Investment Plan cannot be proposed in the Regional Plan. Provisions for fund requirement will have to be made by the constituent State Governments in their five-year plans on the basis of District level Drainage Master Plans.

9.4 IRRIGATION

9.4.1 Background

Water requirement for irrigation is closely related to population, demand for food, production of non-food agricultural and industrial items, improvement in quality of life and preservation of ecology and environment.

9.4.2 Issues

Studies have revealed that the requirement of water for irrigation in the region cannot be seen in isolation. The demand for drinking water and industrial use have also to be considered.

A) Insufficient Water Sources in the Region

The present surface water resources of the NCR are insufficient to meet the requirement of the various sectors. A holistic view of water requirements should be taken including the demand for the drinking water supply, industrial use and irrigation assigning priority to drinking water and industrial use.

Drinking water requirement for the entire NCR in the year 2001 was 6,330 MLD (6.33 MCM/day or 2,310 MCM/annum) and the projections for the year 2021 are 8,620 MLD (8.6 MCM/day or 3,147 MCM/annum). The estimated annual water demand of NCR in the year 2021 for drinking water, industry and agriculture is projected to be 23,435 MCM as mentioned below:

Drinking Water	3,178 MCM/annum
Industrial use	1,996 MCM/annum
Irrigation	18,292 MCM/annum
Total Demand	23,466 MCM/annum

This water requirement cannot be met from river Yamuna alone. The average annual water availability of river Yamuna up to Delhi has been assessed at 12,000 MCM. The Ganga basin is also water deficit up to Allahabad. Present canal system of Yamuna, Ganga and Bhakra Beas meet the surface water demand of NCR and NCT-Delhi. The MOU signed on 12th May 1994 by the Chief Ministers of the Co-basin States provides annual allocation of 5,730 MCM to Haryana, 1,119 MCM to Rajasthan, 4,032 MCM to U.P., 378 MCM to Himachal Pradesh and 724 MCM to NCT-Delhi. The agreement takes care of the irrigation and consumptive drinking water needs of all Co-basin States. The MOU also provides for separate agreement to be executed in respect of each storage identified in the Upper Yamuna river basin within the overall allocation made under the agreement. A part of the demand is also met from ground water. However, entire NCR has been witnessing decline in ground water levels. A more detailed analysis of ground water availability and decline in water levels are given in Regional Plan chapter on Environment and Water.

B) Lack of Ground Water Recharging Resulting in the Depletion of Ground Water

The rate of development of the groundwater resources is unsustainable with most districts of the NCR that are sliding into the dark zone category as discussed in previous paragraph. This is due to lack of ground water recharging, higher rate of withdrawal; fast pace of urbanization and reduction in run off time for rainwater. Thus, recharge of groundwater is a priority.

C) Sources Outside the Region

Planning and development in NCR, for the existing situation, is based upon the assurance of water supply from the three proposed dams in the Himalayas, for augmenting surface flow. The infrastructure work on these dams is held up for want of clearances. Even if the construction is initiated immediately, these dams would not be ready for use for next 10-15 years, thus jeopardizing the NCR Plan.

9.4.3 Policies and Proposals

The direction of growth in the National Capital Region will depend on the availability of water resources. Demand-supply gap of water is one of the key elements for the growth of the region, which needs to be bridged through various policy interventions and demand management. Following policies are proposed:

A) Regional and Integrated Approach

Integrated Water Resource Management Approach for the region is required for optimum water resources utilization and demand management including the demand for irrigation, drinking water and industry. In order to meet the demand of water in the region for various uses such as irrigation, drinking and industry, the region is dependent upon various multi-purpose River Valley/Dam Projects where large storages can be created and long distance transfer of water is done through canals. While the priority should be given to the drinking water and industrial water demand in the region, the allocation of water for agricultural purposes should also not be discarded. Overall demand of the region should be considered by the Ministry of Water Resources, riparian States and constituent States while signing the MOU for water sharing in

consultation with Ministry of Urban Development. While preparing an overall Integrated Water Resource Management Plan in the Sub-regions, the requirement of water for various purposes, treated sewage effluent and storm water collected through various rainwater harvesting methods should be considered. This should also be incorporated by the States in their Master/Development Plans.

