CITY SANITATION PLAN FOR NELLORE

Nellore City Map

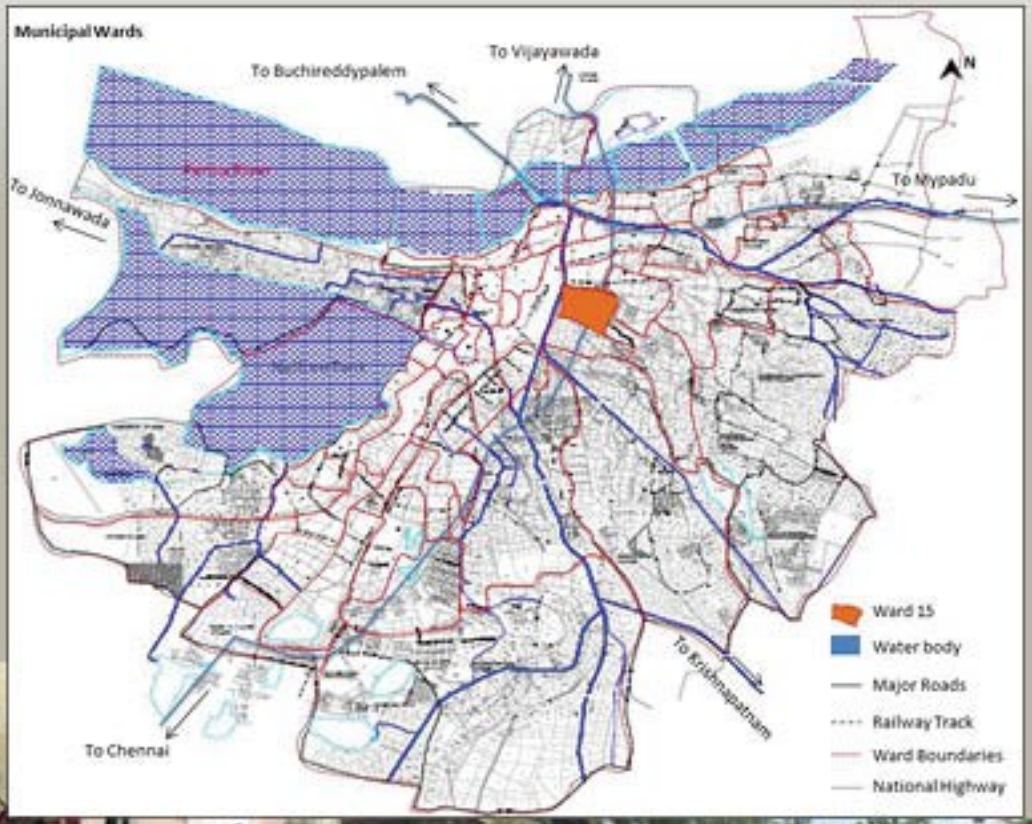


TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS:

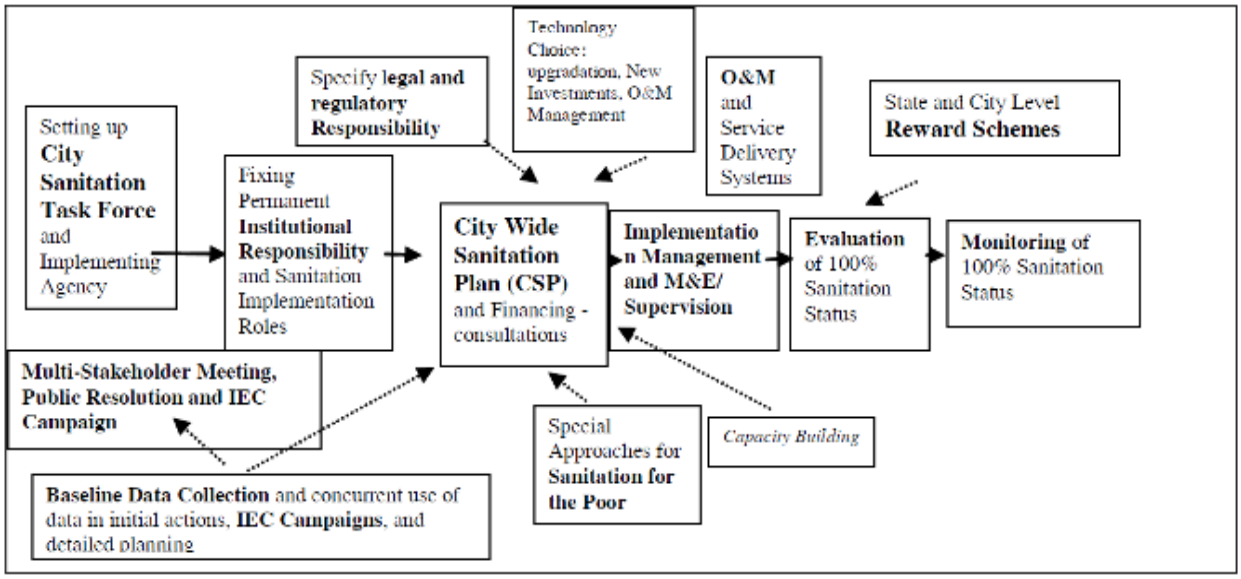
AMRUT	Atal Mission for Rejuvenation and Urban Transport
APMDP	Andhra Pradesh Municipal Development Project
APSRTC	Andhra Pradesh State Road Transport Corporation
ASP	Activated Sludge Process
BOST	Build Operate Share Transfer
BOT	Build Operate Transfer
CBO	Community Based Organisation
CBSE	Central Board of Secondary Education
CLTS	Community Led Total Sanitation
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSP	City Sanitation Plan
CSR	Corporate Social Responsibility
CSTF	City Sanitation Task Force
DeWATS	Decentralized Wastewater Treatment System
DPR	Detailed Project Report
DTD	Door to Door
ELSR	Elevated Level Service Reservoir
FAB	Fluidized Aerobic Bioreactor
GoI	Government of India
GLSR	Ground Level Service Reservoir
HH	Household
HUDCO	Housing & Urban Development Corporation Limited
HWW	Head Water Works
ICDS	Integrated Child Development Services
IEC	Information, Education and Communication
IHHL	Individual Household Latrine
IHSDP	Integrated Housing and Slum Development Programmes
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KPCL	Krishnapatnam Port Company Limited
KSRTC	Karnataka State Road Transport Corporation
LPCD	Litres Per Capita per Day
M&E	Monitoring and Evaluating
MA&UD	Municipal Administration & Urban Development
MBBR	Moving Bed Bio Reactor
MBR	Membrane Bio Reactor
MDG	Millennium Development Goals
MLD	Million Litres per Day
MoHRD	Ministry of Human Resource Development
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoUD	Ministry of Urban Development
MPN	Most Probable Number
MSW	Municipal Solid Waste
NBA	Nirmal Bharat Abhiyan

NGO	Non-Governmental Organization
NH	Nation Highway
NMC	Nellore Municipal Corporation
NTS	Nellore Tank Supply
NTU	Nephelometric Turbidity Unit
NUSP	National Urban Sanitation Policy
O&M	Operation & Maintenance
OD	Open Defecation
OHT	Overhead Tank
PHED	Public Health Engineering Department
PMU	Project Monitoring Unit
RAY	Rajiv Awas Yojana
RWH	Rain Water Harvest
SBR	Sequential Batch Reactor
SFC	State Finance Commission
SMP	Septage Management Plan
SWM	Solid Waste Management
TSC	Total Sanitation Campaign
TNSTC	Tamil Nadu State Transport Corporation
TPD	Tonnes per Day
UASB	Up-flow Anaerobic Sludge Blanket
UDDT	Urine Diversion Dehydration Toilet
UFW	Unaccounted for Water
UGD	Underground Drainage
UIDSSMT	Urban Infrastructure Development Scheme for Small & Medium Towns
ULB	Urban Local Body
USHA	Urban Statistics for HR and Assessments
WHO	World Health Organisation
WSP	Waste Stabilisation Pond
WTP	Water Treatment Plant

1 INTRODUCTION & BACKGROUND

The City Sanitation Plan (CSP) for Nellore provides an integrated action plan to achieve universal sanitation access as envisioned in Government of India's National Urban Sanitation Policy (NUSP) and in the framework of Swachh Bharat Mission. The CSP identifies the issues related to governance, technical, financial, capacity enhancement, awareness raising and pro-poor interventions and proposes short, medium and long term measures to achieve the goals of National Urban Sanitation Policy (NUSP) to create community driven, totally sanitized, healthy and liveable cities and towns. The Nellore Municipal Corporation is formulating its City Sanitation Plan (CSP) with the support of ICLEI Local Governments for Sustainability, South Asia.

The CSP's main purpose is to support urban local bodies and NGOs, CBOs, citizens and private sector agencies to take concrete steps to achieve 100% sanitation in their respective cities that includes Water Supply, Waste Water and Sewerage, Storm Water, Sanitation, and Solid Waste Management. The mentioned sectors are considered under CSP as these are directly and indirectly linked to the other sectors that ultimately affect the hygiene of the city. Thus considering the influence of all these sectors on the city sanitation, the Nellore Municipal Corporation in consultation and considering the recommendations from citizen groups, elected representatives, government departments and City Sanitation Task Force is developing the CSP. The main aim of the CSTF is to achieve 100% sanitation in the city by involving the suggestions from public, private institutions, NGOs and Aided Organizations in coordination with Town Planning Wing.



(*Source: MoUD 2008 NUSP*)

Figure 1: Generic elements of planning, implementation and M&E of city sanitation

Considering the local situations and its need, the Nellore Municipal Corporation has followed the procedure that is depicted in the figure 1 while planning, implementing and evaluating a CSP.

To develop the CSP a detailed analysis of baseline information including a primary survey, spatial mapping and city inspection has been conducted. Detailed baseline situation assessment has been conducted for water supply provision, sanitation, solid waste management, situation behaviour and

awareness levels on sustainable sanitation practices within the community. This information coupled with information from previous, on-going and future proposals has been used to assess the demand and needs for sanitation and allied services within the city.

1.1 Steps towards preparation of CSP

According to the National Urban Sanitation Policy, the preparatory actions that has been carried out in order to achieve 100% sanitation are

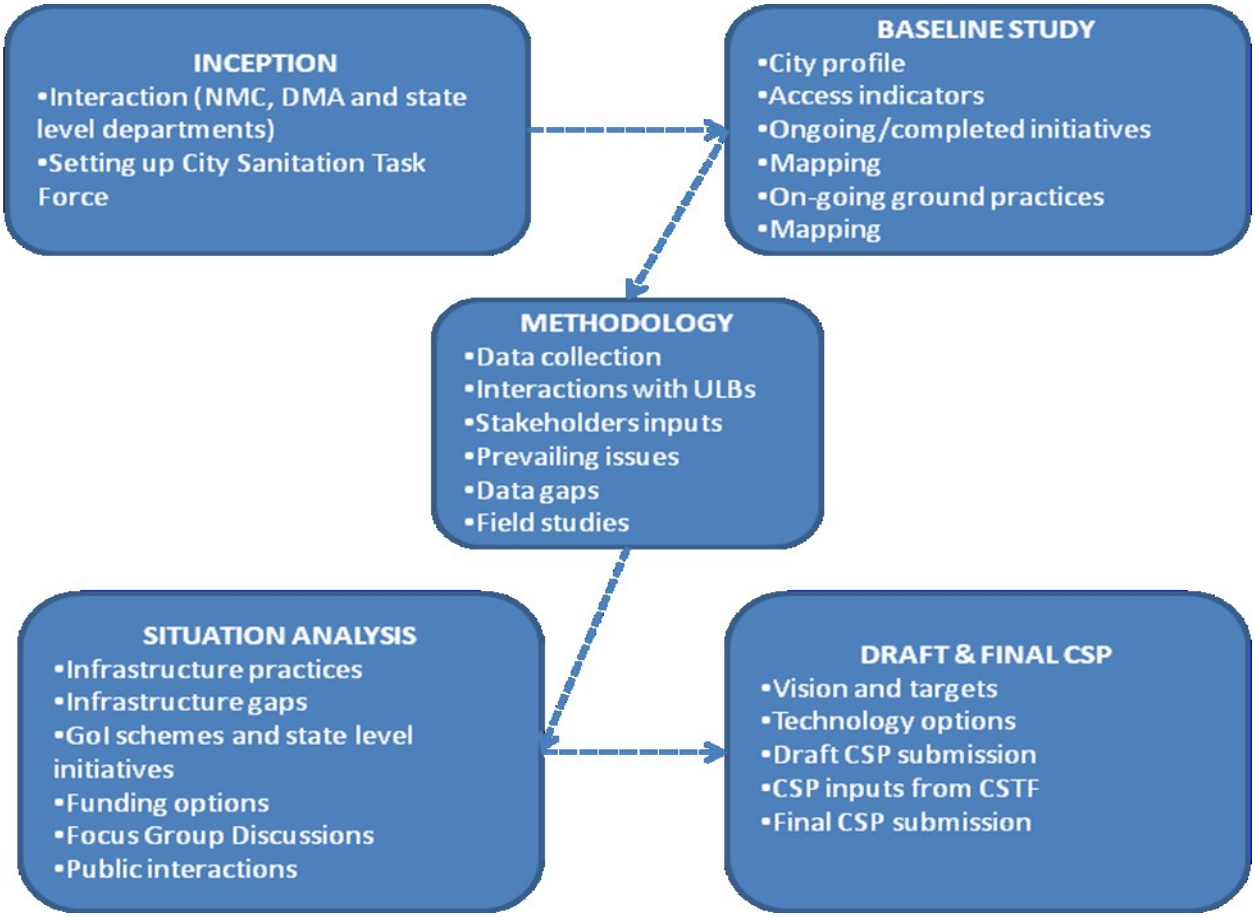


Figure 2: Steps towards preparation of CSP

- Formation of City Sanitation Task Force:

Mobilize Stakeholders: The first step in making the cities 100% sanitized is to elevate the consciousness about sanitation in the mind of municipal agencies, government agencies and most importantly, amongst the people of the city. A multi-stakeholder City Sanitation Task Force has been formed, comprised by representatives from agencies directly responsible for sanitation (divisions and departments of the ULB, PHED, etc.), agencies indirectly involved, and practitioners, representatives of the different stakeholders sectors, NGOs and sanitary workers.

- Baseline Data Collection and Creating Database:

In parallel with the preparatory steps, the ULB / Implementing Agency have collated the information on sanitation that exists with the ULB itself and other agencies in the city. This has included demographic, institutional, technical, social and financial information.

- Awareness Generation and Launch of 100% Sanitation Campaign:

After a reasonable amount of data has been collated from secondary and primary sources, and the Task Force is in place, the first task will be of launching a citywide 100% Sanitation Campaign.

- Specifying Legal and Regulatory Institutional Responsibilities:

Even though many of the municipal laws refer to sanitation responsibilities of households and ULB, etc. these are not clearly laid out or comprehensive. The Implementing Agency will examine the law and rules in this regard and make recommendations for the Task Force to make the rules explicit regarding total sanitation services.

- Planning and Financing:

The task of planning and finding sources of funding will be under the oversight of the Task Force but carried out by the Implementing Agency. The Agency has developed plans for the city for different aspects including institutional, social, technical, financial, etc with the help of different departments involved in city sanitation.

- Technical Options:

Technology choice poses a major problem in Indian cities not only because of lack of information on what exists at present, but also because of the constraints of land, tenure, and low budgetary priority accorded to sanitation historically. Considering the current practices and obstacles that are stopping for the development of sanitation sector in the city, certain technologies that suit best for the city has been recommended.

- Reaching the Un-served Population and the Urban Poor:

Experiences from many Indian cities show that a differentiated approach is necessary to extend good quality sanitation services to the poor – the group that suffers the most in terms of adverse impacts on health and lost earnings.

- Operation & Maintenance and Service Delivery Systems:

Institutional systems for O&M are at the heart of any successful set of systems and procedures to achieve and sustain 100% sanitation.

- Capacity Building & Training:

The role of capacity building and training is crucial in achieving and sustaining 100 % sanitation.

- Implementation Plan and Monitoring and Evaluation

While the Implementation Agency will be responsible for overall implementation, it is useful to think about plan implementation and delivery mechanisms for each of the components of the Plan. The City Sanitation Task Force and the Implementing Agency need to think about M&E of the implementation as an integral part of the City Sanitation Plan.

CSP Focal Points:

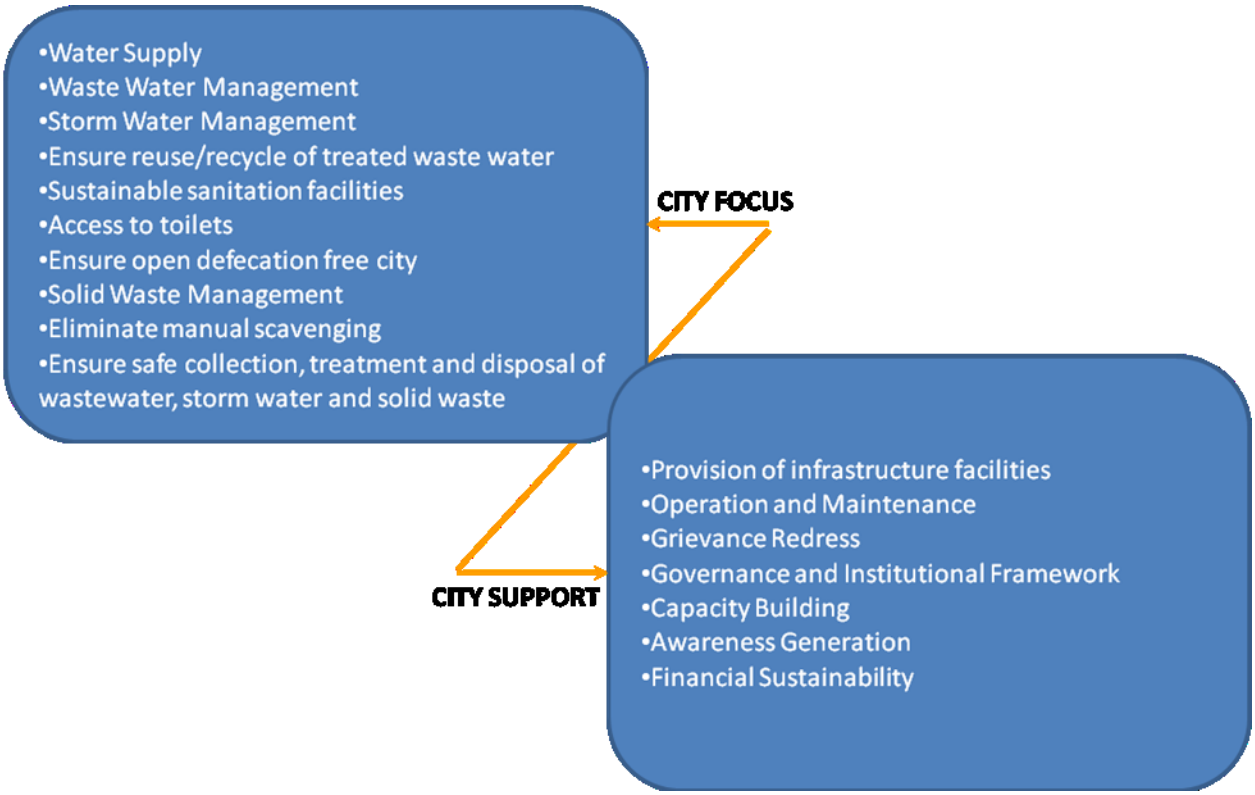


Figure 3: CSP focus area

2 CITY SANITATION TASK FORCE

A city wide sanitation plan includes the vision, mission and goals of sanitation development as well as strategies to meet these goals. Therefore, for the implementation of the certain strategies, considering that a team with the representatives from the city and corporation would play a responsible role towards launching 100% sanitation campaign, coordinating the activities for awareness raising, revising and approving the CSP and implementing the plan defined in the CSP developed by the consultancy, Nellore Municipal Corporation has constituted a City Sanitation Task Force as per the NUSP guidelines.

Each strategy can be found translated into indicative programs (and projects). The CSP shall contain an assessment of the current situation and an immediate, short, medium and long term plan for implementation of the following services and aspects:

Technical aspects including strategies and programs for the development of

- Domestic waste water services
- Solid waste management services
- Storm water drainage services

Non-technical aspects, including strategies for the development of non-physical aspects such as

- Community awareness and participation
- Policy and regulation
- Institutional capacity
- Private sector engagement
- NGO engagement
- Financing and tariffs
- Monitoring and evaluation

2.1 Responsibilities of the CSTF:

The City Sanitation Task Force is responsible for

- Launching the City 100% Sanitation Campaign
- Generating awareness amongst the city's citizens and stakeholders
- Approving materials and progress reports provided by the implementing agency, other public agencies, as well as NGOs and private parties contracted by the Implementing Agency, for different aspects of implementation (see below)
- Approving the CSP for the city prepared
- Undertaking field visits from time to time to supervise progress
- Issue briefings to the press / media and state government about progress
- Providing overall guidance to the Implementation Agency
- Recommend to the ULB fixing of responsibilities for city-wide sanitation on a permanent basis

The CSTF shall also responsible to monitor and guide the planning process and implementation at the initial stages of the project and shall conduct meetings and field visits at a later stage on an as-needed basis to ensure quality implementation of the project.

The CSTF shall responsibly recommend and assign below listed aspects to the ULB for the citywide sanitation.

- The ULB to have final overall responsibility for citywide sanitation, including devolving power, functions, functionaries and funds to them
- Planning and financing including State Government and Government of India schemes
- Asset creation including improvement and augmentation
- Operations and Management (O&M) arrangements for all networks, on-site, individual, community and public sanitation facilities and systems (including transportation up to final treatment and disposal of wastes)
- Fixing tariffs and revenue collections in order to make O&M sustainable
- Improving access and instituting special O&M arrangements for the urban poor and un-served populations in slum areas and in mixed areas
- Adopting standards
- Infrastructure (e.g. design standards) (PHEDs/Parastatals), and
- Service delivery standards (e.g. by urban development departments)
- Adoption of regulatory roles including environmental standards (e.g. state pollution control boards), health outcomes (e.g. health departments)
- Measures in case specific stakeholders do not discharge their responsibilities properly
- Training and capacity building of implementing agency and related personnel
- Monitoring of 100% sanitation involving multiple stakeholders

2.2 Members of the CSTF:

As per the NUSP guidelines, considering that CSTF shall comprise of representative/agencies from some of the elected members of ULB, social volunteers, institutions involved in law, health, water supply, sanitation, town planning, slum development, eminent persons and practitioners in civil affairs, health, urban poverty, NGOs working on environmental components and representatives of unions of Safai Karmachari's etc, following members were elected as the members of the CSTF for Nellore city.

- Honorable Mayor (Executive Head)
- 5 Standing Committee Members
- Municipal Commissioner (Convener)
- Superintending Engineer
- 3 Executive Engineers – One from Water Works, one from UGD Works and one from SWM)
- Municipal Health Officer
- Sanitation Supervisor (I & II)
- Deputy City Planner
- Examiner of Accounts
- Non-Governmental Organization
- Community Organizer
- Town Level Federation
- Principal (DKW College)
- Project Director (ICDS)

3 CITY PROFILE

3.1 Location

Nellore also known as Vikrama Simhapuri existed from the times of the Mouryan Empire and was ruled by Ashoka in the 3rd century. Nellore was known by the name of Vikrama Simhapuri till the 13th century. Nellore is the head quarter of recently named Sri. Potti Sriramulu Nellore District, previously known as Nellore District, in the coastal region of Andhra Pradesh.

It lies between latitudes 14° 24' and 14° 30' North, and between longitudes 79° 55' and 80° 0' East. It is situated about 279 kilometers south of the state capital Andhra Pradesh Capital City and 168 kilometers north of Chennai on the Chennai-Kolkata Highway. Nellore City is spread in a north easterly direction off National Highway No. 5 connecting Jharpokharia in Orissa and Chennai in Tamil Nadu. The Balasore-Chennai stretch of NH-5, on which Nellore is an exit point, forms an arm of the Golden Quadrilateral – a four lane divided carriageway, built as per International Standards. The Broad Gauge railway line of South Central Railway from Vijayawada to Gudur runs through the city, with Nellore being an important station on the main line. Convenient rail connections exist from Nellore to Secunderabad/Hyderabad, Howrah and New Delhi to the north and with Chennai, Tirupati and Thiruvananthapuram towards the south. It is located on the banks of Penna River and is well known for its agriculture and aquaculture.

3.2 Economy

Proximity to the sea and fertile land towards the east has led to agriculture and aquaculture being the backbone of the economy. The district has a cultivable area equal to 41.3% and the crops which are most commonly grown in the district are paddy, jowar, bajra along with tobacco, chillies, groundnut and sugarcane. Handloom, mica mines, thermal power generation and handmade jewellery are other industries that contribute to the economic development. Also salt production is the most popular in Nellore District mostly in Gogulapalli, Iskapalli and Ramathirdam villages. For the salt production Krishnapatnam port takes the top position in Andhra Pradesh which is located around 20 km from the city serving major economic activities to the city and district as whole.

3.3 Transportation

Road: Nellore is well connected by road with National Highway 5 from Chennai to Kolkata, part of the Golden Quadrilateral expressway project, and passing through it. Nellore is connected by APSRTC (Andhra Pradesh State Road Transport Corporation) to major parts of Andhra Pradesh, Tamil Nadu and Karnataka, TNSTC from Chennai and KSRTC from Bangalore. Nellore is zonal headquarters of APSRTC, comprising Nellore, Prakasam and Chittoor Districts.

Rail: Nellore railway station lies on Vijayawada – Chennai section of Howrah-Chennai main line and hence well connected by rail to most parts of category station. It is recognized as an Andhra Station in the Vijayawada railway division of South Central Railway Zone. It is also one amongst the top hundred booking stations of Indian Railway.

Sea: Krishnapatnam Port Company in the sea is where Nellore lives. KPCL was formed by government of Andhra Pradesh to develop the existing minor port into modern, deep water and high

productivity port, on BOST (Build–Operate-Share-Transfer) concession basis for 50 years. It was opened on July 17, 2008. On May 9, 2013, Government of India decided to set up a second major port at Duga Rajapatnam in Nellore District. It will be the second major port in Andhra Pradesh.

Air: The nearest airport is at Tirupati (Renigunta), which is 130 km from the city which has limited services to certain domestic destinations like Vijayawada, Hyderabad, Visakhapatnam, Mumbai and Delhi. The nearest major airport is the Chennai International Airport, about 189 km from the city, which is an international airport providing connectivity to major parts of India and the world. The Government of Czech Republc has evinced interest in building a domestic airport in Nellore. However, so far no concrete work has been done on this front as the process of land acquisition for the airport is posing a problem.

3.4 Topography

The ground level of Nellore varies from 12m to 30m GTS, with the general slope being towards the east. River Penna (or Pennar), also called Pinakini, rises in the Chennakesava Hills, also known as Nandi Hills in the Kolar district of Karnataka. It flows for about 600 km and discharges into the Bay of Bengal. It enters Andhra Pradesh near Chowlur, south of Hindupur in Ananthapur district. It is impounded by the Somasila Dam in the Eastern Ghats at the border between Kadapa and Nellore districts, after which the entire flow is through Nellore district. The dam is about 100 km upstream of Nellore city. Two Anicuts, one at Sangam, 28 km upstream of Nellore, and the other in Nellore itself were constructed by Sir Arthur Cotton in the 19th century. At Nellore Anicut, a Head Regulator was constructed on the southern (or right) bank of the river and a canal, namely 'Jaffer Saheb Canal', was excavated. After about 1.5 km., the said canal branches off within the city itself into three canals namely – Maipadu and Koduru canals towards the east and Sarvepalli Canal initially to the south and later towards south-east. Sarvepalli Canal flowing south east has an offshoot in Krishnapatnam Canal. Sarvepalli Canal flows for a length of 32 km. and discharges into Sarvepalli Cheruvu feeding agricultural fields enroute. The Kotha Koduru or Koduru Canal flows east besides Kotha Koduru road for a length of 8 km. and joins the Buckingham Canal near Bay of Bengal, feeding small cheruvus and canals enroute for irrigation and aquaculture purposes.

A large water body, namely Nellore Cheruvu, is located on the western side of the city. This is fed by Nellore Tank Supply Canal or NTS Canal, which takes off from Sangam Anicut. The cheruvu has recently been divided by an earthen bund and the eastern part, in the adjoining village of Kothuru, has been converted into a Summer Storage Tank (SS Tank) for water supply.

3.5 Climate

The climate of Nellore city is generally dry with maximum temperature being of the order of 45^{o}C in April and May and lasting till June, and20^{o}C in December – January. As the Bay of Bengal is only at a distance of 26 km from the town, the sea breeze renders the climate of the city moderate both in winter and in summer.

Annual rainfall is between 900 to 1200mm of which the Southwest Monsoon from June to September contributes about 30% while the remainder takes place during the Northeast monsoon in the months of October to December. The average number of rainy days is 51. The town is

susceptible to cyclones which occur once or twice in a decade. The recent cyclones took place were in 2015 and 2009.

3.6 Demography

As of 2011 census, Nellore City had a population of 505,258 of which male population is 257,043 and female population is 248,215. 42,041 children are in the age group of 0-6 years, of which 21,701 are boys and 20,340 are girls. Sex ratio of the city stands at 966 females per 1000 males. Average literacy rate stands at 83.59% (male 87.53% and female 79.52%) with 387,192 literates, significantly higher than the state average of 73%.

But later in 2013, 15 Gram Panchayats were included in the Municipal Corporation limits vide GO. Ms. No. 113, Dated: 25.03.2013 and the population is revised to be **600,869.**

Table 1: Gram Panchayats added in the corporation limits

15 GPs added in the corporation limits	Navalakulathota; Chinthareddypalem and Rajupalem; Vaviletipadu and Dhanalakshmi; Vaddipalem and Gundlapalem (part); Kanuparthipadu; Kallurupalli (part) housing colony; Bujabuja Nellore; Ambhapuram; Kothur; Pottepalem; Allipuram; Peddacherukuru; Gudupallipadu; Kodurupadu; and Narayanareddy Peta

Decadal wise population of Nellore City since 1901 to 2011 is provided in the table 2.

Table 2: Decadal wise population

Year	Population	Growth Rate
1901	32,040	
1911	33,246	3.76
1921	35,863	7.87
1931	45,895	27.97
1941	56,315	22.70
1951	81,480	44.68
1961	106,776	31.04
1971	133,607	25.12
1981	237,065	77.43
1991	316,606	33.55
2001	378,428	19.52
2011	**505,751**	**33.64**
2011 (Revised with newly added population)	**600,869**	**58.78**

Source: Census data

The increase in population during the decade 1971 – 1981 was mainly due to the substantial enhancement of municipal area from 18 Sq.km to 48.52 Sq.km. The expanded city population post merger of 15 Gram Panchayats into Nellore Municipal Corporation stands at **600,869.**

3.7 Ward wise population and area details of Nellore City (2011)

The following table provides the ward wise population of the Nellore City along with its area. Out of the entire 54 wards from the city the sparsely populated wards are identified to be ward no.s 11, 14, 16, 17, 23 and 24 with population 70,673 covering an area of 2004.631 hectares.

Table 3: Ward wise population and area details

Ward No	No. of Households	Population 2011 Census	Area in Acres	Gross Area in Hectares	Area covered by Penna river in Hectares	Net Area in Hectares	Population Density (person/hectare)
1	2,967	11,829	776.733	314.3332	200	114.3332	103
2	2,630	10,701	252.595	102.2217		102.2217	105
3	2,510	10,226	183.294	74.17656		74.17656	138
4	3,010	11,355	346.732	140.3177		140.3177	81
5	2,131	8,344	75.544	30.57162		30.57162	273
6	2,088	7,759	60.806	24.60735		24.60735	315
7	2,763	11,224	102.877	41.63291		41.63291	270
8	1,393	6,287	75.713	30.64001		30.64001	205
9	3,220	12,433	237.912	96.27972		96.27972	129
10	3,827	14,463	75.134	30.4057		30.4057	476
11	2,657	10,349	434.737	175.9321		175.9321	59
12	1,776	7,806	94.879	38.39623		38.39623	203
13	2,143	8,419	63.383	25.65023		25.65023	328
14	3,430	13,655	595.23	240.8814		240.8814	57
15	2,913	15,009	253.37	102.5354		102.5354	146
16	1,256	8,470	992.962	401.8381		401.8381	21
17	3,329	14,153	1475.191	596.9895		596.9895	24
18	1,642	7,219	152.312	61.63857		61.63857	117
19	1,921	8,843	138.914	56.21659		56.21659	157
20	2,379	9,267	236.271	95.61563		95.61563	97
21	3,036	11,611	292.084	118.2024		118.2024	98
22	1,964	8,629	79.672	32.24216		32.24216	268
23	3,155	12,867	598.668	242.2727		242.2727	53
24	2,465	11,179	856.755	346.717		346.717	32
25	2,605	10,700	144.56	58.50145		58.50145	183
26	2,494	9,661	125.606	50.83102		50.83102	190
27	2,547	11,125	182.69	73.93213		73.93213	150
28	2,789	10,537	244.047	98.76247		98.76247	107
29	3,249	14,856	133.288	53.93982		53.93982	275
30	1,473	7,986	139.85	56.59537		56.59537	141
31	2,824	11,783	82.896	33.54687		33.54687	351
32	2,772	12,416	252.346	102.121		102.121	122
33	2,731	12,144	139.861	56.59983		56.59983	215
34	1,234	6,402	107.152	43.36294		43.36294	148

Ward No	No. of Households	Population 2011 Census	Area in Acres	Gross Area in Hectares	Area covered by Penna river in Hectares	Net Area in Hectares	Population Density (person/hectare)
35	2,059	8,283	55.168	22.32573		22.32573	371
36	2,017	8,575	52.107	21.08699		21.08699	407
37	2,163	9,567	58.21	23.55679		23.55679	406
38	1,704	10,127	140.322	56.78639		56.78639	178
39	1,906	8,379	25.862	10.466		10.466	801
40	1,884	8,328	49.437	20.00647		20.00647	416
41	1,631	10,197	84.495	34.19397		34.19397	298
42	1,912	8,400	38.727	15.67229		15.67229	536
43	1,490	7,049	19.757	7.995387		7.995387	882
44	2,732	12,271	90.529	36.63584		36.63584	335
45	2,087	9,189	146.542	59.30353		59.30353	155
46	2,100	10,296	65.732	26.60084		26.60084	387
47	1,934	8,109	597.82	241.9295	220	21.92954	370
48	1,990	8,871	71.367	28.88124		28.88124	307
49	2,453	10,035	127.405	51.55905		51.55905	195
50	1,880	8,368	361.535	146.3082	48	98.30825	85
City Total	**117,265**	**505,751**	**11989.08**	**4851.816**	**468**	**4383.816**	**11766**

Source: Nellore Municipal Corporation

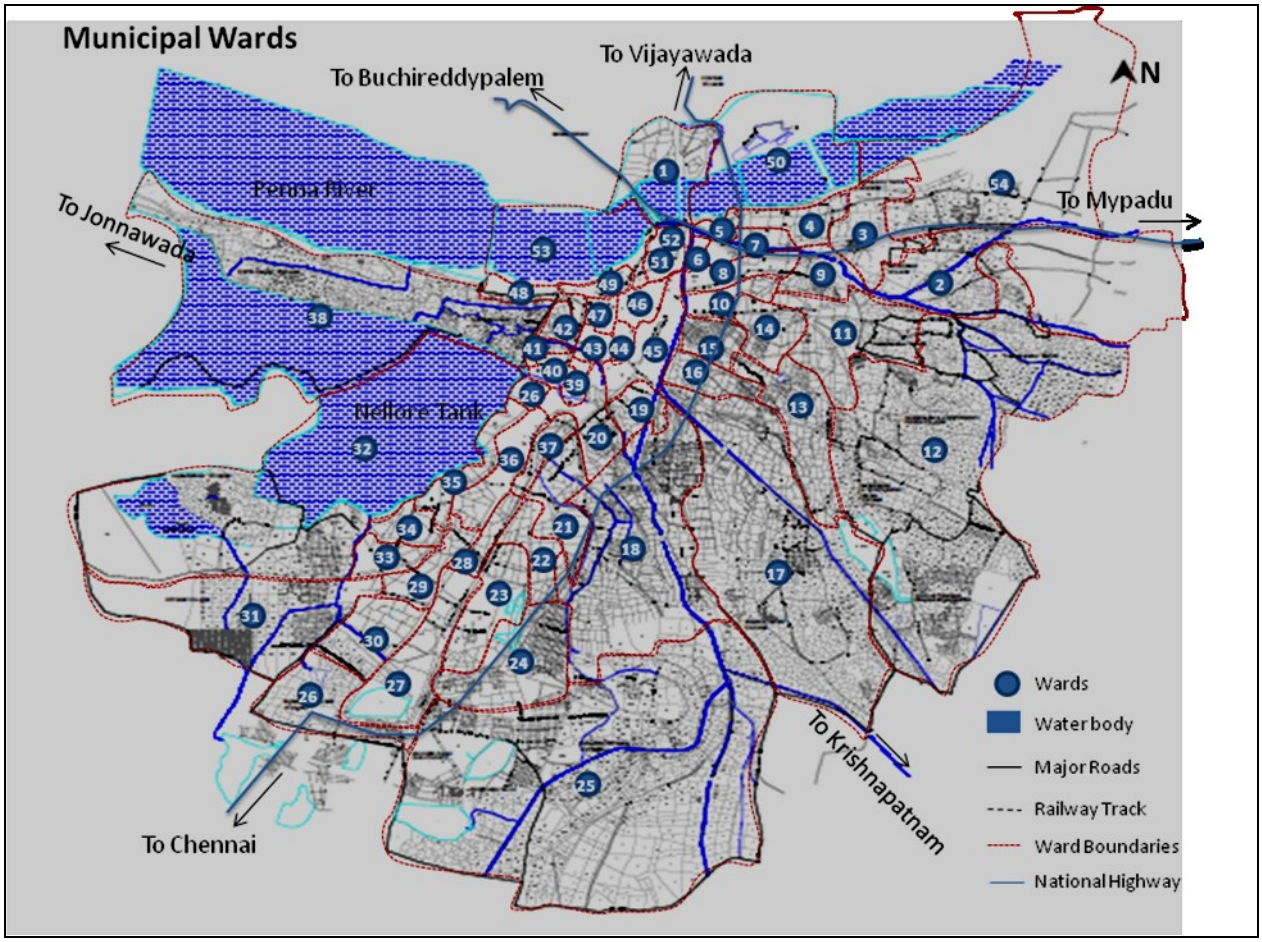


Figure 4: Nellore Wards Map

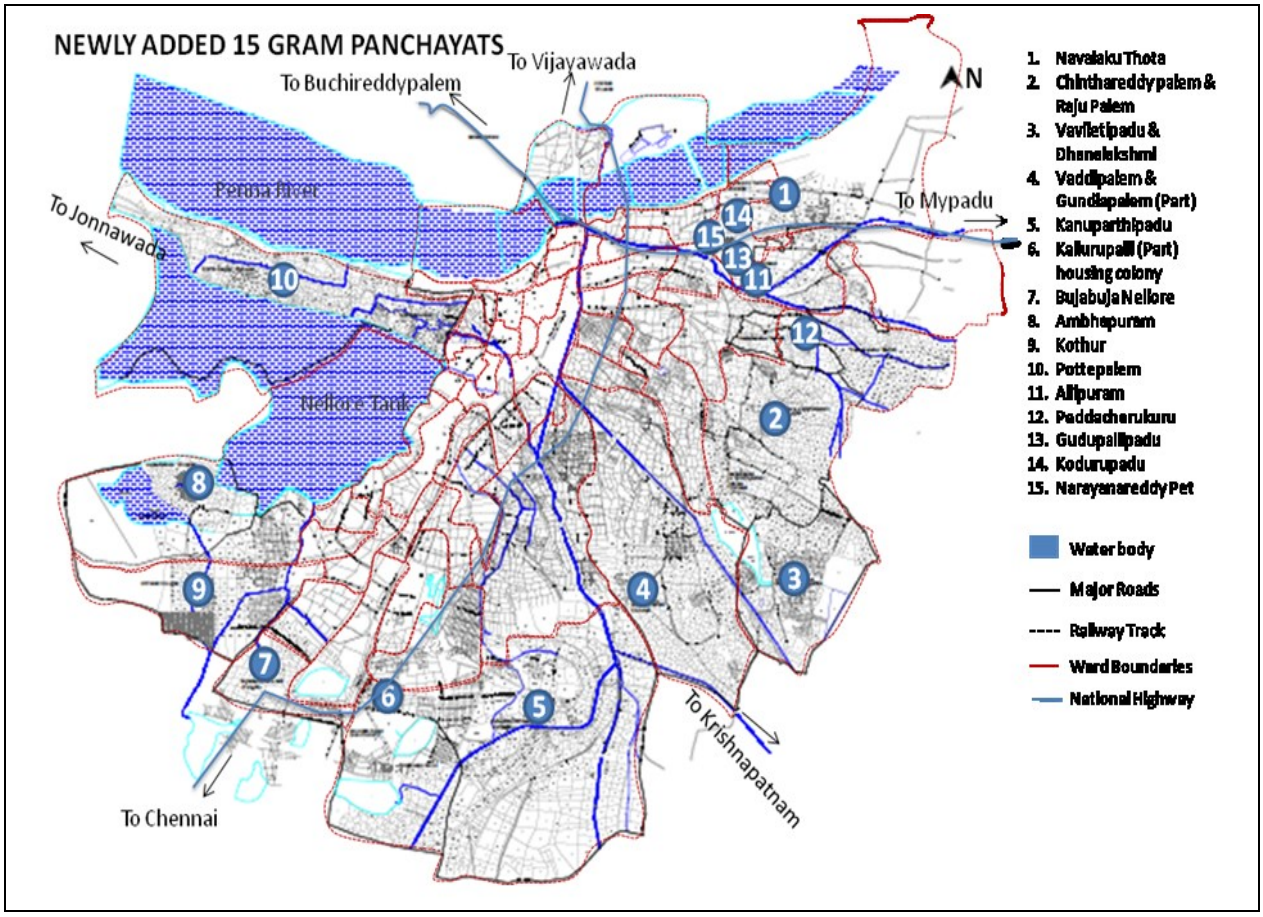


Figure 5: Newly added 15 Gram Panchayats

3.8 Population projections:

Population projection for the city is estimated considering population as per the newly added Gram Panchayats. The methods considered for projecting the current population to the future decades are Arithmetic, Geometric and Incremental methods and projected populations are provided in the table 4.

Table 4: Population projections

Year	Population	Population projection		
		Arithmetic	Geometric	Incremental
1961	106776	-	-	-
1971	133607	-	-	-
1981	237065	-	-	-
1991	316606	-	-	-
2001	404775	-	-	-
2011	600869	-	-	-
2021	-	699688	834022	742003
2031	-	798506	1157645	925453
2041	-	897325	1606842	1151219

Though the above methods calculates different numbers, as there is no consecutive average growth because of merging of Gram Panchayats in 1971 and 2011, the population is projected considering annual average growth rate of 3.4% as provided in table 5.

Table 5: Population projections

Year	Population(at 3.4% growth rate)
2011	600869
2012	621299
2013	642423
2014	664265
2015	**686850**
2016	710203
2017	734350
2018	759318
2019	785135
2020	811829
2021	839431
2022	867972
2023	897483
2024	927997
2025	959549
2026	992174
2027	1025908
2028	1060789
2029	1096856
2030	1134149
2031	1172710
2032	1212582
2033	1253810
2034	1296439
2035	1340518
2036	1386096
2037	1433223
2038	1481953
2039	1532339
2040	1584439
2041	1638310
2042	1694012
2043	1751608
2044	1811163
2045	1872743
2046	1936416
2047	2002254
2048	2070331
2049	2140722

Year	Population(at 3.4% growth rate)
2050	2213507
2051	2288766

The following chapters are worked based on the projected population of 686850 for 2015.

4 WATER SUPPLY

Nellore is said to be the first town in India to have metered water supply, with 407 house connections metered among 892 house connections in 1935. Nellore has commissioned its water supply distribution in 1908 with an infiltration gallery and connecting well on the bank of the River Penna. During its initial phase, pumping was done by oil engines till June, 1935, and is replaced by electric motors.

Nellore city is geographically located on either sides of the River Penna, where 5% of the total city area is on the northern part of the river and 95% is on the southern part of the river passing through the city. The city area and population is recently increased with additional 15 Gram Panchayats merged in the Nellore Municipal Corporation. As per 2011 census the population of the city including newly merged Gram Panchayats is 600,869 with 139320 HHs. Considering an annual average growth rate is at 3.4% the population of the Nellore city is estimated to be 686850 as on 2015 with 159362 HHs at 4.3 persons per HH. The following report is developed considering current population at 686850.

The city is divided into 54 wards including newly added Gram Panchayats. Of the entire 54 wards, only two wards (ward 1 and ward 50) are located on the northern side of the River Penna and the rest 52 wards are located on the southern side of the River Penna. Since, these two parts are separated by the river of 750 m wide and cannot be brought under one source; water is supplied in these regions by:

- An infiltration gallery of 5MLD capacity and the Clear Water Rising Main in the northern side.
- Existing 20 infiltration wells at HWW connected to galleries from sub-surface water of River Penna supplies adequate quantity of water in the southern region.

4.1 Water Source

Nellore city is mostly dependent on sub-surface water from infiltration galleries/wells in Penna River and power bores. The city has in total 23 infiltration wells in the southern part of the River Penna that are connected to 4 infiltration galleries. Of the 23 infiltration wells, currently only 20 are operational yielding meagre quantity of water as most of these were constructed in early 1960's. Only 6 among 23 were constructed recently under Rajiv Drinking Water Scheme in 2001. Of the 3 defunct infiltration wells, 2 are connected to a gallery at Bujjamma Revu which is at 1.4km downstream of HWW. Therefore, water supply in the defunct infiltration well areas is served by existing bore wells in the locality. In addition to these sources, there are 166 power bores operational in the city contributing for water supply demand in the city.