B) Resources Augmentation, Demand Management and Efficiency in the Use of Water

With the scarcity of available water, alternative could be proper demand management and efficiency in use of water. It is expected that by the year 2021, there will be additional requirement of 17,394 MCM per annum (assuming that only 50% of water from river Yamuna will be made available for NCR out of 12,000 MCM per annum), for which additional water resource has to be created/augmented/existing resource has to be properly managed. Since augmentation of water resources through large dams on the Yamuna and Ganga are likely to take time, as envisaged in the earlier plans, it would be necessary to increase the availability of water by adopting following means:

i. Artificial Recharging and Ground Water Harvesting:

   a) Artificial recharge through rainwater harvesting in ponds, Yamuna flood plains, paleo-channels, ox-bow channels, construction of small check dams at favourable locations in part of the Ridge for recharge, etc.

   b) Utilizing surplus canal water during monsoon period for recharging the depleted aquifers.

   c) Roof-top rainwater harvesting should be made mandatory in building bye-laws especially in the over exploited and dark Blocks i.e., the areas with unsustainable ground water resources as identified by Central Ground Water Board.

ii) Demand Management of Water:

   a) It is expected that the treated waste water from sewerage system in the region would be around 1,824 MCM per annum which must be put for agricultural/non-potable use to reduce the overall demand for water for irrigation purposes.

   b) It is expected that water requirement for industrial purposes by the year 2021 in the region would be 1,996 MCM per annum, therefore, it is recommended that water based industries should not be allowed in the region.

   c) Drip Irrigation method should be promoted in the region to save water from irrigation sector. Even if 25% of the water is saved, it would amount to saving of 4,500 MCM per annum.

   d) Decentralization of authority, responsibility and technical units along with community awareness, participation and monitoring of various aspects is a must for any successful water resource management system.

9.4.4 Plan of Action and Phasing of Implementation of Strategies/Policies/Proposals

In order to implement the policies of irrigation in the region, it is imperative to have a phase wise plan of action so that the implementation of policies and proposals in the Regional Plan can be dovetailed in the five-year plans. In view of this, each recommendation has been phased plan-wise where certain activities are to be completed within first five-year of the implementation of the Regional Plan whereas some activities will span over to all the four five-year plans.

All the policies need to be implemented immediately. These include Integrated Water Resource Management Approach for the region for optimum water resources utilization and demand management, augmentation of water resources by adopting rainwater harvesting (micro and macro) and recycling/reuse of treated waste water, adopting sprinkler/drip irrigation. Investment Plan cannot be prepared at this stage because it needs micro level planning at the town/district level. Investment Plan will have to be prepared by the constituent State Governments at Sub-regional level.

Annexure 9/I: Town wise Coverage with Sewer Network

Sub-Region	Town	Population		Population Covered		Percentage	
		2001	2011	2001	2011	2001	2011
NCT	**Total Urban**		**16,334,000**	**8,388,757**	**8,983,700**	**65**	**55**
Haryana	Panipat	3,54,148	4,42,000	1,77,074	4,06,640	50	92
	Samalkha	29,886	41,096	17,920	28,767	60	70
	Sonepat	2,25,074	3,07,000	90,030	2,45,600	40	80
	Gohana	48,532	66,780	12,133	46,746	25	70
	Ganaur	29,006	39,912	11,602	31,930	40	80
	Kharkoda	18,763	25,818	0	21,945	0	85
	Rohtak	2,94,577	3,73,000	1,91,475	3,35,700	65	90
	Maham	18,174	25,007	0	20,006	0	80
	Kalanaur	16,853	23,190	0	20,407	0	88
	Bahadurgarh	1,31,925	1,81,529	79,155	1,54,299	60	85
	Jhajjar	39,002	53,667	25,351	40,250	65	75
	Beri	16,162	22,239	0	17,791	0	80
	Palwal	1,00,722	1,31,000	60,433	1,04,800	60	80
	Hodal	38,309	52,713	0	39,535	0	75
	Gurgaon	2,28,820	9,02,000	1,37,292	7,12,580	60	79
	Sohana	27,570	37,936	16,542	29,211	60	77
	Firozpur	17,755	24,431	0	8,551	0	35
	Hailey mandi	17,081	23,503	12,811	9,871	75	42
	Nuh	11,039	15,190	3,312	9,418	30	62
	Rewari	1,00,684	1,38,541	70,479	1,10,833	70	80
	Bawal	12,144	16,710	0	13,368	0	80
	Punhana	13,179	18,134	0	0	0	0
	Pataudi	16,085	22,133	0	0	0	0
	Faridabad	10,55,938	1,405,000	6,86,360	9,83,500	65	70
	Balance	1,03,270	3,66,470	0	0	0	0
	Total Urban	**29,64,678**	**4,755,000**	**1,591,968**	**3,391,748**		
Rajasthan	Alwar	2,66,203	3,41,000	13,310	34,100	5	10
	Greater	33,877	1,05,000	1,016	42,000	3	40
	Balance	1,34,859	2,08,000	0	0	0	0
	Total Urban	**434939**	**6,54,000**	**14,326**	**76,100**		
Uttar Pradesh	Meerut	11,61,716	1,450,000	3,48,515	4,49,500	30	31
	Ghaziabad	10,89,201	2,148,000	7,62,441	1,288,800	70	60
	Noida	3,05,058	6,42,000	0	4,62,240	0	72
	Greater Noida	30,000	1,08,000	0	85,320	0	79
	Bulandshahr	1,76,425	3,78,000	0	0	0	
	Garmukteswar	33,847	46,573	0	0	0	
	Balance	18,52,277	23,20,000	0	0	0	0
	Total Urban	**4,614,677**	**7,046,000**	**1,110,956**	**2,285,860**		