Table 6: Infiltration wells details at HWW

Year	Infiltration Length	Gallery Dia.	Pipe Type	No. of Infiltration Wells	No. of working Infiltration Wells	Pump House No. to which fed (Year of construction)
1908	748 ft x 2 (228M x 2)	15 inch (375mm)	S.W.	2	–	Abandoned (1908)
1935	200 ft (61M) 200 ft (61M)	9 inch (225mm) 15 inch (375mm)	Cement Cement	3	2	1 (1935)
1961	1400ft x 2 (427M x 3)	12 inch (300mm)	S.W.	7	7	1 (1935)
1964	900ft x 2 (427M x 3)	12 inch (300mm)	S.W.	5	5	2(1964)
Under Rajiv Drinking Water Scheme 2001				6	6	3(2001)
Total				23	20	

Source: Engineering Department, Nellore Municipal Corporation.

Details of the entire water sources available in the city along with the capacities of the ELSRs and GLSRs are listed in table 7.

Table 7: Different sources of Water Supply

Details of Sources of Water Supply	
No. of Infiltration wells	23 Nos.
No. of Infiltration Galleries	4 Nos.
No. of power bores existing	166 Nos.
No. of IM-II Hand Bores existing	707 Nos.
No. of IM-II Hand Bores functioning	685 Nos.
No. of Bores under repair	22 Nos.
No. of HSC's	42218 Nos.
Total No. of Public Fountains	1225 Nos.
No. of ELSR's Existing	33 Nos.
Total ELSRs Capacity	25325 KL
No. of GLSRs Existing	6 Nos.
Total GLSRs Capacity	3820 KL
No. of new ELSR's (brought to functioning)	8 Nos.
Infiltration Gallery in Northern region	5 MLD

Source: Engineering Department, Nellore Municipal Corporation

In addition to the above listed sources, existing 18 MLD Conventional Water Treatment Plant commissioned in 2010 at Kothuru also serves to some extent of the city covering Indiramma Colony, Bujabuja Nellore, Ambapuram and Kothuru zones. The source of the plant is surface water of River Penna conveyed through Nellore Tank Supply Channel (NTS) originating at Sangam Anicut. The Canal is about 36 km long and feeds the Nellore Cheruvu (Summer Storage Tank), a large water body with a water spread area of 14.56 sq.km abutting Nellore to its West. The water from the canal is tapped at Kondlapudi and is pumped to the Summer Storage Tank of 8000 ML capacity carved out of Nellore Cheruvu with a bypass line leading to the aforesaid 18 MLD plant.

4.2 Water Generation

Nellore Municipal Corporation claims that currently (in 2015) 80.26 MLD of water is being generated daily from various water sources detailed in table 8 including water generation from deep bore wells from newly merged villages. In a study done by Lahmeyer GKW consultants in 2011, it reports that the water generated from HWW & Bujjamma Revu, 23 mini schemes, and SS tank is 25 MLD, 8.20 MLD and 9 MLD instead 43.78, 16.22 and 11 MLD.

Table 8: Water generation as per NMC as on 2015

Source	Generation
From infiltration galleries at HWW and Bujjamma Revu	43.78 MLD
From 23 mini schemes – deep bores and open wells	16.22 MLD
From SS Tank – treated at Kothur water treatment plant	11 MLD
From deep bore wells from newly merged villages	9.26 MLD
Total	**80.26 MLD**

Source: Engineering department, Nellore Municipal Corporation

Table 9: Water generation comparison

Source	NMC's Records	Lahmeyer GKW Records
Infiltration Galleries	43.78	25
Bore wells and open wells etc	16.22	8.20
WTP at Kothuru* (SS tank)	11	9
From deep bore wells from merged villages	9.26	-
Total	**80.26**	**42.2**

Source: Lahmeyer GKW consultants report on Comprehensive planning of WS, Sanitation & Waste Water

4.3 Water Supply and Distribution

4.3.1 Water Supply

Water generation in the city being at 80.26 MLD, considering around [1]28% of UFW losses due to leakage and unauthorized connections, it is calculated that 58 MLD of water is being distributed to the people at 85 lpcd considering 6,86,850 population as on 2015. Per capita supply of water is observed to be low to the CPHEEO standard of 135 lpcd.

[1] The calculations are done considering 28% UFW losses due to leakage and unauthorized connections claimed in Comprehensive Planning for WS, Sanitation and Waste Water developed by Lahmeyer GKW Consultants for Nellore Municipal Corporation under APMDP and approved by Nellore Municipal Corporation.

Water supply in the Nellore city varies from area to area depending on their location and proximity to the pumping station. At the present situation water is supplied in two shifts for 2 hours each to almost 49 wards among 54 wards, and is supplied once in a day to the remaining 5 wards namely 26, 31, 32, 53 partly and 54 partly.

4.3.2 Water Distribution

Water collected at the infiltration galleries and wells is chlorinated by direct pipe feed from tonner cylinders and is distributed to the consumers through the existing 33 elevated reservoirs and 6 ground level reservoirs. Further 22 numbers of tankers supplies (each tanker of capacity 3000 litres) water at the rate of 5 trips per day in Shivaji Nagar, Samatha Nagar, Bhagath Singh Colony, Nagamma Colony, BujaBuja Nellore, YadavaPalem, RTC colony, Talpagiri colony, Vikalangula colony, KothuruChoutamitta, KothuruShivaji Colony, Chandra Babu Nagar, Sramika Nagar, Valluramma Colony, YSR Nagar, Ram Nagar, Nethaji Nagar and Janardhan Reddy colony.

Out of the 33 elevated reservoirs, 31 are on the south bank of the river and 2 are on the north bank of the river. The 2 reservoirs on the north banks are at the dilapidated conditions and still serving the requirement and are under use. 10 from the 31 reservoirs serving on the south bank are damaged and witnessed no distribution. Another 2 reservoirs one at Podalakuru road (1000KL capacity) and another at BV Nagar (450KL capacity) which are at the dilapidated condition are proposed to undergo improvements as these are currently under use. Out of the 6 ground level service reservoirs, 5 are in working condition and 1 is discarded. All the GLSRs are located on the south bank of the river.

In addition to the existing elevated reservoirs another 17 ELSRs for serving entire Nellore core area and another 15 ELSRs for serving areas recently added have been proposed for construction by PHED under HUDCO plan.

Details of the existing ground level service reservoirs and existing elevated service reservoirs are provided in table 10 and 11.

Table 10: Details of GLSRs in Nellore city

S. No.	Location	Capacity (KL)	GL (GTS) (m)
1	Thotabadi	500	16.604
2	Podalakur Road	1400	32.320
3	Head Water Works	410	18.651
4	Head Water Works	410	18.651
5	Magunta Layout	500	17.221
6	Akuthota (dilapidated and out of use)	600	12.701
Total		**3820**	

Source: Engineering department, Nellore Municipal Corporation.

Table 11: Existing ELSRs in Nellore city

S. No.	Location	Capacity (KL)	GL (GTS) (m) As Surveyed	Staging Height in m	LWL (GTS) (m)	MWL (GTS) (m)
North of River Penna						
1	Gandhi Girijana Colony * (1)	450	17.857	12.000	29.857	33.857
2	Venkateswarapuram*	450	15.360	12.000	27.360	31.360
South of River Penna						
1	Head Water Works (1)	1700	18.743	15.000	33.743	37.743
2	Head Water Works * (2)	1700	18.651	15.000	33.651	37.651
3	Pinakini Park * (1)	250	17.410	17.000	34.410	38.410
4	Ranganayukulupeta	750	17.419	17.000	34.419	38.419
5	Zakir Hussain Nagar *	225	16.593	12.000	28.593	32.593
6	Thotabadi (1)	500	15.752	15.000	30.752	34.752
7	Thotabadi (2) *	450	16.604	10.000	26.604	30.604
8	Pappula Street Park	1590	16.519	10.000	26.519	30.519
9	Janda Street *	800	21.560	13.000	34.560	38.560
10	A.C.Nagar*	450	14.943	10.000	24.943	28.943
11	NTR Nagar *	250	13.527	15.000	28.527	32.527
12	Mulapeta*	1400	22.256	10.000	32.256	36.256
13	Mahboob Khan Park	1000	19.155	15.000	34.155	38.155
14	Aditya Nagar	500	14.116	14.000	28.116	32.116
15	Fathekhan Peta *	1000	17.814	13.000	30.814	34.814
16	Muthyalapalem	500	14.553	13.000	27.553	31.553
17	Haranathpuram*	910	14.943	14.000	28.943	32.943
18	Magunta Layout (1)	1000	17.493	13.000	30.493	34.493
19	Magunta Layout (2)	500	17.221	15.000	32.221	36.221
20	Kondayapalem	500	18.040	10.000	28.040	32.040
21	Podalakur Road (1)	1000	32.320	15.000	47.320	51.320
22	Podalakur Road ++ (2)	1000	34.995	15.000	49.995	53.995
23	B.V. Nagar (1)	500	18.390	10.000	28.390	32.390
24	B.V. Nagar ++(2)	450	23.839	10.000	33.839	37.839
25	Swatantra Park	750	15.847	12.000	27.847	31.847
26	Military Colony	1000	21.700	15.000	31.700	36.350
27	M.G.Nagar Road (1)	1000	29.676	10.000	39.676	43.676
28	M.G.Nagar Road (2)	750	29.676	14.000	43.676	47.676
29	Padarupalli	1000	21.647	12.000	33.647	37.647
30	Elamvari Dinne +++	250	11.855	12.000	23.855	27.855
31	Sri Krishna Avenue MPL Park +++	750	13.500	15.000	28.500	32.500
	Total Capacity	**25325**				
	* Reservoir needs repair					
	++ Dilapidated and beyond repair					
	+++ Distribution system being laid					

Source: Lahmeyer GKW consultants report confirmed with engineering department, NMC

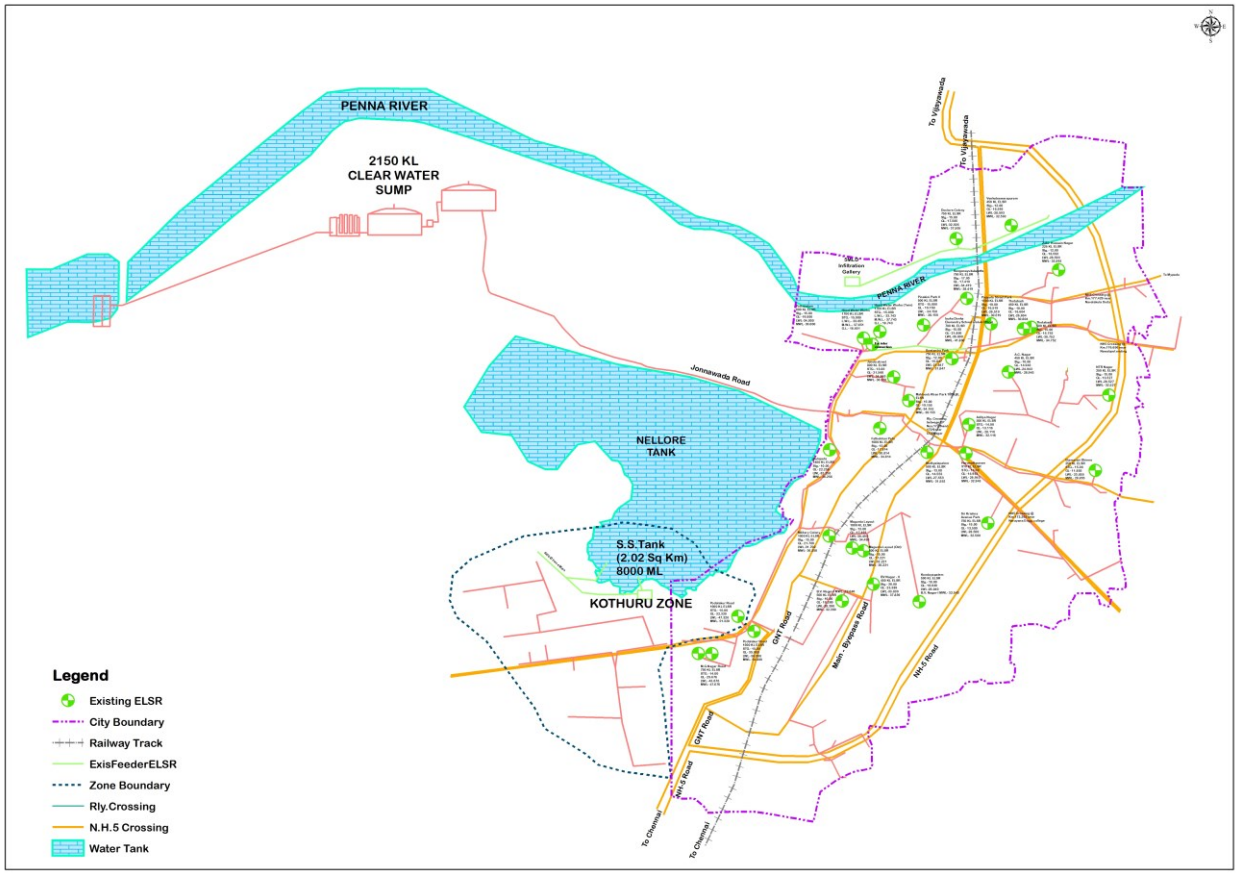


Figure 6: Map depicting existing ELSRs in Nellore City

The raising main from the pumping stations to the ELSRs are about 58 km in length and the length of distribution system originating from the ELSRs to the consumers is a little over 438 km.

The details of Diameter wise length of distribution pipe lines are provided in table 12.

Table 12: Diameter wise length of distribution system in Nellore

S. No.	Diameter	Length (km)
1	4” (100 mm) AC	354.2
2	6” (150 mm) PVC	3.31
3	6” (150 mm) AC	45.8
4	8” (200 mm) AC	35.13
	Total	**438.44**

Source: Lahmeyer GKW consultants report confirmed with engineering department, NMC

4.4 Water Supply Connections

There are nearly 42,218 house service connections out of which only 444 are metered. Out of these 444 metered connections, 124 are Domestic connections and 320 are Commercial connections. The number of house connections which are unmetered are around 34,366. In addition to these connections there are 1821 public stand posts.

4.5 Water Supply in Slums

Slums in the city receives water from these 1821 public stand posts which supply potable water for 4 hours daily. [2]Out of the 138 slums in the city, 75 slums are fully connected with municipal water supply network, 62 are partially connected and one is not connected at all. [4]More than 42% of the slum HHs is dependent on tube wells and hand pumps for drinking purposes, 40% HHs have direct water supply connections within their premises, 7% depends on community taps, and more than 5% collects water from open wells and 0.3% HHs depends on surface water for drinking purposes.

Table 13: Status of WS in slums

Status of WS in Slums	
Fully connected	75
Partially connected	62
Not connected	1
Total no. of slums	**138**

Source: Socio-economic survey conducted in slums under RAY

4.6 Non-Revenue Water

As per the surveys conducted by the Lahmeyer GKW consultants for preparation of DPR on Comprehensive Planning for Water supply identified that there are about 28% of losses due to leaking and unauthorized connections which do not generate the revenue. Recently in 2015, 5250 unauthorized house service connections have been detected and regulated after penalizing them.

4.7 Operation and Maintenance

4.7.1 Water Supply Charges

Table 14: Water Supply Charges

Type of Charges	Cost	Frequency of collection
Tap connection	Rs. 8265	Collected one time
Monthly charges	Metered Connections: Varies; Unmetered Connections: Rs. 100/month	Metered Collected monthly Unmetered Collected once for 6 months

Source: Accounts department, Nellore Municipal Corporation as on 2015.

[2] Analysis developed based on the Socio-Economic Survey conducted under RAY program.

4.7.2 Water Supply revenue and O&M costs and cost recovery – April 2014 to March 2015

Table 15: WS revenue and O&M costs and cost recovery

Water Supply	Income/Revenue (In Rs)		Water Supply	O&M Expenditure (Rs)	
	Apr 2013 - Mar 2014	Apr 2014 - Mar 2015		Apr 2013 - Mar 2014	Apr 2014 - Mar 2015
Properties-Water Tax	121089	183158	Water supply lines	5618678	12769252
Direct Water Tax	9943155	14019441	Water Supply	10145819	11613151
WS - Security Deposits		5208240	Water works	9960830	10375379
WS - Tap Donation	3853935	6259305	Open/Bore Wells	221016	534092
Raw Water		4508952			
WS - Tap Estimation Charges	588696	602573			
Tap Repairs	61390	139900			
WS (User Charges)	869227	830797			
WS Tanker (User Charges)	67200	71400			
Total	**15504692**	**31823766**	**Total**	**25946343**	**35291874**

Source: Accounts department, Nellore Municipal Corporation.

From the table 15 it is evident that the Nellore Municipal Corporation is extensively focused on the revenue generation from Water Supply sector with an increase in revenue from 59.75% during financial year 2013 – 2014 to 90.17% during financial year 2014 – 2015.

4.7.3 Departments Responsible

There is a separate department for handling Water supply in the town that is responsible for Planning, Asset creation, O&M, Cost recovery and Regulation. Water Supply department and the Superintend Engineer of the municipal corporation are responsible to handle water supply, generation and distribution related works, while the Public Health department is responsible in developing and implementing the proposed state and central government schemes and interventions.

4.8 Water Demand

Considering that currently NMC supplies 85 lpcd of water calculated including the UFW losses of 28% as identified and reported by Lahmeyer GKW consultants in their study in 2011, there is a gap of 50 lpcd to be supplied to each and every individual as per the CPHEEO standard of 135 lpcd. Therefore, it is estimated that 118.72 MLD of

- Current supply – 85lpcd
- Supply gap – 50lpcd
- Current water generation demand – 118.72 MLD
- Current water generation gap – 38.42 MLD
- Estimated generation demand – 324 MLD by 2045.

water has to be generated daily by the NMC to meet the existing demand considering 28% of UFW losses during generation and distribution. The gap in water generation at the existing situation is 38.42 MLD.

Therefore, it is estimated that the gap would reach upto 243 MLD by 2045 if there are no developments in the existing water generation and distribution sectors. Table 16 gives the water supply, demand and gap analysis.

Table 16: Water Supply, Demand and Gap Analysis

Year	Population	Current Supply (85 lpcd)	Demand (Litres)	Demand (including 28% CFW losses)	Demand in MLD	Gap (80.26 MLD)
2015	**686850**	**58382250**	**92724750**	**118687680**	**118.6877**	**38.42768**
2016	710203	60367255	95877405	122723078	122.7231	42.4630784
2017	734350	62419750	99137250	126895680	126.8957	46.63568
2018	759318	64542030	102507930	131210150	131.2102	50.9501504
2019	785135	66736475	105993225	135671328	135.6713	55.411328
2020	811829	69005465	109596915	140284051	140.2841	60.0240512
2021	839431	71351635	113323185	145053677	145.0537	64.7936768
2022	867972	73777620	117176220	149985562	149.9856	69.7255616
2023	897483	76286055	121160205	155085062	155.0851	74.8250624
2024	927997	78879745	125279595	160357882	160.3579	80.0978816
2025	959549	81561665	129539115	165810067	165.8101	85.5500672
2026	992174	84334790	133943490	171447667	171.4477	91.1876672
2027	1025908	87202180	138497580	177276902	177.2769	97.0169024
2028	1060789	90167065	143206515	183304339	183.3043	103.044339
2029	1096856	93232760	148075560	189536717	189.5367	109.276717
2030	1134149	96402665	153110115	195980947	195.9809	115.720947
2031	**1172710**	**99680350**	**158315850**	**202644288**	**202.6443**	**122.384288**
2032	1212582	103069470	163698570	209534170	209.5342	129.27417
2033	1253810	106573850	169264350	216658368	216.6584	136.398368
2034	1296439	110197315	175019265	224024659	224.0247	143.764659
2035	**1340518**	**113944030**	**180969930**	**231641510**	**231.6415**	**151.38151**
2036	**1386096**	117818160	187122960	239517389	239.5174	159.257389
2037	1433223	121823955	193485105	247660934	247.6609	167.400934
2038	1481953	125966005	200063655	256081478	256.0815	175.821478
2039	1532339	130248815	206865765	264788179	264.7882	184.528179
2040	1584439	134677315	213899265	273791059	273.7911	193.531059
2041	1638310	139256350	221171850	283099968	283.1	202.839968
2042	1694012	143991020	228691620	292725274	292.7253	212.465274
2043	1751608	148886680	236467080	302677862	302.6779	222.417862
2044	1811163	153948855	244507005	312968966	312.969	232.708966
2045	**1872743**	**159183155**	**252820305**	**323609990**	**323.61**	**243.34999**
2046	1936416	164595360	261416160	334612685	334.6127	254.352685
2047	2002254	170191590	270304290	345989491	345.9895	265.729491
2048	2070331	175978135	279494685	357753197	357.7532	277.493197

Year	Population	Current Supply (85 lpcd)	Demand (Litres)	Demand (including 28% CFW losses)	Demand in MLD	Gap (80.26 MLD)
2049	2140722	181961370	288997470	369916762	369.9168	289.656762
2050	**2213507**	**188148095**	**298823445**	**382494010**	**382.494**	**302.23401**
2051	2288766	194545110	308983410	395498765	395.4988	315.238765
2052	2366584	201159640	319488840	408945715	408.9457	328.685715
2053	2447048	207999080	330351480	422849894	422.8499	342.589894
2054	2530247	215070995	341583345	437226682	437.2267	356.966682
2055	**2616276**	**222383460**	**353197260**	**452092493**	**452.0925**	**371.832493**

Source: Calculated by ICLEI South Asia

4.9 [3]Water Quality

The quality of water may vary depending on the season. The water from the infiltration galleries is chlorinated and supplied. Only conventional type of treatment is followed.

The drinking water samples were collected and micro-biological lab tests were reported from different areas of the city to the NMC in November, 2015 by Regional Public Health Laboratory. It reports that to the international standard of World Health Organization, as against MPN count to be 0 (no total coliforms or E.coli should be detected) for every 100ML of drinking water tested, MPN count is witnessed at Infiltration wells 1, 2, 3 at HWW and Summer Storage Tank as detailed in table 17 which is bacteriologically un-satisfactory for drinking purpose. In water, coliform bacteria have no taste, smell or colour. To the international standards of Escherichia coli (E.coli) to be at 0 for every 100ML of drinking water tested, it is witnessed at 5 at Infiltration wells 1, 2, 3 and Summer Storage Tank. Escherichia coli (E.coli) in drinking water indicate the water has been contaminated with fecal material that may contain disease causing micro-organisms, such as certain bacteria, viruses or parasites.

Table 17: Microbiological Analysis of Water in Nellore City

S. No.	Source	Residual Chlorine mg/Lt.	MPN Count of Coli form Bacteria/ 100ml	Nature of Coli form bacteria isolated	MPN of Esch. coli
1	Infiltration well No:1 at Head Water Works	Nil	1100	E.coli	5
2	Infiltration well No:2 water at HWW	Nil	1609	E.coli	5
3	Infiltration well No:3 water at HWW	Nil	1100	E.coli	5
4	Tanker water (mixed of 1 & 2 wells) after chlorination	0.5	Nil	-	-

[3] Analysis developed by Regional Public Health Laboratory in November, 2015.

S. No.	Source	Residual Chlorine mg/Lt.	MPN Count of Coli form Bacteria/ 100ml	Nature of Coli form bacteria isolated	MPN of Esch. coli
5	Bujjemma revu tap water	1.0	Nil	--	-
6	Summer Storage tank water	Nil	1609	E.coli	5
7	Clarifier water	1.0	Nil	--	-
8	Filtered water from Filter Bed No:3	0.5	Nil	--	-
9	Clear water sump water	2.0	Nil	--	-
10	Public Tap near the SS tank	2.0	Nil	--	-
11	Tap at Podalakur road SR	0.5	Nil	--	-
12	Magunta layout sump after chlorination	1.0	Nil	-	-
13	Stored water nearby Mutyalampadu SR	0.2	Nil	-	-
14	Haranadhapuram SR water	0.2	Nil	-	-
15	H.T. at D.No: 27-6-15 AC Nagar SR Supply	0.5	Nil	-	-
16	Pappulavedhi SR water	0.5	Nil	-	-
17	Rythu bazaar SR water	2.0	Nil	--	-
18	Zakir Hussain nagar supply water at D.No:28-21069	2.0	Nil	--	-
19	Banglow thota SR (750 KL) water at D.No: 1-2-514	0.5	Nil	--	-
20	PT Nazir Thoat (FCI colony) SR	1.0	Nil	-	-
21	NTR Nagar SR water	2.0	Nil	-	-
22	PT at Ramnagar Military colony SR	0.2	Nil	-	-
23	BV nagar SR water	1.0	Nil	-	-
24	Tap at Gandhi nagar SR	0.5	Nil	-	-
25	Gollaveedhi SR water	0.5	Nil	-	-
26	NTR Sujala water at Zakir Hussain Nagar	Nil	Nil	-	-
27	NTR sujala water at NTR nagar SR	Nil	Nil		

Source: Water quality report – Regional Public Health Laboratory (November 2015)

In addition, the laboratory has developed physio-chemical analysis for 13 samples from 13 points in the city and the results are detailed in table 18. As per the Indian Standard for Drinking Water – Specification IS 10500:2012, to the actual acceptable limit of 5 Hazen units and maximum permissible limit (in the absence of alternate source) of 15 Hazen units for the colour of the water; the water colour from Infiltration 2 and 3, SS Tank, filtered water from filter bed – 3, clear water sump and public tap near SS tank is witnessed to be beyond the limits with 30, 20, 45, 25, 25 and 25 Hazen units. Turbidity, NTU at the entire quality test points is within the IS 10500:2012 standard of acceptable (max to 1) and permissible (max to 5) limits. Total dissolved solids (TDS) are within the acceptable limit at the entire quality test points as per the IS 10500:2012. Standard for TDS: Acceptable limit (max 500 mg/l) and Permissible limit (max 2000 mg/l - in the absence of alternate source).

Chlorination normally employed in waterworks in the city is witnessed ineffective against certain parasites, including amoebic cysts; they can be excluded only by effective filtration or by higher chlorine doses. To avoid water borne diseases in the city it is suggested for periodical cleaning of sumps, OHTs, regular and adequate chlorination and maintenance of a Log book at reservoirs and in the distribution system to have a regular check on the residual chlorine levels.

Precautions and Solutions:

- Ensure watertight casing and proper vermin-proof cap
- Disinfect the well, pump and plumbing after repairs
- Disinfect any water placed in a well for drinking, repair, or priming of pumps. Never use water from a lake or pond in your well
- To kill micro-organisms, keep water at a rolling boil for at least one minute.

Water Supply Scenario in Nellore City:

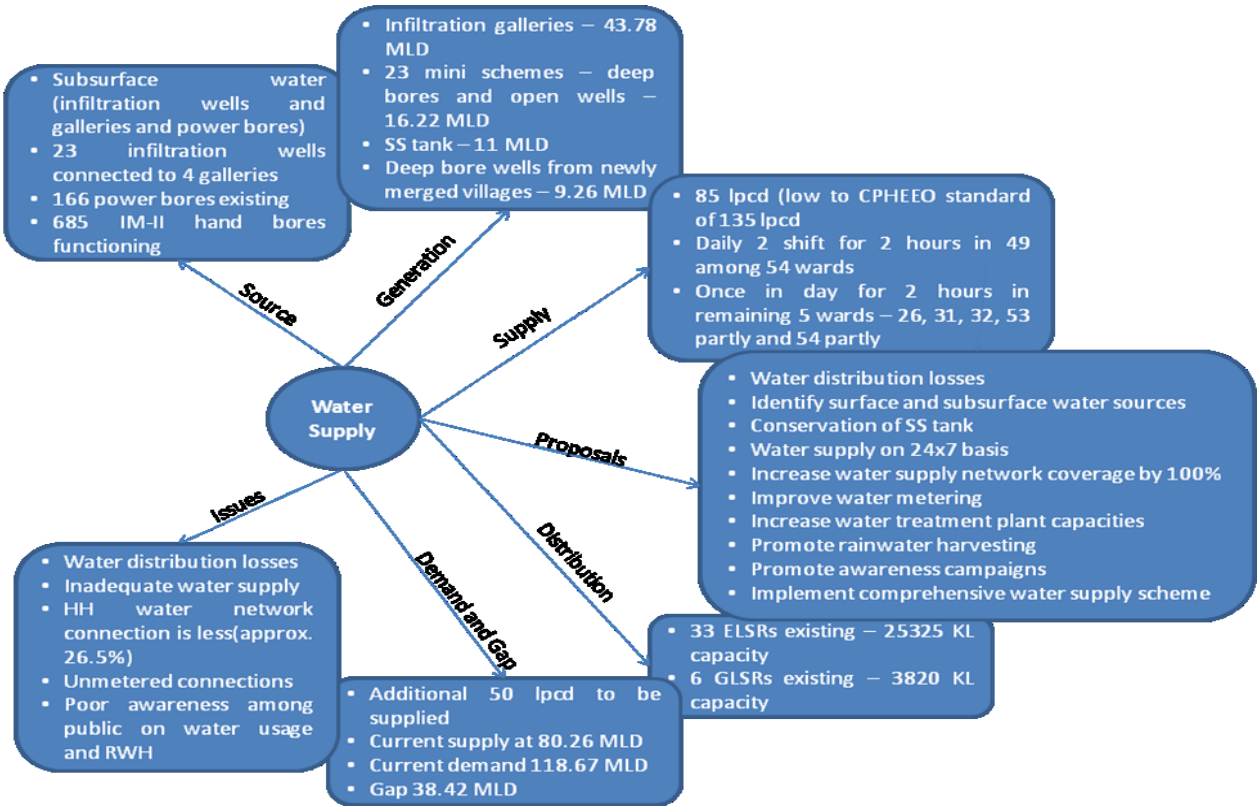


Figure 7: Water supply scenario in Nellore City

Table 18: Physio Chemical Analysis

Water quality test results							
S. No.	**Source of water**	**Colour in Hazen Units**	**Turbidity in NTUs**	**pH**	**Total Dissolved Solids mg/L**	**Nitrate as N**	**Ammonical Nitrogen**
1	Infiltration well No: 1 water at HWW	15	1.5	7.53	343	0.01	Nil
2	Infiltration well No: 2 water at HWW	30	1	7.46	343	Light traces	Nil
3	Infiltration well No: 3 water at HWW	20	1.5	7.56	343	Traces	Nil
4	Tanker water (Mixed of 1 & 2 Infiltration wells) after chlorination	20	3	8.2	502	Nil	Nil
5	Bujjemma Revu tap water (after chlorination)	15	1.5	7.41	462	Nil	Nil
6	Summer Storage Tank water	45	2.7	7.72	284	Nil	Nil
7	Clarifloculator water	30	2	7.6	317	Nil	Nil
8	Filtered water from Filter bed No: 3	25	1	8.1	317	Nil	Nil
9	Clear water sump water	25	0.8	8	317	Nil	Nil
10	PT near SS tank	25	0.8	8	317	Nil	Nil
11	Golla veedhi SR water	15	0.9	7.4	462	Nil	Nil
12	NTR Sujala water at Zakir Hussian Nagar	<10	0.1	6.5	30	Nil	Nil
13	NTR sujala water at NTR nagar	<10	0.1	6.9	356	Nil	Nil

Actual water quality standards for drinking purpose - as per IS 10500:2012							
Colour in Hazen Units		Turbidity in NTUs		pH		Total Dissolved Solids mg/L	
Required*	Permissible**	Required*	Permissible**	Required*	Permissible**	Required*	Permissible**
Max. 5	Max. 15	Max. 1	Max. 5	6.5-8.5	No relaxation	Max. 500	Max. 2000
* Required implies acceptable limit							
** Permissible implies permissible limit in the absence of alternate source							

Source: Water quality report – Regional Public Health Laboratory (November 2015)

4.10 Identified Issues for Water Supply Sector:

While conducting field studies in Nellore in September, 2015, following issues were identified in discussion with the public and the officials from the corporation and public health towards water supply in the Nellore City.

- The current water supply is very less as against present demand with a gap at 38.42 MLD.
- Inadequate supply i.e. water is supplied in two shifts for 2 hours each to almost 49 wards among 54 wards, and is supplied once in a day to the remaining 5 wards namely 26, 31, 32, 53 partly and 54 partly.
- Household water network coverage is less (approx. 26.5%).
- Unmetered connections (just 0.3% is the current metering system covered in the city).
- Quality of water is un-satisfactory for the purpose of drinking. Physio-chemical and Bacteriological parameters are being checked once in every 6 months and the NMC shall monitor periodically and consider water quality improvement activities based on the same.
- Energy audit is not conducted for water supply sector.
- Many hand bores and power bores are defunct due to very low or no ground water table.
- Water distribution system in the newly added Gram Panchayats has to be properly channelized.
- Poor awareness among the public on water usage, conservation and harvesting.
- Lack of awareness on practicing Rain Water Harvesting (RWH) systems in the city.

4.11 [4]Proposed/Sanctioned Water Supply Schemes:

- The Government of Andhra Pradesh has recently accorded Administrative Sanction vide G.O.Ms.No. 272, MA&UD Department, dated 18-12-2015, for the implementation of Nellore Comprehensive Water Supply Scheme with Sangam Anicut on River Penna as source with HUDCO assistance including construction of Intake Well at Sangam Anicut, Raw Water and Clear Water Transmission Main, construction of 122MLD WTP including Electro Mechanical and allied works, providing transmission mains, construction of various ELSRs in the Nellore city, and distribution network, etc.

For the implementation of the above mentioned Comprehensive Water Supply Scheme the project cost is estimated to be Rs. 556.77 Crores and the sources of funding for the same is provided in the table 19.

[4] The proposed interventions are obtained from Public Health and Engineering Department, NMC and are accordingly compared to the future population projected by ICLEI South Asia.

Table 19: Sources of funding for implementation of Comprehensive WS Scheme

Name of the work	Source of funding (In Crores)			Total Project Cost (In Crores)
	Loan by HUDCO	ULB	State funding as additional amount	
Nellore comprehensive water supply scheme	475.00	54.24	27.53	**556.77**

Source: Public Health and Engineering Department, Nellore Municipal Corporation

- The above mentioned 122 MLD capacity Water Treatment Plant is under execution and is proposed at Mohammadapuram hillock that taps raw water from Sangam Anicut/Barrage. This new Barrage at Sangam on river Penna is expected to impound large quantity of water in place of existing old Anicut. This WTP is known as Mohammadapuram WTP – Stage I. This plant is proposed to be located on the government land on the hillock and is 5km away from Sangam Anicut. The intake of the scheme is proposed at Sangam Anicut, 40 Km upstream of Nellore with an assured supply from Somasila Dam, and 50 Km further upstream.

- Considering that the 122 MLD proposed plant would cater to the demand till 2031, it is also been proposed to augment the 122 MLD plant by another 30 MLD (Mohammadapuram WTP – Stage II) in order to meet subsequent demand till 2035 estimating that the water demand in 2031 would be 203 MLD and in 2035 it would be 232 MLD including 28% UFW losses (refer table 16).

- As mentioned above towards construction of various ELSRs in the Nellore city, 17 ELSRs are proposed to take up in the city core area and 15 ELSRs are proposed to take up in recently added Gram Panchayats.

- The ongoing NTR Sujala Pathakam at 10 areas in Nellore city (Zakir Hussain Nagar, Pottepalem, Sundaraiah Colony, NTR Nagar, Dhanalakshmi Puram, Pedda Cherukur, Chinta Reddy Palem, Navalakula Garden, Gudapallipadu and Kodurupadu) is proposed to extend to 3 other locations in the city Ranganayakula pet (wards 51 & 52), Satram Badi (ward 6) and Stone House pet shopping complex (ward 8). This scheme aims in providing Safe Potable Water of 20 liters for Rs. 2/- to each household.

4.12 Proposed Strategies for developing Water Supply:

- Identify the surface and sub-surface water sources for the present and future.
- Conservation of Lakes, SS Tank and Water Quality
- Improve water storage and distribution
- Ensure Water Supply on 24x7 basis
- Increase water network coverage to 100%
- Improve water metering
- Increase water treatment plant capacities
- Capacity building on conservation of water and reuse of treated wastewater
- Promoting rainwater harvesting

Proposed strategies for developing Water Supply sector in Nellore City is detailed under ***Goal 1*** in ***Section 8.1: Implementation Plan.***

Capacities and locations of the proposed ELSRs are detailed in the table 20.

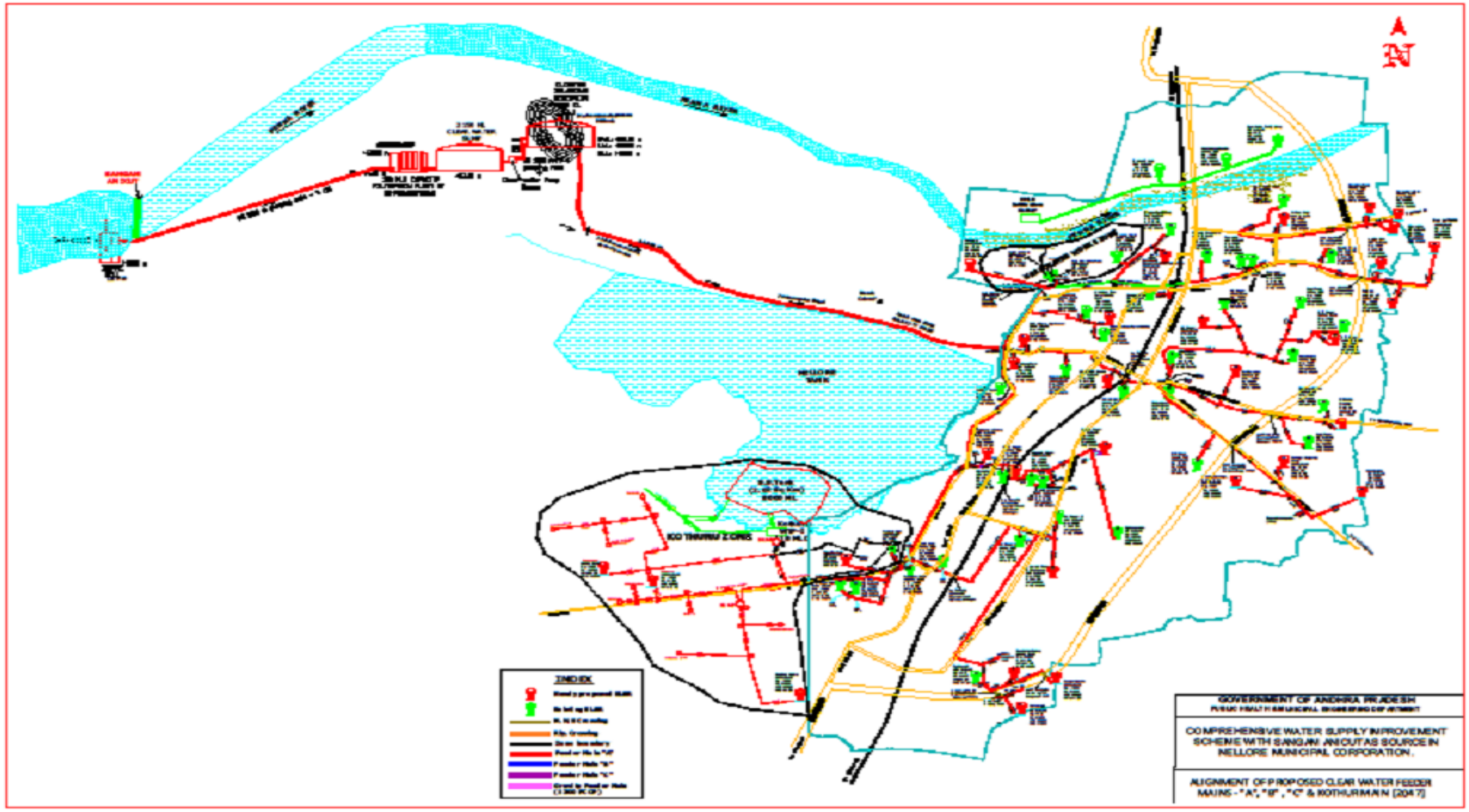


Figure 8: Proposed Water Supply Scheme with ELSR Locations

Table 20: Capacities and Locations of the proposed 32 ELSRs in Nellore City

No. of ELSRs proposed in Core area – 17		
S. No	Location	Capacity (In KL)
1	Sri Ram Nagar	1200
2	NTR Nagar	1100
3	AC Nagar	700
4	Devi Paradse	600
5	Korivivari Kandiriga	500
6	Gomathi Nagar	700
7	CCS Nagar	1000
8	ESRM High School	800
9	Mahaboob Kahn Park	1200
10	Isukadonka	700
11	DPR Layout	700
12	Sujathamma Colony (Old area 32nd division)	1000
13	Mulapet Park	500
14	Sundharaiah Colony (Old area 24th division)	600
15	Vengal Rao Nagar	1000
16	SCCOMCH School	800
17	Janardhan Reddy Colony (Old area 1st division)	1000
No. of ELSRs proposed in added areas		
S. No	**Location**	**Capacity (In KL)**
1	Navalakula Thota	700
2	Kodurupadu	250
3	Narayana Reddy Pet	350
4	Allipuram	250
5	Peddha Cherukuru	200
6	Gudipallipadu	150
7	Chinta Reddy Palem	350
8	Vaviletipadu	250
9	Gundla Palem	250
10	Kanuparthi Padu	600
11	Kalluru Palle Housing Board Colony	300
12	Buja Buja Nellore	600
13	Kothuru	1200
14	Ambapuram	200
15	Pottepalem	600

Source: Public Health and Engineering Department, Nellore Municipal Corporation

5 SANITATION & SEWERAGE MANAGEMENT

5.1 Sanitation

The Swachhta Status report finds huge increase in the construction of individual toilets in the country at 39.96% in 2014-15 to 58.14% in 2016-2017 with construction of around 1,15,75,997 individual toilets in the financial year 2016-2017 as on Dec, 2016. Nellore city has also seen huge increase in facilitating individual toilets in the city during the last two financial years from 15.33% in financial year 2014-2015 to 35.66% in 2016-2017. Andhra Pradesh is driving to attain Open Defecation Free state status under the Swachh Bharat Mission by 2019, as like Himachal Pradesh, Sikkim and Kerala states which were recently declared as Open Defecation Free states in India by Ministry of Drinking Water and Sanitation, GoI. The Open Defecation Free cities scale has been increased from 2.03% to 10.76% in Andhra Pradesh state as per the Swachhta Status report as on Dec, 2016 that indicates access to toilets has improved both in rural and urban India, particularly in slums.

For the cities adequate availability of water for toilets is also a concern. In rural India, 42.5% of households were found to have access to water for use in the toilet compared to 88% in urban India, as per Swachhta status report. Therefore, provision of 24/7 water supply in cites including slums along with citizen's behavioural change is believed to lead in Open Defecation Free cities. Behaviour change is a key priority of the Swachh Bharat Abhiyan as sanitation is a behavioural issue, central government says. "It involves a change of mindset amongst people to stop open defecation and to adopt safe sanitation practices."

The safe disposal of human waste not only involves building toilets but also demands proper conveyance (sewerage system) and treatment of the waste (sewage). In the following section the existing sanitary practices at Nellore is assessed including access to private toilet facilities, availability of public toilets, open defecation and community toilets in slums and schools.

5.1.1 Individual Toilet Connections

Out of 138 slums in Nellore, 66 are notified and 72 are non-notified. Out of the entire 138 slums, 124 are situated in the core area of the city and remaining 14 are located in the fringe areas of the city. 57 slums among 124 slums in the core area of the city and 10 slums among 14 spread in the fringe areas are notified while the remaining are non-notified slums. As per 2011 census, the total number of households in slums was 38962 and was increased to 40980 after merging the 15 Gram Panchayats in the corporation limits. As per the survey conducted under Rajiv Awas Yojana (RAY) program in 2011 for 38962 HHs (without newly merged Gram Panchayats), it was found that

In Slums

- 31948 HHs (78%) have own individual toilets
- 2422 HHs (6%) depend on public and community toilets
- 6609 HHs (16%) practice open defecation.

- 78% of the HHs (30375 HHs) have their own individual toilets connected to septic tanks and dry latrines,
- 6% (2303 HHs) depend on public and community toilets, while
- 16% (6284HHs) practice open defecation.
- Applied the above ratio, the status of individual toilet connections in Nellore city for 40980 HHs is

- 31948 HHs (78%) have their own individual toilets connected to septic tanks and dry latrines,
- 2422 HHs (6%) depend on public and community toilets connected to septic tanks and dry latrines while
- 6609 HHs (16%) practice open defecation in the nearby open grounds, roadside areas, along railway tracks and nearby drains/nallahs.

Table 21: Details of toilet connections in Slums for 38962 and 40980 HHs.

Details of sanitary toilets in slums			
Toilet type	**HHs without new areas**	**%**	**HHs with newly added areas**
Own connected to septic tanks	27869	71.53	29312.99
Own connected to dry latrines	2506	6.43	2635.014
Shared connected to septic tanks	1195	3.07	1258.086
Shared connected to dry latrines	337	0.86	352.428
Community connected to septic tanks	607	1.56	639.288
Community connected to dry latrines	164	0.42	172.116
Open defecation	6284	16.13	6610.074
Total	**38962**	**100**	**40980**

Source: survey report developed under RAY program in 2011.