Annexure 9/II

Treatment Capacity and Interception capacity

Sub Region	Urban Population			Generation MLD			Treatment capacity MLD		Sewage Treated MLD		Gaps in Treatment Capacity		Gaps in Sewage Treatment				
	2001	2011	2021	2001	2011	2021	2001	2011	2001	2011	2001	2011	2001	2011	Plants u/c	Gap 2021with respect to installed capacity	Gap 2021with respect to treatment
Delhi	12905780	16334000	16334000	2540	2996	3275	1828	2475	1500	1589	712	521	1040	1407	564	306	1122
Haryana	2964678	4755000	10648000	374	599	1342	235.5	405.5	164.46	199	138	194	209	400	461	617	681
Rajasthan	434939	654000	2004000	46.97	70.63	216.43	0	24	0	10	47	47	47	61	25	218	181
UP	4614677	7046000	12339000	599.91	861.84	1555	129	444.6	30	450	471	417	570	412	72	1350	1033
NCR Urban	**20920074**	**28789000**	**45255000**	**3560**	**4528**	**6387**	**2193**	**3349**	**1694**	**2248**	**1368**	**1179**	**1866**	**2280**	**1122**	**2491**	**3017**

Note:

- Delhi: 2001 generation is as per RP, 2011 generation is as per DJB letter, 2021 is estimated at 202 LPCD water supply
- Haryana: water supply at 180 LPCD for cities more than 1000000 & 135 LPCD for other cities for 2001,2011,2021=126 LPCD
- Rajasthan: water supply at 180 LPCD for cities more than 1000000 & 135 LPCD for other cities for 2001,2011,2021=135 LPCD
- Uttar Pradesh: water supply at 180 LPCD for cities more than 1000000 & 135 LPCD for other cities

Annexure 9/III: Sub-Region wise Availability of Toilet Facility in NCR

Sub-Region	Total/ Rural/ Urban	Percentage of Households having Toilet Facility within Premises	Percentage Flush/Pour Flush Toilet connected to				Night Soil Disposed into Open Drain in Percentage	Service Toilets in Percentage
			Piped Sewer System	Septic Tank	Other System	Pit Toilet		
Haryana	Total	69.0	39.1	42.0	3.2	14.2	1.2	0.7
	Rural	50.3	5.2	63.5	5.9	24.6	0.5	0.9
	Urban	90.2	60.4	28.5	1.5	7.7	1.5	0.6
Rajasthan	Total	27.5	12.3	72.3	4.7	9.7	0.7	0.0
	Rural	14.8	8.7	65.4	8.5	16.2	0.7	0.1
	Urban	79.3	15.0	77.5	1.9	4.8	0.7	0.0
Uttar Pradesh	Total	70.3	29.1	59.0	2.7	4.8	2.3	2.1
	Rural	47.9	9.2	72.7	3.9	9.0	0.9	4.3
	Urban	92.4	39.2	52.1	2.1	2.7	3.0	1.0
NCT-Delhi	Total	89.5	66.2	28.4	1.0	2.0	2.3	0.0
	Rural	76.3	13.7	76.8	1.3	6.8	1.3	0.1
	Urban	89.8	67.3	27.5	1.0	1.9	2.3	0.0
NCR	Total	74.3	48.0	41.5	2.1	5.7	2.0	0.8
	Rural	43.9	7.7	68.6	4.9	15.8	0.8	2.5
	Urban	90.3	58.3	34.5	1.4	3.1	2.3	0.4
India	Total	46.9	25.5	47.3	4.9	20.1	1.1	1.1
	Rural	30.7	7.2	47.8	8.2	34.3	0.7	1.8
	Urban	81.4	40.2	46.9	2.1	8.7	1.5	0.6