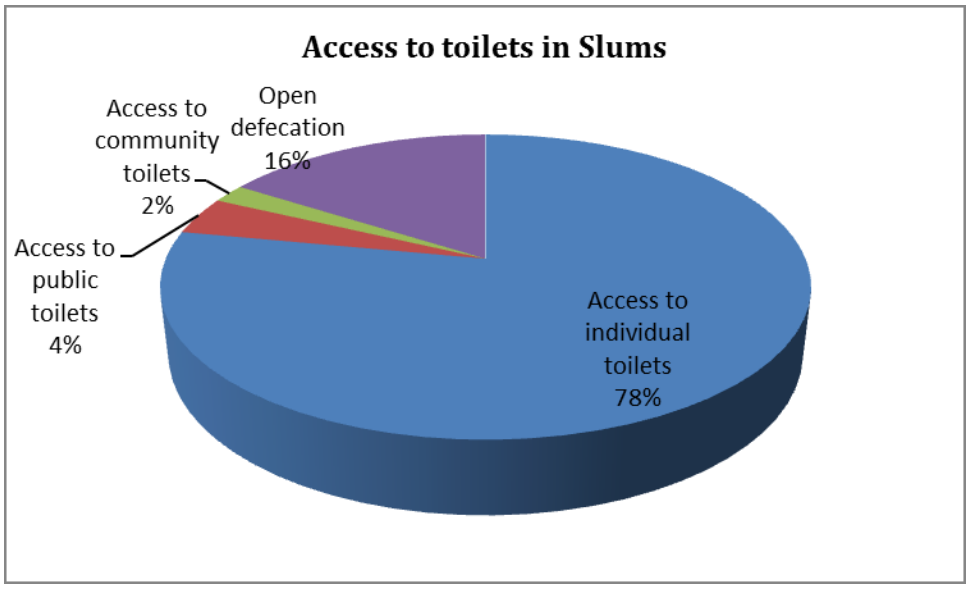


Figure 9: Details of toilet connections in Slums

5.1.2 Public and Community Toilets

At present, there are only 3 pay and use community toilets and 12 pay and use public toilets maintained by private parties at various locations in the Nellore city. However, this is inadequate to meet the demands and there is a need for more community and public toilets with facilities like water supply to each water closet, proper ventilation and lighting arrangement. As calculated above around 811 HHs are dependant on community toilets and 1610 HHs depend on shared toilets in the slum areas, there is a need to construct individual toilets in their premises.

Considering that 16.13% (6610 HHs) of the slum population practice open defecation, there is currently a need to construct community and public toilets with 615 seats (considering 50 persons/day/seat) to meet the target of eliminating open defecation practice.

Since Nellore Municipal Corporation does not have data regarding floating population, it is difficult to estimate the public toilet coverage. However, additional public toilets are required near public places like bus stands, railway stations and vegetable markets.

5.1.3 Open Defecation Areas

Open defecation is common in many wards and slums in the Nellore City. The incidence is highest in wards where most of the slums are located. There are over 11 open defecation spots in Nellore

- Near banks of Penna river (North)
- Hindu burial ground near Penna river
- Vengal Rao Nagar extension
- Along the National Highway
- BV Nagar extension
- Kisan Nagar extension
- Chemudu gunta
- Buji Buji Nellore extension
- Manuma Sidhi Nagar
- Surroundings of Nellore Cheruvu
- Along the banks of Sarvepalli Canal

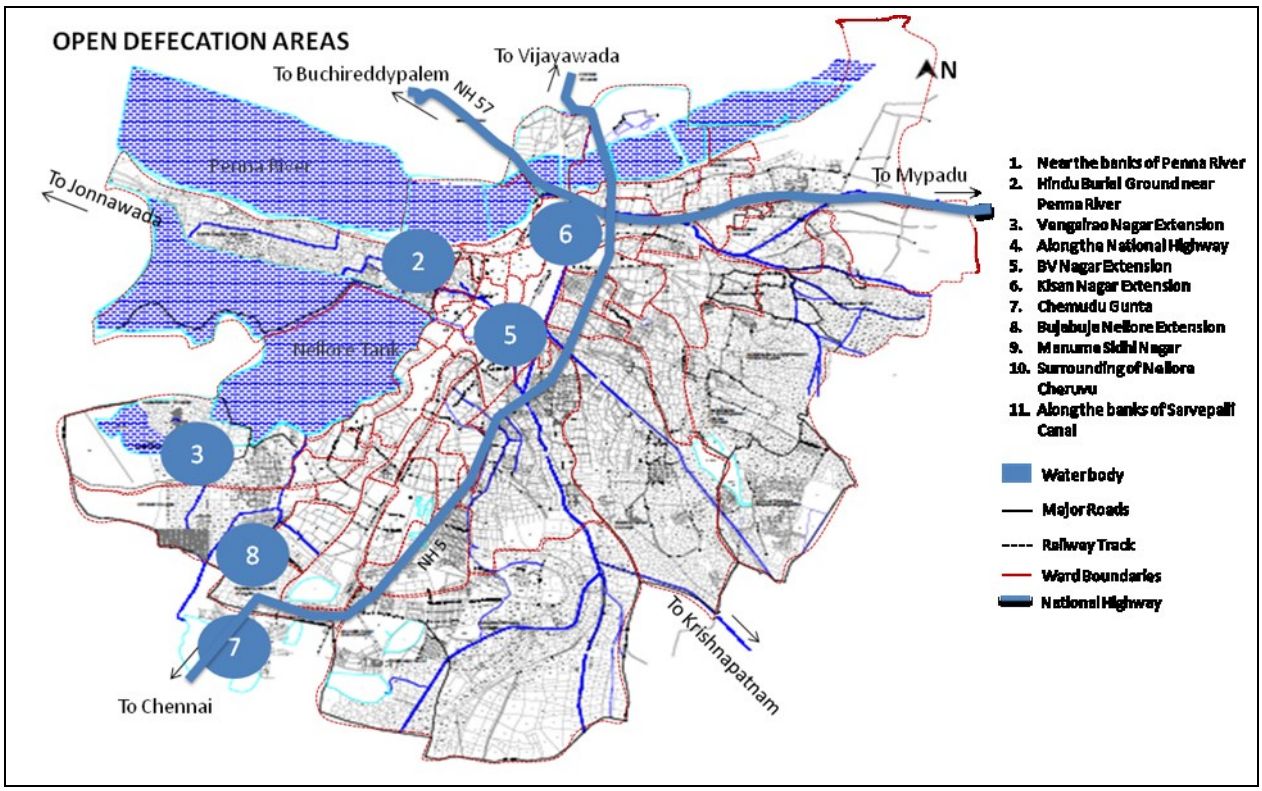


Figure 10: Open defecation areas in Nellore

5.1.4 School Sanitation

There are about 51 primary and upper primary schools and 15 high schools in Nellore. The status of sanitation in these schools is summarised below:

- Primary and Upper Primary Schools (51 in nos.)
  - Approximate school strength: 4624
  - 82 toilet seats available (32 for boys and 50 for girls)
- High Schools (15 in nos.)
  - Approximate school strength: 6694
  - 59 toilet seats available (16 for boys, 41 for girls and 2 for staff).

The following table shows the distribution of toilets per primary, upper primary and high schools.

Table 22: Toilets distribution in Primary and Upper Primary Schools

Primary and Upper Primary schools						
	Strength			Toilet Seats		
S. No	Strength	Boys	Girls	Boys	Girls	Staff
1	83	39	44	1	1	
2	26	11	15	1	1	
3	49	27	22	NA	NA	
4	44	23	21	NA	NA	
5	97	44	53	NA	NA	
6	88	44	44	NA	1	
7	31	21	10	1	1	
8	50	26	24	1	1	
9	240	130	110	1	1	
10	84	45	39	1	1	
11	62	28	34	1	1	
12	225	110	115	1	1	
13	39	26	13	1	1	
14	22	16	6	NA	1	
15	173	78	95	2	2	
16	26	12	14	NA	1	
17	120	65	55	NA	NA	
18	15	7	8	NA	1	
19	64	30	34	1	1	
20	59	26	33	1	1	
21	25	11	14	NA	1	
22	309	150	159	1	1	
23	124	54	70	1	1	
24	26	11	15	NA	1	
25	67	34	33	NA	1	
26	89	43	46	1	1	
27	350	176	174	NA	NA	
28	NA	NA	NA	NA	NA	
29	121	66	55	1	1	
30	403	213	190	1	2	
31	58	27	31	1	2	
32	76	34	42	1	1	NA

Primary and Upper Primary schools						
	Strength			Toilet Seats		
S. No	Strength	Boys	Girls	Boys	Girls	Staff
33	202	99	103	1	2	
34	82	42	40	1	1	
35	14	6	8	NA	NA	
36	NA	NA	NA	2	2	
37	NA	NA	NA	2	2	
38	146	75	71	1	2	
39	30	18	12	1	1	
40	97	43	54	1	2	
41	242	95	147	1	2	
42	67	34	33	1	1	
43	NA	NA	NA	NA	NA	
44	52	NA	NA	NA	NA	
45	67	36	31	NA	NA	
46	65	32	33	NA	1	
47	142	65	77	NA	NA	
48	61	28	33	NA	2	
49	44	26	18	NA	2	
50	NA	NA	NA	NA	NA	
51	68	33	35	1	1	
Total	**4624**	**2259**	**2313**	**32**	**50**	**-**

Source: Engineering Department, Nellore Municipal Corporation.

Table 23: Toilets distribution in High Schools

High schools						
	Strength			Toilets		
S. No	Strength	Boys	Girls	Boys	Girls	Staff
1	478	351	125	NA	3	NA
2	475	-	475	NA	5	2
3	159	82	77	1	2	NA
4	370	166	204	2	2	NA
5	200	186	14	2	2	NA
6	731	348	383	NA	2	NA
7	170	106	64	2	2	NA
8	606	282	324	2	2	NA
9	459	220	239	5	4	NA
10	414	54	360	NA	5	NA
11	1240	650	590	NA	6	NA
12	317	142	175	1	1	NA
13	225	105	120	1	1	NA
14	411	174	257	NA	NA	NA
15	439	272	167	NA	4	NA
Total	**6694**	**3138**	**3574**	**16**	**41**	**2**

Source: Engineering Department, Nellore Municipal Corporation

It is evident from the above tables that in the primary, upper primary and high schools the sanitation facilities are very low and hence seeks immediate attention to increase the number of toilet seats and urinals for maintaining hygiene and health of students.

5.1.5 Demand Assessment: Future Scenario

5.1.5.1 Slum Sanitation

The Nellore Municipal Corporation under Swachh Andhra Mission has initiated to construct around 9269 individual toilets in slums that are currently under execution. With the implementation of this project it is believed that the residential sectors in the slum areas will have 100% access to toilet facilities. However, to avoid open defecation and urination, public toilets and urinals in transit areas such as bus stands and commercial areas need to be constructed.

5.1.5.2 School Sanitation

In the 51 primary and upper primary schools in Nellore, for school strength of 4572 students among which boys are 2259 and girls are 2313 there are currently 32 toilet seats for boys and 50 toilet seats for girls. Therefore, considering that 1 toilet seat is required for 50 boys, 1 urinal is required for 100 boys and 1 toilet seat is required for 30 girls, there is an immediate need to construct 13 toilet seats and 23 urinals for boys and 27 toilet seats for girls in addition to the available facilities.

In Schools

Immediate need to construct 59 toilet seats and 54 urinals for boys and 105 toilets seats for girls in primary, upper primary schools and high schools in addition to the available facilities..

In the 15 high schools in Nellore, there is an immediate need to construct another 46 toilet seats for boys, 31 urinals for boys and 78 toilet seats for girls in addition to the available 16 toilets for boys and 41 toilets for girls.

5.2 Sewerage Management

5.2.1 Present Situation

The underground drainage system in the city was laid during 1972-1973 and was first inaugurated on 3rd June, 1975 by the then Chief Minister of Andhra Pradesh – Hon'ble J. Vengal Rao. The city is presently covered with 1415 km length of drains, out of which 895 kms is pucca drain and 520 kms is kutcha drain. Out of the entire 54 wards, only 11 wards (Ward No's – 18, 19, 38, 39, 40, 41, 42, 46, 47, 48 and 49) serving a population of nearly 60,000 is covered with the underground drainage system in the city.

Major canals passing through the city are Mypadu Canal that takes off from Jaffar Saheb canal and flows east to the Bay of Bengal and Kotha Koduru Canal that branches off from Mypadu Canal and flows east, terminating at Buckingham Canal which finally discharges into Bay of Bengal.

5.2.2 Sewerage Network

Wastewater treatment and disposal is a major problem in most of the Indian cities. Discharging untreated wastewater into low-lying areas and various water bodies has resulted in severe water and land pollution problems. Presently, the city do not have a complete sewerage system while the open drains constructed along the road side ends up carrying the storm water and the waste water (black & grey) together.

Though 11 out of 54 wards in the city are provided with underground drainage facilities, these are designed without any proper disposal and treatment facilities. Therefore, there is a need to design a comprehensive sewerage system for the entire city. The length of the sewer lines in the city is 27.48 km comprising of pipes of diameters 3" to 36".

The different available diameters of sewer lines can be characterized as following:

- Trunk sewers
    - The largest sewer viz. 914 mm leading to Harnathapuram sewage pumping station along Krishnapatnam road flowing from west to east
    - The 610 mm line connecting 914 mm line sloping from north to south along Mini Bye-pass road
- Branch sewers
    - 229 mm diameter sewer is laid for about 9.5 km with large portion on the NSC Bose road
    - 203 mm dia is laid on GNT road and Justice Ansari road.

There are several other smaller lines of dia 152mm and 76mm in the city.

5.2.3 Sewage Treatment

Initially it was proposed to drain off entire sewage from the city to the 3 oxidation ponds at Allipuram through 8m sump at Harinathapuram pumping station. But as the sewage treatment plant did not take off, the entire untreated sewage is diverted to the Krishnapattanam Canal towards South-East through the same Haranathapuram pumping station by a 60 HP Vertical Turbine Pump. The entire untreated sewage is ultimately disposed into the Bay of Bengal near Krishnapattanam port. The originally envisaged Allipuram site is at present partly covered with shrubs and partly occupied illegally by cultivators.

Nellore Municipal Corporation has only one Vacuum Sewer Cleaner to clean the existing sewers.

5.2.4 Human Resources

There are no separate staffs recruited for sewerage and sanitation management. The staffs responsible for solid waste management are also responsible for sewerage and sanitation in the city.

5.2.5 Sewerage Generation

Currently Nellore city generates 46.4 MLD of sewage taking into account that approximately 58 MLD of water is supplied daily. Once 100% water supply i.e., 135 lpcd is provided to each and every

individual it is estimated that the city would generate around 94.4 MLD of sewage daily at 4.72 MLD in the Northern Bank and 89.68 in the Southern Bank.

5.2.6 Demand Assessment: Future Scenario

5.2.6.1 Sewerage System

The water demand to serve the current population is estimated to be 118 MLD and accordingly the estimated waste water generation will be 94MLD. As per the analysis, for the year 2025, the production of wastewater estimated is 133 MLD for the entire town. NMC has been sanctioned for implementing Comprehensive Sewerage Scheme under which 8 in number Sewage Treatment Plants are proposed of capacity 105MLD that would suffice in treating the waste water till 2020. Therefore, there is an immediate need to add another STP of capacity 28MLD to treat the estimated waste water generation till 2025. The waste water production till 2055 is provided in the table 24.

Table 24: Waste water production estimation for Nellore

Year	Population projected	WS demand in MLD	Waste water generation
2015	686850	118	94
2020	811829	140	112
2025	959549	166	133
2030	1134149	196	157
2035	1340518	232	186
2040	1584439	274	219
2045	1872743	324	259
2050	2213507	382	306
2055	2616276	452	362

Sanitation scenario in Nellore City:

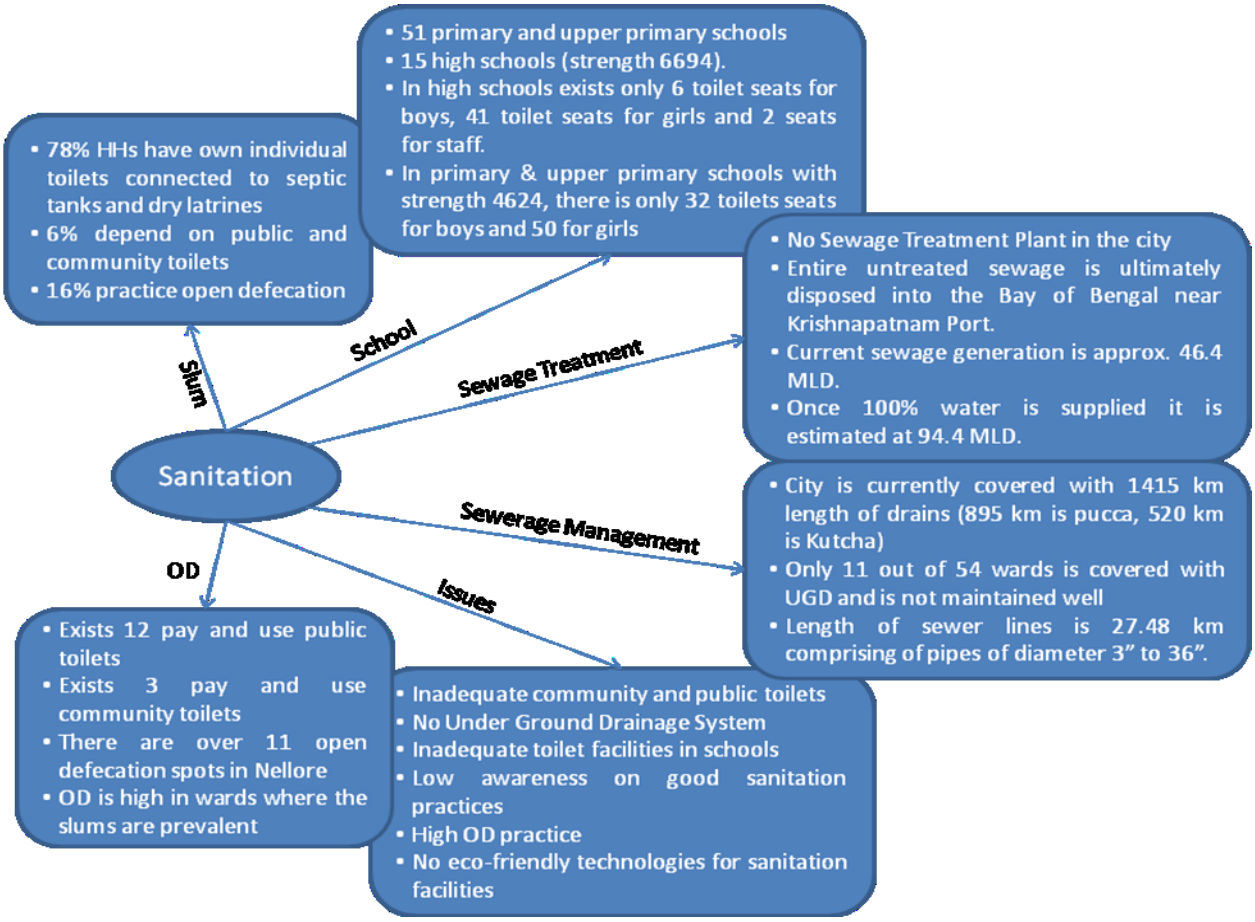


Figure 11: Sanitation scenario in Nellore City

5.3 Identified Issues for Sanitation and Sewerage System

Based on baseline data, field investigations and discussion with the municipal officials, following issues have been identified in the existing sanitation and sewerage system in the Nellore city;

- Coverage of individual toilet needs to be increased
- Require community and public toilets in commercial areas and transit places
- No underground sewerage system in the town
- No facility for treatment of waste water
- Sanitation facility in schools is a major concern as the toilets seats are very less compared to standard norms.
- Low awareness in the community regarding good health & hygiene practices, particularly in slum areas
- Statistical records of parameters like access to sanitation and sewerage need be maintained by the municipal corporation
- Lack of adequate sewage treatment facilities leads to pollution of surface water bodies (Penna River).

5.4 Ongoing/Proposed projects

1. A Comprehensive Sewerage Scheme is proposed and the same has been sanctioned by Government of India vide G.O.Ms.No.144 MA&UD (C) Dept., Dt: 17-06-2015. The estimated cost of the proposed project has come to Rs. 580.85 Crores. The project is planned to be completed by 2019. Technical features of the proposed project include
   - Laying sewage pumping mains: DI K9 pipes – 32 pipes of 250 -1100 mm dia to an extent of 340 kms.
   - Construction of 8 sewage treatment plants based on SBR technology
     1. Driver's Colony – 11 MLD
     2. Goutham Nager – 6 MLD
     3. Kondayapalem – 18 MLD
     4. Srikrishna Puram – 13 MLD
     5. Balaji Nagar – 14 MLD
     6. Head Water Works – 34 MLD
     7. Sri Ram Nagar – 4 MLD
     8. Janardhana Reddy Nagar – 5 MLD
   - Gravity Sewers Network :
     - DWC-SN8 - HDPE Pipes : 150 mm dia. for HSCs – 492.39 Kms
     - DWC-SN8 - HDPE Pipes : 150 – 300 mm dia. pipes – 426.14 Kms
     - RCC - NP3 Pipes : 350 – 1000 mm dia – 35.73 Kms.
2. Construction of 9269 individual toilets in slums. The project is already initiated under Swachh Andhra Mission.

5.5 Proposed strategies for improving sanitation facilities in Nellore City:

Proposed strategies:

- Encourage individuals to build their own toilets
- Ensure proper management system for community/shared toilets and public toilets
- Implement Community Led Total Sanitation Program
- Provide toilets for floating population, slums and other impoverished areas
- School sanitation in accordance with National School Sanitation Initiative (NSSI)
- Capacity building and awareness programs
- Ensure eradication of open defecation with 100% individual toilets
- Required comprehensive UGD scheme
- Need for periodic cleaning of drains
- Need for proper management of debris removed after cleaning/desilting work
- Eradicate choking of open drains due to dumping of garbage and other solid wastes
- Ensure proper Septage management
- Sewerage and wastewater management system for saturated areas (highly dense), developing areas, scattered areas.
- Minimization of sewage generation and reuse of treated waste water

Proposed strategies for developing sanitation facilities in Nellore City is detailed under ***Goal 2 and 3*** in ***Section 8.1: Implementation Plan.***

6 STORM WATER MANAGEMENT

The ground level of Nellore varies from 12m to 30m GTS, with the general slope towards the East. The city is broadly divided into three parts, where a small portion of the city, about 5% by area comprising wards – 1 and 50 is situated in the Northern bank of River Penna, and the other two parts is divided into eastern and western portions demarcated by the railway line connecting Gudur and Vijayawada. The ground level of the northern part of the city varies from +14m to +18m GTS, and the ground level of the south-east except the extreme south and the western portions varies from +16m to +11m GTS and +30 to +16m GTS.

The major drains which carry sewerage and storm water in Nellore city are open drains. The existing drainage system was constructed to meet temporary local needs of the community and did not take into account of the overall topography of the region for carrying the full discharge during the rainy season resulting in unhygienic conditions particularly in slum settlements.

Currently, the city has around 1415km of open drains of which 895 km are Pucca drains and remaining 520 km are Kutcha drains. The drains are usually characterized by mixed sewer overflows in the rainy season, with outlets for wastewater from individual houses opening into the storm drains. During dry season, the drains carry sullage water and wastewater from households and other establishments.

6.1 Flood prone areas

Recent floods in December, 2015 in Nellore and Chittoor districts had devastated urban physical infrastructure in the Nellore city , disrupted transport networks and resulted great disturbances in life caused by increasing incidence of heavy rainfall in a short period of time, indiscriminate encroachment of waterways, inadequate capacity of drains and lack of maintenance of the drainage infrastructure. Some of the major flood prone areas of the city are identified to be Gandhi Girijana Colony and Dr. Zakir Hussain Nagar Extension. During rainy seasons, existing RUB's in the city even witnessed floods causing traffic jams from East to West and West to East directions.

The following table details on the areas near to the water bodies and prone to flooding

Table 25: Flood prone areas in Nellore

Ward	Slum	Inundation		Flooding	
		heavy rains	normal rains	Full	Partial
9	Rayapu Harijanawada	-	✔	-	✔
23	Vengalrao Nagar	-	✔	-	✔
9	Kusuma Harijanawada	-	✔	-	✔
9, 11, 12	Saraswathi nagar	-	✔	-	✔
19	Anand nagar	✔	-	✔	-
17	Yerrakatta harijanawada	-	-	✔	-
44	Gandhi girijana colony	✔ -	-	✔	-
9	Sri venugopala swamy temple lands	-	-	✔	-
16	Akuthota harijanawada	✔	-	✔	-
11	Balija palem	-	-	✔	-

Ward	Slum	Inundation		Flooding	
		heavy rains	normal rains	Full	Partial
20	Padarupalli	-	-	-	-
19	Kondayapalem harijanawada	✔	-	✔	-
2	Dr. Zakir hussain nagar extension	✔	-	✔	-
17	Gilakala bavi sangam	-	✔	-	✔
12	Vepadoruvu	-	✔	-	✔
30	Muthyalapalem-III	✔	-	✔	-
15	Chilakala sangam	-	✔	-	✔
20	Padarupalli PHC colony	-	-	-	-

Source: Master Plan, 2011

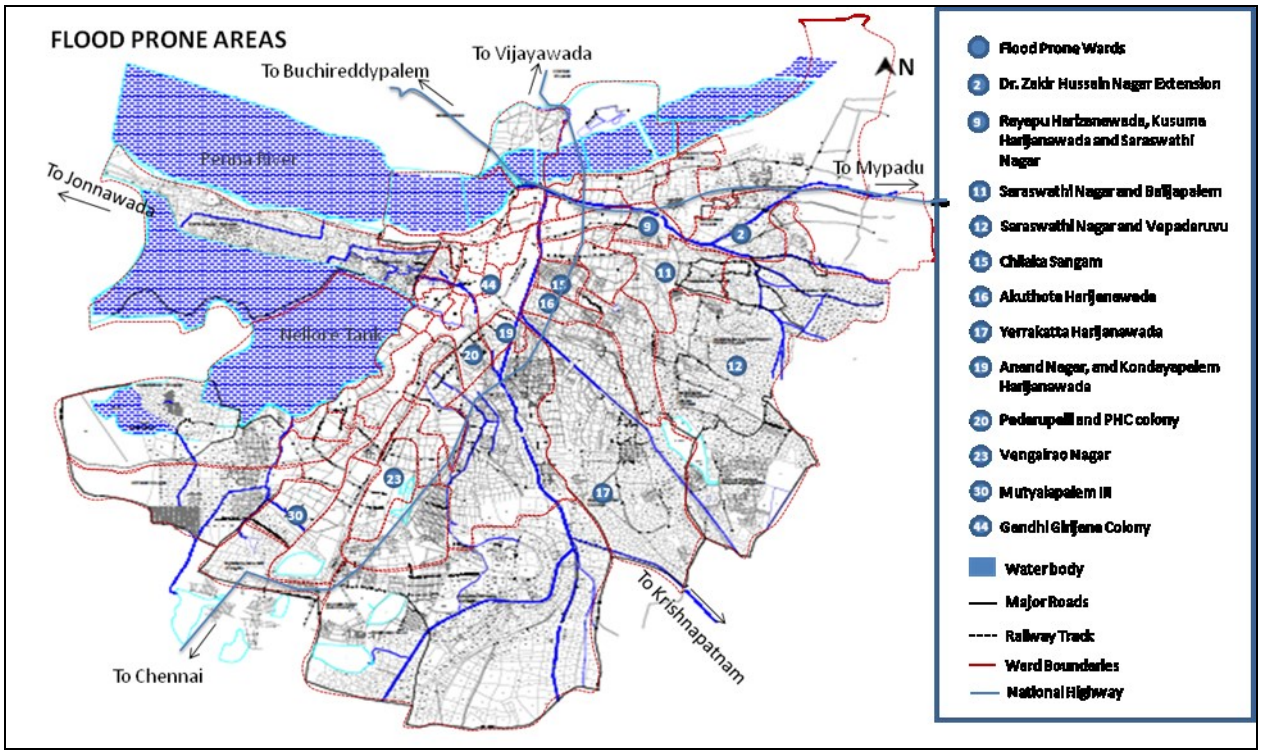


Figure 12: Flood prone areas in Nellore

6.2 Analysis of Current and Future Scenario for Storm Water Drains

6.2.1 Gap Assessment – Current Scenario

The total road length of the city is 1130km of which the drainage system covers only 63% (1415), which is far less when compared to the actual requirement of 2260km of drains covering either side of the roads. Of the entire 1415km length of drains, 63% (895 km) is pucca drain and 37% (520km) is kutcha drain. These drains carry both storm water and also wastewater generated from household activities, including sullage.

During the field survey, it has been observed that the slum households particularly, having toilets (which are not connected to the septic tank) or bathroom facilities are directly connected to these drains and the sewage & grey water are discharged directly into these drains. In areas close to agricultural fields, the wastewater from storm drains flows into downstream fields, becoming

breeding grounds for mosquitoes, thereby creating health issues. Use of untreated wastewater for irrigation is also a cause of concern. Solid waste is dumped into open drains causes choking and flooding. Besides flooding, untreated waste water disposal causes land pollution and adverse environmental impacts. There are 16 areas in the town which are prone to flooding; and have been reported major incidences during the cyclone recently in 2015.

Table 26: Service indicators for storm water drainage system

S. No.	Indicator	Unit	Norm	Status
1	Coverage of Storm Water Drainage Network	%	100	63
2	Incidence of water logging/flooding	Number	0	2

6.2.2 Demand Assessment

Considering that only 63% of the road length is covered by storm water drains, there is currently an immediate need to lay another 845km length of drains in the city

6.3 Identified issues for Storm Water Drainage System

The following have been identified for the storm water drainage system in Nellore city

- Storm water drain coverage is inadequate and most of them are defunct
- 37% of drains in the city are kutcha
- Existing drains have been constructed in an unplanned manner
- Choking of open drains due to dumping of garbage and other solid wastes
- Poor maintenance of open drains and grey water stagnation
- Need for periodic cleaning of the open drains
- Need for proper management of debris removed after cleaning/desilting work
- In the entire city there is no separate system to carry sewage and storm water separately. The road side drains also serves as sewers
- There is a need for a comprehensive storm water drain scheme in the Nellore city

6.4 Recommendations

- Removal of encroachments and unauthorized structures along natural drains
- Construction of road side drains as per the drainage designs
- Database management – detailed mapping of natural and built storm water drains
- Preparation of DPR specially for storm water management
- Installation of grating points for collection of solid waste entering into storm water drains
- Conduct feasibility study for treatment measures
- Augmentation of storm water drainage system

7 SOLID WASTE MANAGEMENT

7.1 Existing Municipal Solid Waste Management System in Nellore

Municipal Solid Waste Management is one of the major responsibilities of ULBs, typically consuming almost more than 50% of municipal budget as well as involves huge number of manpower. The increasing population and change in living standards have led to dramatic increase in MSW generation rate creating tremendous pressure on ULBs. Lack of financial resources and inefficient planning capacity has also resulted in inadequate service levels. Realizing that MSW is an essential task having direct consequences on public health, hygiene and environment, it calls for an immediate planning and execution.

This chapter discusses the existing Municipal Solid Waste Management practices in Nellore. The various sources of waste generation, amount of waste generated, existing handling and management methods prevalent in Nellore City is discussed in detail. All the information provided in this chapter is as per the interactions with various stakeholders, officials of Nellore Municipal Corporation (NMC) and site investigations performed by ICLEI – South Asia.

7.2 Institutional Capacity

The sanitary department of NMC is responsible for the provision of solid waste management services in Nellore city. The Health Officer heads the department and reports to the Commissioner. The role of the Health Officer is to ensure the overall functioning and monitoring of MSWM activities in the city.

54 wards of the city are divided into 20 sanitary divisions for effective monitoring. To manage entire city sanitation, 2 sanitary supervisors are deployed along with 20 sanitary inspectors. Each sanitary division is provided with 1 sanitary inspector where, one of the Sanitary Supervisor is supported with 13 Sanitary Inspectors and the other Sanitary Supervisor is supported with 7 Sanitary Inspectors. Sanitary Inspectors are responsible for managing entire sanitation related activities in their assigned sanitary divisions and reports to the Sanitation Supervisors, who then reports it to the Health Officer.

- 54 wards
- 20 sanitary divisions
- 2 sanitary supervisors
- 20 sanitary inspectors
- 1317 sanitary workers (293 permanent, 174 contractual and 850 society workers)

Sanitary Inspectors have engaged 1317 sanitary workers who are responsible for collection, transportation and disposal, street sweeping and drain cleaning activities. Among the 1317 workers, 293 are permanent workers, 174 are contractual workers and remaining 850 are society workers. Contractual workers are hired by Nellore Municipal Corporation for a certain period, while society workers are hired by a private society that is responsible to send agreed number of sanitary workers irrespective of the person.

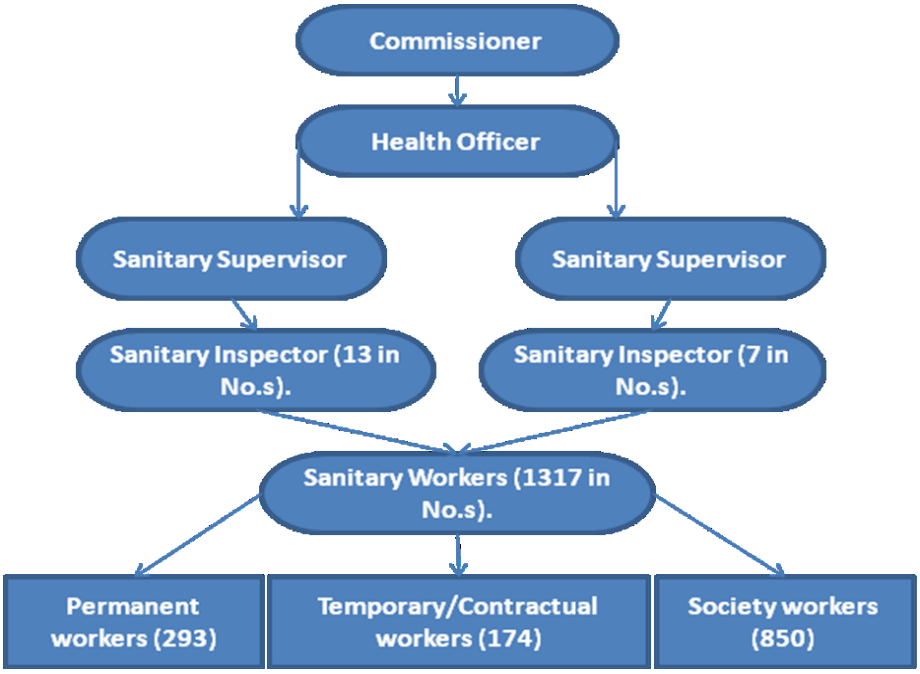


Figure 13: Institutional Capacity of Sanitation Department, NMC

The allocation of work to the sanitary workers in NMC is as discussed below:

- 173 sanitary workers are engaged for door to door collection and are provided with push carts
- 464 sanitary workers are engaged for Door to Door collection and Street Sweeping,
- 372 sanitary workers are engaged for drain silting,
- 56 workers are engaged for night sanitation n (street sweeping),
- Rest of the workers are involved as drivers: 100 for running lorries, 80 for running autos, 56 for running private tractors and 16 for running Municipal tractors.

Table 27 gives the details of the designated staff and responsibilities assigned to each position and Table 28 provides information on workers deployed under society, permanent, and temporary basis.

Table 27: SWM Municipal Staff and their responsibilities

Designation	No of Sanctioned posts	No. on rolls	Roles	Report to	Report on	Frequency
Health Officer	1	1	Overall monitoring of the system and supervise Sanitary Supervisors to Sanitary workers and head Grievance Redressal System	Commissioner	Complaint Redressal	Weekly
Assistant Health Officer	-	-	Supervise sanitary supervisors and Grievance Redressal	Health Officer	Complaint Redressal	Daily
Sanitary Supervisors	-	2	Manage city sanitation and supervise SI's to Sanitary workers	Health Officer	Complaint Redressal and allocate work/monitor Sanitary Inspectors	Daily
Sanitary Inspectors	-	20	Monitor and assign works to sanitary workers and maintain attendance	Sanitary Supervisors	Complaint Redressal, assign work and staff attendance	Daily
Sanitary Workers	-	1317	Street sweeping, door to door collection, drain cleaning. transportation, disposal,	Sanitary Inspectors	Sanitation related works	Daily

Source: Engineering Department, Nellore Municipal Corporation

Table 28: Allocation of SWM workers in each Sanitary Division involved in door to door collection, street sweeping, drain cleaning and transporting

Division	San. Division	Workers		
		Permanent	Temporary	Society
1,2,3,4	**1**	19	8	45
5,6,7	**2**	22	9	42
8,9,10	**3**	19	0	72
11,14,15,16	**4**	23	27	62
12,13,17,18P	**5**	19	3	45
29,35,36	**6**	32	8	37
27,28,30	**7**	15	5	45
20,22,37	**8**	20	14	57
19,38,39	**9**	22	6	49
43,47	**10**	22	0	21
44,46	**11**	20	4	72
45	**12**	15	5	25
51	**13**	11	0	26
49,50	**14**	10	0	35
18P,21,23,24,25	**15**	5	32	48
26,31,32,33,34	**16**	0	24	61
40,41	**17**	9	10	27
52	**18**	6	2	26
53,54	**19**	1	9	29
42,48	**20**	3	8	26
Total	**20**	**293**	**174**	**850**

Source: Engineering Department, Nellore Municipal Corporation.

7.3 Sources of waste generation

ICLEI – South Asia and its team had conducted the Solid Waste Management field investigations consecutively for 8 days from 9th -16th September, 2015to understand the physical characteristics and quantity of waste generated in the city. After a general understanding of the city, areas for the study were selected. It was ensured that the samples collected will represent different layers of the society viz. Lower Income Groups (LIG), Middle Income Groups (MIG) and Higher Income Groups (HIG) among the residential sector. Samples were collected from GT and Trunk roads for commercial sector, secondary bins near the residential, commercial and hotels and restaurants, main vegetable market and transfer station as well. The survey has been conducted for nearly 550 - 600 HHs daily for residential sector, 100 properties for commercial sector, 5 hotels for commercial sector, one main vegetable market, and transfer station.

The quantification of waste from selected areas was conducted by the team. The samples for laboratory analysis was collected through quartering method on the last day and sent to VIMTA Laboratories Pvt. Ltd for further analysis viz. physical characterization, and chemical analysis (proximate and ultimate)

The details of the waste generated at each sector per day out of the randomly selected properties during our field studies are provided in the Table 29, 30, & 31.

Residential Sector:

Table 29: Waste generation analysis from residential sector based on field study

Residential Properties				
LIG				
Days	Total HHs studied	Total HHs waste deposited (Nos.)	Total Waste (Kg)	Analysis
1	204 daily	74	157	For LIG, the total waste generation is calculated to be 1.33 kg/day with per capita generation rate at 0.309kg/day. (considering 4.31 as avg. HH size as noted during study)
2		77	123	
3		73	74	
4		80	93	
5		77	79	
6		72	82	
7		58	84	
8		62	73	
For 8 days	**1632**	**573**	**765**	
MIG				
Days	Total HHs studied	Total HHs waste deposited	Total Waste (Kg)	Analysis
1	195	92	132	Total waste generated by each HH is calculated to be 1.37kg/day with per capita
2		77	151	
3		84	109	

4		83	98	generation rate being 0.318kg/day. (considering 4.31 as avg. HH size as noted during study)
5		101	121	
6		80	137	
7		89	109	
8		89	97	
For 8 days	**1560**	**695**	**954**	
HIG				
Days	**Total HHs studied**	**Total HHs waste deposited**	**Total Waste (Kg)**	**Analysis**
1	183	73	107	Total waste generated by each HH is calculated to be 1.15 kg/day with per capita generation rate being 0.268 kg/day. (considering 4.31 as avg. HH size as noted during study)
2		139	211	
3		142	141	
4		153	148	
5		127	140	
6		142	182	
7		129	121	
8		134	154	
For 8 days	**1464**	**1039**	**1204**	
Residential (LIG + MIG + HIG)				
8 days	**4656**	**2307**	**2923**	**Analysis**
Out of the total 4656 HHs covered for 8 days only 49.5% of the HHs (2307) is observed to be giving waste daily to the worker in hand and the maximum number from the remaining 50.5% of the HHs is observed to be dumping waste daily directly in the secondary bins and at the street corners. Therefore, total waste generated from 2307 HHs is calculated to be 1.26 kg/day with per capita generation rate being 0.293kg/day (considering 4.31 as avg. HH size).				

Source: Analysis developed by ICLEI South Asia based on the field studies conducted.

Considering that each HH generates 1.26kg of waste every day, the entire city with 159362 HHs (2015) is estimated to generate around 200796.1kg of waste daily, i.e. approximately 201 tons per day.

Commercial Sector:

Table 30: Waste generation from commercial sector as per field study

Commercial Sector				
Days	Total properties	Total prop. waste deposited	Total Waste (Kg)	Analysis
1	55	30	65	Out of the total 513 properties covered for 6 days only 53.41% of the prop. (274) disposing waste daily. Therefore, total waste generated by each prop. is calculated to be 2.46kg/day.
2	102	64	111	
3	102	56	119	
4	102	56	144	
5	50	15	100	
6	102	53	136	
Total for 6 days	**513**	**274**	**675**	

Source: Analysis developed by ICLEI South Asia based on the field studies conducted.

Therefore, considering that each commercial property generates around 2.46kg/day, with 7150 total properties covering entire city, commercial sector is estimated to generate around 17589 kg of waste daily, i.e. 17.5 tons per day.

Veg. Markets:

The vehicles transporting waste from the vegetable markets were weighed for 6 days. The total amount of vegetable waste generated in the city is calculated below:

Table 31: Waste transported from veg. market at Nehru Statue to Transfer Station

Vegetable Waste		
Waste transported to Transfer Station every day		
Day	Waste (Kg)	Tractor trips per day
1	7660	2 trips (4920kg + 2740 kg)
2	17290	4 trips (4720 + 3680 + 3980 + 4910 kg)
3	7180	2 trips (4000kg + 3180 kg)
4	6320	2 trips (3060kg + 3260 kg)
5	12990	4 trips (2770 + 2970 +4480 + 2770 kg)
6	10210	3 trips (3940 + 2400 + 3870 kg)
Total	**61650**	*Consider 3 trips on an average per day*

Source: Analysis developed by ICLEI South Asia based on the field studies conducted.

It is estimated that on an average 10275kg of waste, i.e. 10.28 tons of waste per day is transported to the transfer station from the main vegetable market at Nehru Statue area.

Restaurants:

During the field investigations it was found that 650 kg of waste was generated from each restaurant for every 4 days. Based on this information, it is estimated that around 20300kg i.e. 20.3 tons of waste is generated daily from the existing 125 restaurants in the city. It is also

very interesting to note that as much as 70% of food waste from restaurants is collected by pig feeders to be used as feed hence only 6.09 TPD of waste needs to be disposed.

Following the above analysis through field studies, it is observed that residential sector is the major source of waste generation in the Nellore city followed by commercial sector.

Residential waste comprises of the municipal solid waste that originates from single and multi-family households, while the commercial waste addressed above comprises of the solid waste that originates in wholesale and retail stores, warehouses and other commercial shops and establishments. Though waste from banquet halls, hotels, institutions, offices, hospitals, fish market and slaughter houses are not considered in this study, waste from these sectors along with the waste from street sweeping and drain cleaning also forms the part of the municipal solid waste.

7.4 Waste generation from different sectors

From the field investigations and the analysis discussed above, following can be summarised about the waste generation from different sectors in Nellore:

- Residential Sector (comprising LIGs, MIGs and HIGs): 201 TPD
- Commercial Sector: 17.5 TPD
- Restaurants: 20.3 TPD (Accounting 70% of food waste being used as feed for pigs, it can be calculated as 6.09 TPD)
- Vegetable Market: 10.28 TPD
- Others (hotels/institutions/hospitals/fish markets/slaughter houses, street sweeping and drain cleaning): 52.9 TPD[5]

Hence, the total amount of waste generated in the city is calculated to be 287.77 TPD

- The quantum of waste generated from specific sources is listed in the Table 32.

Table 32: Waste generation in Nellore city

Waste Generators	No. of Units	Waste Generated (TPD)	%
Residential	159362[1]	201	70
Veg. markets	1	10.28	4
Restaurants	125	6.09	2
Street sweeping		21[6]	7
Drain Silt		20[2]	7
Commercial shops	7150	17.5	6
Hotels/lodges, Restaurants, institutions, Hospitals, Offices, etc	-	11.9[2]	4
Total		**287.77**	**100**

Source: Calculated by ICLEI South Asia based on the data through field studies

[5] 52.9 TPD is estimated by IPE Global in a SWM study developed for APUFIDC. 3 tpd from hotels, 3.2 tpd from institutions and offices, 0.6 tpd from hospitals, 5.1 from fish market and slaughter houses, 21 tpd from street sweeping and 20 tpd from drain cleaning.

[6] Draft detailed project report on SWM for Nellore developed by IPE Global for APUFIDC

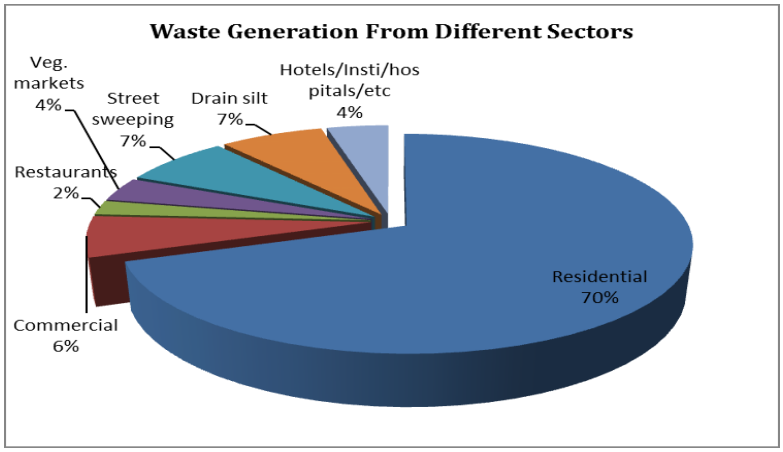


Figure 14: Sources of waste generation in Nellore City

In the following chapters the analysis has been done integrating commercial shops, hotels/lodges, restaurants, schools/college, offices, hospitals/nursing homes/diagnostics, and slaughter house wastes under one category as commercial.