Source: Census of India 2011.

Annexure 9/IV: Land Requirement for Sanitary Landfill in NCT Delhi upto Year 2051

S.No	Particulars	2001-2021	2022-2035	2036-2051
a)	Generation of Wastes			
i)	Per Capita Waste Generation Per Day	600 grams	600 grams	600 grams
ii)	Projected Population	2021: 202.64 lakhs	2035: 262.66 lakhs	2051: 339.31 lakhs
iii)	Waste Generation (Beginning of block year)	8,280 MT/Day	12,158 MT/Day	15,733 MT/Day
iv)	Waste Generation (End of the block year)	12,158 MT/Day	15,733 MT/Day	20,358 MT/Day
b)	Assuming life of sanitary landfill	20 Years	20 Years	20 Years
c)	Total Waste Generated	74.6 x 10^6 MT	101.80 x 10^6 MT	131.73 x 10^6 MT
d)	Assuming 25% of the total waste generated is going to sanitary landfill	18.65 x 10^6 MT	25.45 x 10^6 MT	32.93 x 10^6 MT
e)	Total Waste Volume (assumed density 0.475 MT/m^3)	39.26 x 10^6 m^3	53.58 x 10^6 m^3	69.33 x 10^6 m^3
f)	Volume of Daily Cover	3.93 x 10^6 m^3	5.36 x 10^6 m^3	6.93 x 10^6 m^3
g)	Volume of Liner and Cover System	4.91 x 10^6 m^3	6.70 x 10^6 m^3	8.67 x 10^6 m^3
h)	First Estimate of Volume requirement of waste, liner and cover system (e)+(f)+(g)	48.10 x 10^6 m^3	65.64 x 10^6 m^3	84.93 x 10^6 m^3
i)	Likely shape of landfill (partly below and partly above the ground)	Rectangular in Plan Length:Width = 2:1	Rectangular in Plan Length:Width = 2:1	Rectangular in Plan Length:Width = 2:1
j)	Area restriction	Nil	Nil	Nil
k)	Possible maximum height	20 m (16 m above ground and 4 m below ground)	20 m (16 m above ground and 4 m below ground)	20 m (16 m above ground and 4 m below ground)
l)	Area Required	2.40 sq.km	3.28 sq.km	4.25 sq.km
m)	Area will be	0.80 sq.km (Assuming 3 different locations) = 1,257 x 628 m	1.09 sq.km (Assuming 3 different locations) = 1,479 x 740 m	1.42 sq.km (Assuming 3 different locations) = 1,683 x 841 m
n)	Additional 30 m land will be required around the landfill to place the equipments around the landfill			
o)	As per schedule III, para 10 of Notification No.583 dated 27.09.1999 of MoEF, a 500 m wide buffer zone of no development be maintained around landfill site and shall be incorporated in the Town Planning Departments Land Use Plans			
p)	Approximate dimensions of each site incorporating (n) & (o)	2,317 x 1,688 m	2,539 x 1,800 m	2,743 x 1,901 m
q)	Total area required for sanitary landfill site for NCT-Delhi upto the year 2021	11.74 sq.km	13.71 sq.km	15.64 sq.km
	Assumptions: 1. Land requirement for disposal of solid waste, which will be generated in NCT Delhi upto the year 2051 through sanitary landfilling assuming 25% disposal through landfill. 2. Actual decadal growth rate for Delhi population was 21% as per Census and subsequent population growth rate have been taken in line with population projection as per NCRPB			