7.5 Waste generation quantity and composition

The gross per capita generation from the city based on the total municipal waste generated excluding waste from street sweeping and drain silting is considered to be 359 grams per capita per day.

In order to assess the quantum of waste generated in future years, waste increase from life style change is also considered in addition to the increase due to population growth. A growth rate of 1.5% is ascribed to accrue annually as a consequence of lifestyle change. Based on this consideration, municipal solid waste generation in the city of Nellore is expected to get more than double i.e. 580.21 TPD by 2033.

Table 33: Population and waste projected till 2055

Year	Population (at 3.4% growth rate)	Annual Domestic Waste	
		Tons/Day	Tons/Year
2015	**686850.00**	**246.77**	
2016	710202.90	258.99	94530.47
2017	734349.80	267.79	97744.50
2018	759317.69	281.05	102583.83
2019	785134.49	294.97	107662.76
2020	811829.07	309.57	112993.14
2021	839431.25	324.90	118587.43
2022	867971.92	340.98	124458.70
2023	897482.96	357.86	130620.65
2024	927997.38	375.58	137087.68
2025	**959549.29**	**394.18**	143874.89
2026	992173.97	413.69	150998.13
2027	1025907.88	434.18	158474.05

Year	Population (at 3.4% growth rate)	Annual Domestic Waste	
		Tons/Day	Tons/Year
2028	1060788.75	455.67	166320.10
2029	1096855.57	478.23	174554.61
2030	1134148.66	501.91	183196.81
2031	1172709.71	526.76	192266.88
2032	1212581.84	552.84	201786.01
2033	**1253809.63**	**580.21**	211776.44
2034	1296439.15	608.94	222261.49
2035	**1340518.09**	**639.08**	233265.66
2036	1386095.70	670.73	244814.64
2037	1433222.95	703.93	256935.41
2038	1481952.54	738.78	269656.28
2039	1532338.92	775.36	283006.97
2040	1584438.44	813.75	297018.64
2041	**1638309.35**	854.04	311724.04
2042	1694011.87	896.32	327157.49
2043	1751608.27	940.70	343355.06
2044	1811162.95	987.27	360354.57
2045	**1872742.50**	**1036.15**	378195.72
2046	1936415.74	1087.45	396920.19
2047	2002253.88	1141.29	416571.71
2048	2070330.51	1197.80	437196.18
2049	2140721.74	1257.10	458841.76
2050	2213506.28	1319.34	481559.02
2051	2288765.50	1384.66	505401.00
2052	2366583.52	1453.21	530423.41
2053	2447047.36	1525.16	556684.67
2054	2530246.97	1600.67	584246.13
2055	**2616275.37**	**1679.92**	613172.15

Source: Projected by ICLEI South Asia

The average population growth rate from 2001 to 2011 is 33.6%. Considering an annual average growth rate of 3.4%, the population listed in the Table 33 has been projected from the year 2015 to the year 2055. This growth rate has not been calculated considering the growth rate with the recently included Gram Panchayats into the Nellore Municipal Corporation but the population for the newly added Gram Panchayats has been considered.

Physical Characterization of Waste:

During the field studies, the team had conducted physical characterization of waste samples from households using quartering method and the details are provided in the Table 34.

Table 34: Composition of waste from residential HHs in Nellore

Waste Type	Waste type fraction (%)
Organic	67.98
Recyclables	
Plastic	1.61
Polythene	8.29
Medical	2.27
Glass	1.05
Metal	0.15
Paper	7.61
Cardboard	1.05
Coconut Shells	5.44
Textile	2.87
E-waste	0.13
Thermocol	0.23
Leather/Rubber	1.01
Sack Bags	0.17
Wood	0.14

Source: Survey conducted by ICLEI in September, 2015.

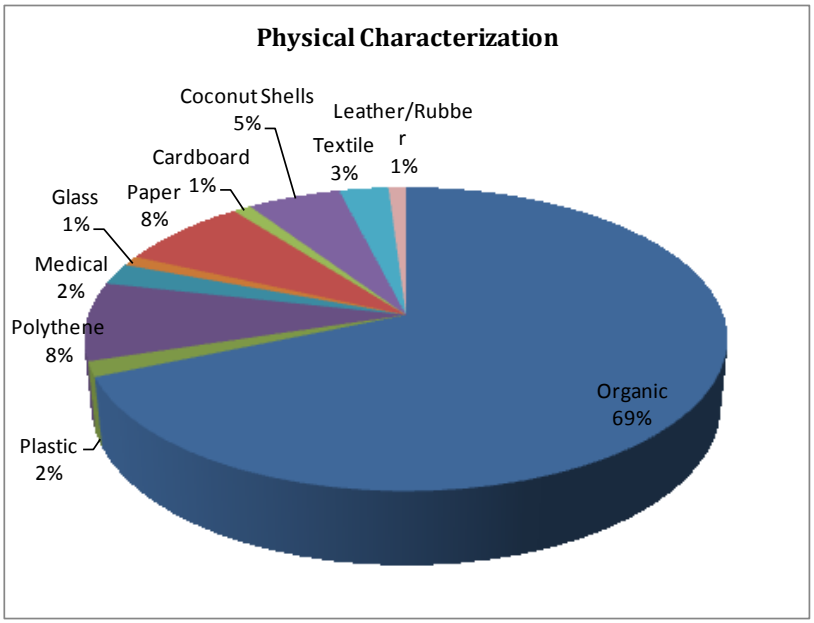


Figure 15: Physical characterization of MSW in Nellore

Chemical Composition:

The samples from study investigations were sent to the lab for further analysis. The chemical composition of the waste from the residential, commercial, hotels, vegetable markets, transfer station and secondary bins are provided in Table 35.

Table 35: Chemical composition of waste

Analysis	Units	Residential	Commercial	Hotels	Veg. Market	Transfer Station	Secondary Bins
Proximate Analysis							
Moisture	%	51.96	47.21	61.83	82.08	71.62	43.59
Ash	%	11.83	6.4	1.79	2.46	16.63	8.38
Volatile Matter	%	35.04	38.29	32.9	10.84	6.92	43.19
Fixed Carbon	%	1.17	8.1	3.48	4.62	4.83	4.84
Ultimate Analysis							
Mineral Matter	%	24.63	12.12	4.69	13.73	58.6	14.86
Carbon as C	%	41.27	41.23	46.88	28.12	22.49	42.36
Hydrogen as H	%	5.69	6.12	7.08	4.4	3.3	5.97
Nitrogen as N	%	0.53	0.57	1.78	1.41	0.69	<0.10
Sulphur as S	%	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygen as O (as remainder)	%	27.78	39.86	39.47	52.24	14.82	36.61
Gross Calorific Value	Kcal/Kg	2450	2261	1825	546	571	2192
Net Calorific Value	Kcal/Kg	4798	3959	4407	2816	1838	3569
Chlorides as Cl	%	0.48	0.63	1.56	1.11	0.75	1.03
C:N Ratio	-	41.2:0.5	41.2:0.5	46.8:1.7	28.1:1.4	22.4:0.6	42.6:0
P2o5, K2O Analysis							
Potassium as K2O	%	5.33	7	8.11	14.52	5.66	7.43
Phosphorus as p2O5	%	6.07	6.32	36.77	8.8	6.26	4.64

Source: Analysis from VIMTA Labs to the waste sample provided by ICLEI

7.6 Existing MSWM Practices Prevailing in Nellore City

This section describes the existing practices pertaining to MSWM in the city.

7.6.1 Storage of Domestic waste at source

Waste is stored either in plastic waste bins or in plastic covers/polythene bags at household level. Waste segregation is not practiced at all in the city. Recyclable material such as paper, cardboard and metal is sold to the local rag-pickers.

7.6.2 Storage of market & trade waste at source

Waste in commercial markets is stored in plastic receptacles or polythene bags which are kept at the store front.

7.6.3 Segregation of recyclable wastes

Currently, there is no practice of waste segregation at source taking place. However, segregation at very macro level is being practised by the rag-pickers who separate recyclables like polythene; plastics etc. at transit point located in ward no. 5 as well as at existing dumping site located at Dhontali and sell it to the private agencies.

7.6.4 Primary collection of domestic waste

- Only 22 wards out of 54 wards of the City is covered under the 100% door to door collection. While in the rest of the 32 wards, it is practiced only partially.
- Municipal workers, society workers and temporary workers are involved in door to door collection in the city.
- 173 push carts with 4 bins each and 40 autos with hooters are engaged in city for primary collection of waste at household level. Each bin in the push cart is of 60 kg capacity and the autos are of 1.5 cum capacity.
- In the commercial areas autos of capacity 1.5 cum are engaged for waste collection.
- On an average 3 push carts are provided for every individual ward. Each pushcart is pushed by one worker who also collects waste from Households.

Figure 16: Door to Door collection of waste in Nellore

Wards with 100% door to door waste collection	3, 4, 5, 6, 7, 8, 16, 17, 33, 34, 39, 40, 41, 42, 44, 45, 46, 48, 49, 50, 51 and 52.

It is observed during the field studies that each pushcart covers around 200 households with an average of 2-3 trips a day depending on the need. At several corners of the street, secondary bins are also provided to collect the waste from the households. There are of about 137 secondary bins in the entire city at an average of 2 - 3 bins for each ward. Autos cover around 1000 Households in each trip and dumps the waste collected directly at the Transfer Station.

Pushcarts and autos together cover around 60, 000 households out of total 159362 (as per 2015) households, which are about 38% of the total households. Each auto has two persons allocated for it – one driver and one helper.

Door to door collection takes place daily starting from 7 am to 11 am. Residents get their waste out when these workers blow a whistle and dump in the pushcart or the auto.

7.6.5 Street sweeping and drain cleaning

One worker is deployed for a stretch of 500m in Nellore city. Waste piles heaped after street sweeping are collected by the pushcart workers after the door to door collection is completed. Road dust and sand is often mixed with waste from households, shops and restaurants. The waste collected is transported to the nearby secondary bins by means of pushcarts.

On main roads street sweeping is done 3 times a day on a daily basis between 5.30am and 10.30am; 3pm to 6pm and 10pm to 4pm. Streets are swept once a day on a daily basis between 5.30am to 10.30am for the minor roads.

Separate workers are deployed for drain cleaning and the drain silts are also disposed off again at the nearby secondary bins. All internal drains are cleaned daily and major drains are cleaned weekly once.

Figure 17: Street sweeping in Nellore city

Sweepers are provided with brooms, tubs and hand carts for street sweeping and brooms and bamboo stick to clean drains. In addition to the existing secondary bins, NMC has also proposed to construct concrete bins at the street corners.

7.7 Waste storage depots

The waste collected from households and commercial areas, is dumped either in community bins or at open areas. A total of 137 bins i.e. 2-3 bins per ward, are available with the Nellore Municipal Corporation. Each bin with a capacity of 3 cum can carry around 205 tonnes of waste. While the quantum of waste bins is sufficient to cater to the total waste generated, there is a scope to ensure their need based placement, in order to get rid of the open kachra points.

Table 36: Secondary bins location and its capacity

Election Division	San. Division	Capacity (in tonnes)	No. of bins
1,2,3,4 & 9	1	1.5	7
5,6,7	2	1.5	9
8,10	3	1.5	10
11,14,15,16	4	1.5	6
12,13,17,18	5	1.5	9
29,35,36	6	1.5	9
27,28,30	7	1.5	6
21,22,37	8	1.5	8
19,38,39	9	1.5	9
43,47	10	1.5	6
44,46	11	1.5	5
45	12	1.5	6
51,52	13 & 18	1.5	6
49,50	14	1.5	6
20,23,24,25	15	1.5	9
26,31,32,33,34	16	1.5	6
40,41	17	1.5	6
53,54	19	1.5	8
42,48	20	1.5	6

Source: Engineering department, Nellore Municipal Corporation

Figure 18: Secondary bins in Nellore

7.7.1 Secondary collection and transportation of waste

Waste is transported from secondary storage points to the transfer station through the use of autos, tractors, dumper placers and lorries (407s).

- Autos transport the waste collected directly from HHs and commercial areas to the transfer station instead dropping at the secondary points. The city has in total 42 autos, among which 1 is used for fogging and 1 for collecting drain silt and the remaining 40 autos are engaged for door-to-door waste collection and waste disposal. On an average 110 trips to transfer station are being made by 40 autos dumping around 510 kg of waste daily in each of its trip. On public holidays and on Sundays, only around 10 – 15 trips are observed to transfer stations by entire 40 autos.

- The city is served by 16 tractors, among which 4 are owned by Municipal Corporation and 12 are private tractors catering to 20 sanitary divisions. Each tractor with a capacity of 3 cum. carries on an average 1890 kg of waste from the designated open sites, commercial areas and from the road sides to transfer station in its each trip making 4 trips daily. On public holidays and on Sundays it is observed during field studies that each tractor makes only one trip to the transfer station accounting to 16 trips daily by 16 tractors. These 16 tractors also include the vegetable. market waste being transported separately by the market tractors to the transfer station. Tractors from vegetable. market makes 3 trips daily carrying around 3650 kg of waste in its each trip i.e. 10950 kg.
- In addition to the tractors and autos, 5 Dumper Placers and 18 Lorries (407s) dumps waste collected from secondary points, designated open sites, and commercial areas and from the road sides at transfer station. On an average each dumper placer makes 3 trips daily carrying 2450 kg of waste in each of its trip and each lorry makes 1 trip daily carrying 1745 Kg of waste in its each trip.

Approximately, 245.22 tonnes of waste is transported daily from HHs and secondary points to the transfer station, or in other words 85% of the entire city waste generated is being transported to transfer station.

Table 37: Waste transported to transfer station

Vehicle Type	No. of vehicles	Avg. no. of trips	Total vehicle trips	Waste carried in each trip (Kg)	Total waste transported to Transfer Station (Kg)
Autos	40	2.5 - 3	110	510	56100
Tractors	16	4	64	1890	120960
Dumper Placers	5	3	15	2450	36750
Lorries	18	1	18	1745	31410
Total					**245220**

Source: Analysis obtained from field studies by ICLEI

The waste dumped at the Transfer Station is again collected and transported to the final dumping point "*Dhontali Dump Site"* which is located at a distance of 27 km from the Nellore City by means of Compactors and Tippers. Dhontali dump site that falls in Kothur Panchayat is spread over in 25 acres of land and is in use since 2010. The site is currently observed to have piled up with waste at an estimated height of 6-7 feet. Before Dhontali, the waste was being dumped at the Allipuram site which is spread in 6.5 acres located in the corporation limits.

The city has 6 Tippers and 1 Compactor to transfer the waste from transfer station to the final dumping point at Dhontali. Considering that each tipper makes on an average 6 trips daily carrying around 6030 kg of waste in its each trip and Compactor makes on an average 6 trips daily carrying around 4640 kg of waste in its each trip to the dumping site, it is calculated that 6 tippers transports around 217 TPD and compactor transports around 28 TPD to the dumping site from transfer station i.e. all together 245 TPD of waste is transported to the dumpsite.

7.7.2 Processing and disposal of waste:

Figure 19: Waste disposal and collection at transfer station to transport to dump site.

Figure 20: Dump site at Dhontali

In the absence of any segregation taking place, entire waste that is collected is dumped at Dhontali which is located at a distance of 27 km from the Nellore City.

Presently, there is no waste processing plant existing in the city as well as no scientific disposal facility thereby causing unsanitary conditions and environmental hazards in the surrounding area..

7.8 Gap Analysis

7.8.1 **Manpower & Vehicle requirement for DTD Collection, Street Sweeping,** Drain cleaning and Transportation of waste to Transfer Station and to Final Dump Site:

Primary Collection:

Nellore Municipal Corporation has permanent staff for executing and monitoring all the activities related to sanitation in the city. In addition, the corporation has also hired temporary staff and society staff on contract basis to support solid waste management activities in the city. At present, door to door collection is being practiced in 22 wards by both the permanent and temporary staff. In order to increase efficiency of collection and ensure regular continuous service, it is proposed to engage more municipal permanent workers for the purpose of door to door collection and street sweeping.

As informed by the municipal officials, approximately 30% of the HHs in the city is scattered wide giving way only for the autos to collect the waste while the remaining areas can be covered by pushcarts. , Considering that 1 auto covers around 1000 HHs and 1 pushcart covers around 200 HHs, it is proposed to procure another additional 8 autos and 385 pushcarts to supplement the existing 40 autos and 173 pushcarts.

Also to cover commercial sector with nearly 7150 properties, it is proposed to procure 7 more autos to the aforementioned 8 autos.

Therefore, to run the proposed number of pushcarts and autos for residential and commercial sectors, the corporation shall engage additional 385 pushcart workers and 30 auto workers.

Street Sweeping:

The length of roads in the city being at 1130 km stretch (Asphalt – 60 km and Concrete – 240 km), considering that one worker shall cover 500m it is proposed to engage 2260 workers specifically to carryout street sweeping and drain cleaning. Workers engaged in street sweeping shall also be engaged in drain cleaning along the same beat.

Secondary collection and transportation to transfer station:

Autos dump waste directly from the HHs at the transfer stations without dumping at the secondary bins. The waste disposed at the secondary bins from domestic, street sweeping and drain silting is collected and transported to the transfer station by means of tractors, dumper placers and lorries. As mentioned under subsection 1.12 that only 245.22 TPD of waste is being transported to the transfer station out of the total 287.77 TPD of waste generated in the city, it is recommended to procure 6 new Dumper Placers or increase the number of trips by the vehicles to transport balance 42.55 TPD of waste to the transfer station instead procuring additional vehicles.

Waste transportation from Transfer Station to final Dump site:

As mentioned in subsection 7.13 that of the entire daily waste dumped at the transfer station only 245 TPD is being transported to the final dump site with the available tippers and compactors, considering that balance 42.77 TPD is to be transported to the dump site, it is recommended to procure 1 compactor and 1 tipper or increase one trip by each tipper and compactor to transfer the waste disposed at the transfer station.

Man Power and vehicle requirements:

With the above analysis to collect 100% waste from HHs, and transfer 100% waste from secondary bins to the transfer station and to the dump site there is a requirement to procure 385 pushcarts and 15 autos. In addition to this there is also a need to hire another **1769** workers for collection and transportation of waste in the city.

Table 38: Existing and proposed man power and vehicle requirements

Activities	Residential	Commercial
Door to Door Collection		
Total HHs	159362	7150
Total Pushcarts available	173	-
Total Autos available	40 (including residential and commercial)	
Total Pushcarts required	558	
Total Autos required	55	
Pushcarts gap	385	
Autos gap	15	
Street Sweeping		
Length of streets	1130 Km	
Manpower Availability		
DTD and street sweeping manpower	464	
Sweeping (Night)	56	
Drain Silting	372	
Auto Workers	80	
DTD	173	
Tractor workers	72	
Lorry + Dumper placer + Compactors workers	100	
Total Manpower Available	**1317**	
Manpower requirement		
DTD (residential)	558	
Street sweeping and drain silt	2260 (one person for 500m)	
For running autos	110	
Night sweeping	56	
For Tippers	12	
For Tractors	42	
For Dumper Placers	10	
For Compactors	2	
For Lorries	36	
Total Manpower required	**3086**	
Total Manpower Gap	**1769**	

Source: Analyzed by ICLEI South Asia

7.8.2 Sufficiency of secondary collection bins:

Total of 137 bins with each bin at capacity 3 Cu.m that carry around 205 tonnes of waste are available in the city. As per the CPHEEO norms, ULBs should provide for the storage capacity which is 20% more than the expected daily in flow of waste. There is a need to provide storage capacity for at least 344 TPD of waste. With the capacity to store 205 TPD of waste already in

place, there is a need for storage of additional 139 TPD of waste. An additional 278 bins of 3 cum capacity is needed to meet the demands for secondary storage of waste.

Table 39: CPHEEO norms for secondary bins

Quantity of waste	287.77 TPD
Number of Secondary Bins	137
As per the CPHEEO Norms, 20% more than expected quantity of waste	344 TPD
Gap	278 bins of 3 cum

7.8.3 Sufficiency in treatment, processing & disposal facilities

- The city does not have any processing or treatment plants. The waste collected is directly dumped in secondary bins or transfer stations.
- No recovery of resources is being parctised
- Construction and demolitions waste is dumped at the open and low lying areas at various locations in the city.
- Dhontali dumping site which is in 25 acres of land is currently piled up with waste at an estimated height of 6-7 feet. The site is being in use since 2010. Before Dhontali, the waste was being dumped at the Allipuram Site which is spread in 6.5 acres located in the Corporation limits. At present there is no waste processing plant existing in the city as well as no scientific disposal method being followed causing unsanitary conditions in the surrounding with leachate generation.

7.9 SWM scenario in Nellore City:

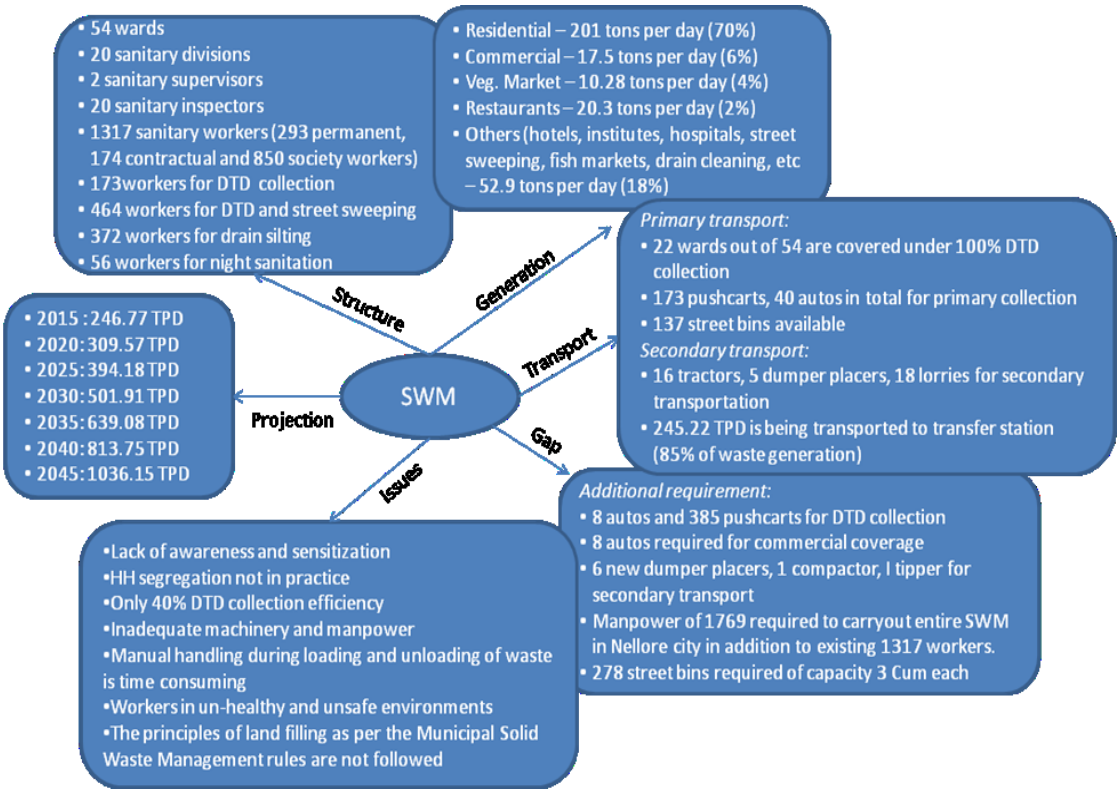


Figure 21: SWM scenario in Nellore City

7.10 Identified Issues for Solid Waste Sector:

While conducting field studies in Nellore in September, 2015, following issues were identified in discussion with the public and the officials from the corporation and public health towards management of solid waste in the Nellore City.

- Lack of awareness and sensitization among public regarding reduction, segregation and proper storage of the waste in the house.
- Segregation of waste at household level is not done. Hence, the organic and inorganic waste land up in the dump site.
- Collection efficiency of the door to door collection system is less than 40% and needs improvement to cover entire city
- Inadequate machinery and manpower
- Manual handling of waste for loading and unloading during collection and transportation is time consuming
- Workers do not have PPEs. Most of them are working in unhealthy and unsafe environment
- The principles of land filling as per the Municipal Solid Waste Management rules are not followed

7.11 Proposed strategies:

- Waste avoidance
- Practice and achieve 100% segregation at HH level
- Zero bin program
- Need to procure machinery and manpower immediately
- MSWM rules to be followed
- Waste transformation (without resource recovery) prior to disposal
- Resource recovery through material recycling
- Maximise on market opportunities in resource recovery technologies.

8 IMPLEMENTATION PLAN

During the project period, the current issues that affect the growth of Water Supply, Sanitation, Storm Water Drainage and Solid Waste Management sectors along with the existing situations, practices and ongoing central and state schemes for the improvement of the same were studied and analyzed considering future demand till 2045. Based on the analysis developed on the current sanitation situations/practices, certain strategies for the development of the said sectors that suit for Nellore city are recommended.

This chapter summarizes the recommendations and strategies that have been addressed for the development of sanitation situation in the Nellore City optimally. To recommend the best suitable measures for each and every sector, the city has been categorized into 4 zones - *North bank of River Penna; Saturated Zone (South bank of River Penna); Developing Zone (South bank of River Penna)* and *Agricultural Zone (South bank of River Penna)* as depicted in the figure below.

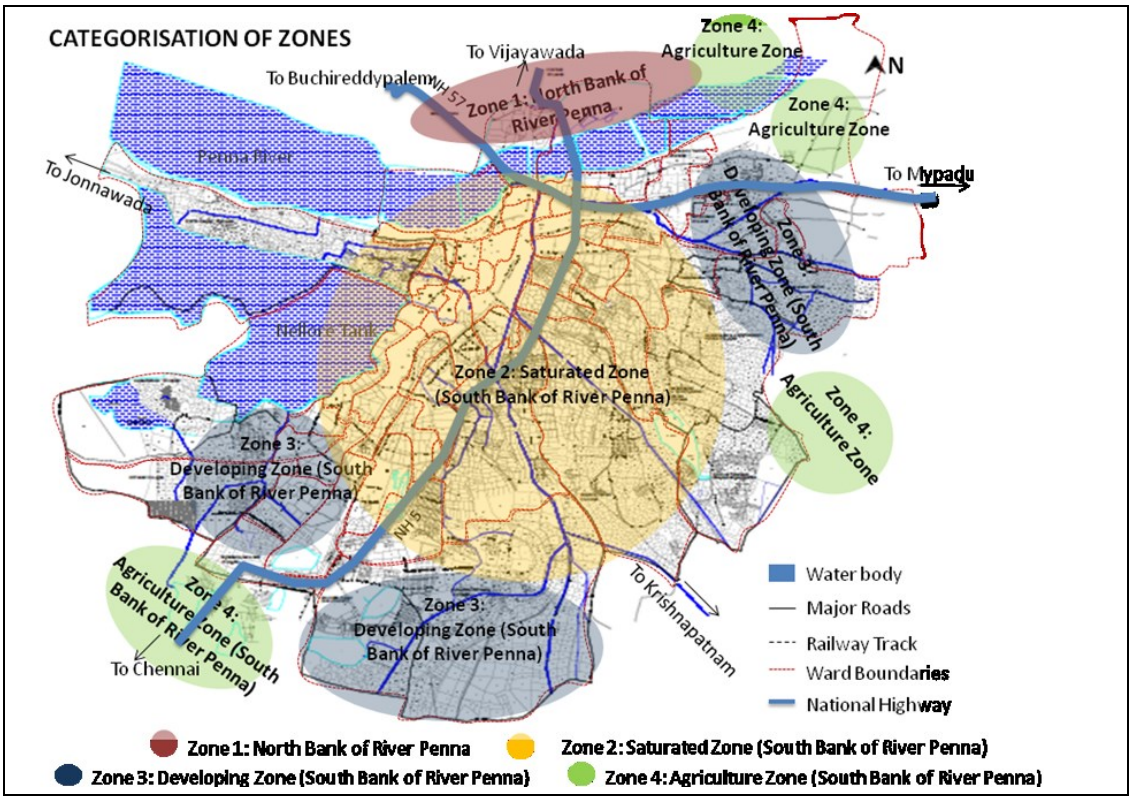


Figure 22: Categorisation of Zones

Considering that CSP's mandate is to understand and develop all aspects of safe and sustainable sanitation, that includes strategic, technical and managerial interventions, the main concerns were classified into Hardware and Software components while planning a sanitation strategy for Nellore city. Software component address institutional roles and responsibilities, awareness generation and capacity building, while Hardware component address the technologies, designs and the implementation strategies keeping in mind sustained improvements, which reaches the un-served and poor in a city-wide approach.

8.1 Implementation Plan: Hardware Component

The city sanitation plan includes strategic technical and managerial interventions for successful achievement of the vision, which includes:

- Safe access to water
- Safe access to sanitation services
- Safe collection, disposal and treatment of household liquid waste
- Safe disposal of storm water drainage
- Safe collection, transport, treatment and disposal of solid waste

For the city to achieve 100% sustainable sanitation, ICLEI-SA has recommended short term (2016-2021), medium term (2022-2027) and long term (2028-2033) action plan goals based on the numerous one-to-one meetings with the officials from Nellore Municipal Corporation towards the development of this CSP. The following table presents the overall general goals for services

Table 40: Overall goals for services

Goal	Present	Short term (2016-2021)	Medium term (2022-2027)	Long term (2028-2033)
Water Supply	68%	100%	100%	100%
Solid Waste Management collection	85%	90%	100%	100%
Access to Toilets (Slum Level)	78%	90%	100%	100%
Sewerage	-	100%	100%	100%
Drainage/Storm Water Drains	63%	100%	100%	100%

Management of municipal waste, scarcity of water and addressing the issues related to water supply has been identified as priorities, with 100% coverage by 2021. Accordingly, access to sanitation, sewerage management and drainage has been considered as second priority, as it will be only by 2027 when total coverage will be met. Also 100% provision of the two basic services benefiting the poorest sectors of society and eradicate open defecation have also been prioritized.

Table 41: List of identified problems for different sectors

Solid Waste	Water Supply	Access to Sanitation	Sewage Management	Storm Water
• Lack of awareness regarding reduction, segregation and storage of waste at HH level.	• Inadequate water supply • No access for new WS sources • Inadequate water storage facilities • Low accessibility to the	• Poor awareness among public on proper sanitation pract	• No comprehensive septage management. • Incomplete underground drainage network system.	• No dedicated storm water drains. • Choking of drains due to solid waste. • Insufficient coverage

Solid Waste	Water Supply	Access to Sanitation	Sewage Management	Storm Water
• Only 40% of the city is covered with Door to Door extension. • Absence of a centralized MSW processing plant. • Absence of scientific landfill for disposal. • Inadequate machinery and manpower • HHs throwing garbage on the roads and drains	piped network. • Unmetered connections. • Unsatisfactory quality of water for drinking purpose • Defunct galleries, wells, hand bores and power bores • Poor awareness among public	ices • 30% of the slums still need individual toilet facilities • Lack of community and public toilets in slums and at major floating areas. • High practice of Open Defecation. • Poor sanitation practices in scho	• No separate drains for sewage and storm water. • No Sewage Treatment Plant in the town. • Need of recycling and better disposal method for sewage water.	of storm water drainage • Width of existing open drains is very less affecting their capacity.

Solid Waste	Water Supply	Access to Sanitation	Sewage Management	Storm Water
		ols • Lack of proper planning, management, operation and maintenance of existing community and public toilets.		

Based on the availability of resources, planning has been made to achieve the aspects of sanitation according to the prioritization. Very evidently, capacity building in terms of understanding the areas of immediate attention as well as equipping Nellore with the necessary skill set to create a sense of responsibility and participation among the residents require immediate attention in view to support future technical interventions. In view of limited resources, it is also prudent to prioritize interventions in terms of the required financial resources. Evidently, high-priority interventions, requiring low or minimal capital investment, are recommended to be taken up in the short term, while interventions requiring higher capital investment and O&M costs should be taken up later in a phased manner. Furthermore, it is important to take into account that currently a set of DPRs are being developed for improving sewerage management, solid waste and water supply, and the strategies to be proposed should build up on these initiatives.

This approach is used to also define appropriate time horizons for various components of the City Sanitation Plan, as shown below:

- Given the novelty of Nellore Municipal Corporation, and the re-structuring due to the merger of 15 Gram Panchayats, there is a need to implement the institutional frameworks and management systems to implement successfully the technical components of the City

Sanitation Plan. Without a proper monitoring and O&M system it is not possible to ensure the sustainability of the actions. The managerial systems and institutional set up should be first priority, and should be completed in a matter of year.

- The current sewerage system in the city is defunct and only 8.7% of the city is provided with sewerage network. While implementing the approved "Comprehensive UGD Scheme", the sewerage network needs to be designed and sized for a long time horizon. The main sewers and intercepting sewers may be designed and constructed to accommodate even the future flows from areas which are developed in stages during the 25 year horizon period as the periodic duplication of the works is not possible at short intervals. However, the network of branch sewers and laterals to be designed during the initial stage will cover only the existing road network and as and when new roads develop, this network will have to be extended in stages.

- Facilities like individual toilets, public toilets, community toilets and roadside drains should be designed considering the present population and incremental population while planning the need at the early stages of requirement and construction. While some components like sewerage treatment plants and pumping stations can be developed in modular fashion in stages as the demand develops.

- While developing initiatives in improving Solid Waste Management services, it is necessary to consider future demand for another 25 years from the current year. A zero bin city concept would bring in environmental, economical and financial benefits to the city, which can be implemented in stages started at one ward and expand it to the entire city.

- Activities towards eradicating open defecation have to be started immediately.

The specific goal, timeframe to achieve the goal and strategies are proposed in the following section based on the baseline status of each of the service sector:

Goal 1: Proposed strategies for Water Supply

Drinking water supply is a very important parameter for upkeep of sanitation facilities and environment/health status. Poor quality of water as well as insufficient quality of potable water can pose serious public health hazardous water borne diseases that are quite common in the cities, particularly among the urban poor. Hence it is considered to include a performance indicator for drinking water sector. Hence drinking water supply is also taken into consideration as one of the element of CSP.

Given the demand-supply gap of nearly 38.42 MLD at present within NMC, there is a need to explore and implement options to generate water. Per capita supply is at 85 lpcd, as against service level norm of 135 lpcd. Supply frequency is for 4 hours daily and household service connections account for only 26.5%.

With the absence of bulk flow metering, in the network, reported network losses cannot be validated. There is no regular monitoring of ground water status. Power cost for operating bore-wells based network is observed to be significantly higher relative. These issues in

service delivery reflect in low Cost recovery and poor Collection efficiency levels. The table below summarizes the issues presently posing serious threat in Nellore.

Table 42: Water supply parameters

Parameter	Unit	Norm	Baseline	Timeframe to achieve norms		
				Short	Medium	Long
Network coverage	%	100	26.5	✔	✔	
Per Capita Supply	Lpcd	135	63	✔	✔	✔
Metered connections	%	100	0.3		✔	✔
Water supply quality	%	100	-[7]	✔	✔	✔
Cost recovery	%	100	-	✔	✔	✔

Various strategies are proposed to address the above stated issues to provide decent water supply, both in terms of quality and quantity, to the residents of Nellore. These strategies are of high priority and the starting point for a sustainable City Sanitation Plan for Nellore.

Table 43: Proposed strategies for Water Supply

S. No	Issues	Proposed solutions	Explanation
1	Existing water sources (Infiltration galleries, deep bore wells and open wells, SS tank)	• Identify the surface and sub-surface water sources for the present and future. • Conservation of Lakes, SS Tank and Water Quality	• Identifying different water source points, implementing a water distribution scheme according to population rise and augmentation of old schemes in addition to the one proposed and approved for implementation by government – Comprehensive Water Supply Scheme with Sangem Anicut on River Penna. • Conservation, rehabilitation of lakes as holding structures for rain water and storm water.
2	Water distribution losses (leakage and unauthorized losses)	Water storage and distribution	• Maintenance and augmentation of storage capacity, leakage control, monitoring and maintenance of distribution network, training the staff, etc. • Proposed 17 ELSRs of capacity 14100 KL to cover entire city core area and 15 ELSRs of capacity 6250 KL to cover recently added 15 Gram Panchayats

[7] Further to the analysis provided towards the water quality in section 1.10, NMC shall focus on improving the MPN count for the water from Infiltration Wells 1, 2 and 3 at Head Water Works and Summer Storage Tank.

S. No	Issues	Proposed solutions	Explanation
3	Inadequate water supply (85lpcd to actual standard at 135lpcd)	Water Supply on 24x7 basis	adequate quantity of supply, adequate size of distribution network, adequate pressure of water even at the farthest end of the system, extensive metering and adequate vigilance is required
4	Household water network coverage is less (approx. 26.5%).	Increase water network coverage to 100%	Facilitate water network coverage to the entire city
5	Un-metered connections (just 0.3% is the current metering system covered in the city).	Improve water metering	Implementation of water metering in order to levy right water tax and to keep check on leakages, collecting full cost of operation & maintenance through volumetric tariff.
6	Quality of water is un-satisfactory for the purpose of drinking.	Increase water treatment plant capacities	In addition to the Comprehensive Water Supply Scheme, more capacities of treatment plants are required to meet the demand till 2050.
7	Poor awareness among the public on water usage, conservation and harvesting	Capacity building on conservation of water and reuse of treated wastewater	• Once the Sewage Treatment Plant (STP) is in place and starts treatment, the reuse of treated (reclaimed) water from STP shall be diverted for use for irrigational purposes in agricultural areas and for recharging of groundwater table using Soil Aquifer Treatment. • Conservation of water using water saving devices and behavioural changes.
8	Lack of awareness on practicing Rain Water Harvesting (RWH) systems in the city.	Promoting rainwater harvesting	Promotion and implementation of rainwater harvesting system.

The following section proposes a set of strategies to be followed in order to overcome the identified problems in the water supply sector:

1. To identify surface and sub-surface water sources for the future:

NMC should start identifying the nearby surface and sub-surface water sources in various areas of Nellore in order to meet the water demand at local level. This approach helps to minimize the capital cost of infrastructure and thereby also the operation and maintenance cost of the infrastructure in future. For the process of identifying the surface water bodies, use of techniques like *Water Resource Assessment, Water Allocation and Water Balance Estimation* etc, can be done. These techniques will be helpful to generate baseline data (Baseline Data Collection) which can be used for Geographical Information System (GIS).

In addition to identifying surface and sub-surface water sources and implementing new schemes that includes high capital investments, it is recommended to identify water leakages

and distribution losses and take necessary measures in controlling such losses and renovate the existing dilapidated and discarded ELSRs and GLSRs that would reduce the water supply and demand gap for future generations and reduce the future capital investments and future operation and maintenance costs in implementing the new schemes.

2. Conservation of Lakes, SS Tank and Water Quality:

It is essential to identify the surface and sub-surface water bodies in the city limits and start planning to conserve and protect these water bodies. Dried lakes can be modified into **Retention Basins** and few ponds can then be converted into **Micro Basins**. The goals for conservation of lakes have to be tailored to individual regions, specific to the problems of degradation and based on the level of dependence. This requires reconstruction of the physical conditions; chemical adjustment of both the soil and water; biological manipulation, reintroduction of native flora and fauna, etc.

Some of the important points to be followed to ensure development and conservation of the groundwater bodies in Nellore include:

- Exiting tanks not be breached but retained as water bodies
- Efforts should be made to ensure that the tanks are not polluted by discharge of effluent and industrial wastes
- Prevent silting up of the tanks by offshore development through tree planting and also removal of encroachments
- Breached tanks not be used for formation of sites but should be used to create tree parks
- De-weed all tanks and develop aquatic life
- The tank areas where there are no agricultural land should be transferred to the Forest Department for developing tree parks/foreshore tree planting and formation of regional parks
- Examine possibility of construction of more tanks along the natural valleys with surplus runoff and implemented.

Further to the Bacteriological and Physico-Chemical Analysis developed by Regional Public Health Laboratory in November, 2011 (Refer section 4.8), in order to improve the current water quality to the satisfactory level for drinking purpose, following recommendations shall be taken up by NMC on a short term immediate basis.

- Presence of huge plantation growth in the SS tank with organic matter in it is observed to be affecting the water colour to be slightly brownish with 45 Hazen units, and is recommended to remove weed growth in the tank, maintain water level at optimum level and cover manholes near the tank to avoid mixing of undesirable matter.
- All the filter beds are functioning but are found to have residual chlorine due to pre chlorination. To reduce the colour and odor it is recommended to have poly activated carbon treatment to the raw water as an interim measures at the SS tank and dual media may be used in filter beds. Also periodical cleaning of all sumps, tanks, beds and service reservoirs is recommended to maintain the Hazen units not to go beyond permissible levels.
- Coverage of manholes is recommended to avoid mixing of undesirable matter at the Filtration Beds.
- In the infiltration wells at Magunta Layout, the aqua chlorinator is not functioning currently and has to be turned on. Necessary arrangements need to be taken up to turn on the non-functioning Aqua Chlorinator at Magunta Layout.

- Periodic cleaning of sumps, OHTs, regular and adequate chlorination and maintenance of a log book at reservoirs and in the distribution system to have a regular check on the residual chlorine levels.
- Maintain residual chlorine at 1.0 to 2.0 PPM in view of recent floods to avoid water borne diseases.

3. Rainwater harvesting (Water Reuse & Ground Water Recharging):

Rain water harvesting can also provide with an alternative source of water. Nellore receives an annual rainfall of 900 to 1200 mm, which means minimum of 630 Cu.m of rain water can be harvested per square meter of area at roof catchments, and 450 liters at ground surface coverings.

Calculation: Water harvesting potential = Rainfall (mm) x Area of catchment x Runoff Coefficient. Runoff coefficient for roof catchments varies from 0.7 to 0.9 and for ground surface coverings it varies from 0.5 to 0.8.

With minimal amount of treatment this harvested rain water can be used for various non potable domestic purposes. With some extra treatment like filtration, UV/Ozonation, etc, it can be used for potable purposes too. Thus water can be harvested and put to use locally with minimal amount of investment.

To spread the awareness about the rain water harvesting, NMC can take up awareness campaigns on mass scale. Also incentives can be given to the citizens and colonies who implement rain water harvesting. Incentives can be in the form of rebate over property tax or water tax. Rain water harvesting should be made mandatory in institutional set-up like apartments, public buildings, institutions, hospitals, schools and colleges, industrial and commercial properties, etc. immediately as these kind of properties generally have huge roof area and also paved surface which are helpful for rain water harvesting. Another way of promoting rain water harvesting is creating entrepreneur opportunities for the young people. As per the guidelines provided in G.O.Ms. No. 350 MA, 10% rebate on the tax can be provided to the owners of the buildings who have adopted both recycling of waste water and rain water harvesting structures. As stated in the G.O.Ms.No. 350 MA, rainwater harvesting shall be made mandatory to take up in all the new and existing buildings in Nellore with an area of 300 Sqm or above in their premises, and household level or community level rain water harvesting shall be immediately taken up in areas where the water is supplied through tankers - Shivaji Nagar, Samatha Nagar, Bhagath Singh Colony, Nagamma Colony, BujaBuja Nellore, Yadava Palem, RTC colony, Talpagiri colony, Vikalangula colony, Kothuru Choutamitta, Kothuru Shivaji Colony, Chandra Babu Nagar, Sramika Nagar, Valluramma Colony, YSR Nagar, Ram Nagar, Nethaji Nagar and Janardhan Reddy colony and in wards where the water is supplied just for 2 hours in a day – 26, 31, 32, 53 and 54.

It is estimated that for constructing 5000-10000 litres capacity of rain water harvesting unit at household level with family size of 4 using around 15000 litres per month, the unit would cost between 13,000 – 16,000/-, and at the community level for 1000 HHs to harvest 170 million litres annually would cost around Rs. 4.5 lakhs.

Once the storm water drains and the STPs are in place, instead of directing the drains to the nearby flowing river, this water should be treated and used to recharge the ground water table. NMC largely depends on the ground water and there are many incidences of bore wells and dug wells going dry. To avoid such problem in future one should try and infiltrate as much amount of water possible in to ground water table. However before resorting recharging and infiltration process it should be kept in mind that the water should be completely treated and free of contamination as infiltration of contaminated water City Sanitation Plan may lead to contamination of the ground water table rendering the accumulated water unfit for drinking.

Nellore Municipal Corporation shall also ensure that the paved surface around the building shall have percolation pits or trenches or combination of pits and trenches in such a way that total volume of such structures shall not be less than 6 cum for each 100 Sqm of roof top area and multiples there on.

The structural type designs, sizes and legislations as per the building category are discussed in detail at http://www.hyderabadwater.gov.in/wwo/UI/neerumeeru.aspx, and http://www.rainwaterharvesting.org/Urban/govt_order2.htm

4. Reuse of treated waste water:

There is a good possibility of using the treated effluent for irrigating the city's agricultural lands. Most of the lands in and around the Nellore city are observed to be dependent on bore-wells for irrigation of lands. Therefore, use of treated sewage for irrigation is definitely a viable alternative.

The treated water coming out of the centralized sewage treatment plant can be used for various non potable purposes. If the treated water fits into the standards of Central Pollution Control Board (CPCB) then the water can be used for Fertigation (irrigational) purposes (BOD < 100 mg/lit & TSS < 200 mg/lit) or can even be safely discharged into a surface water body (BOD < 30 mg/lit & TSS < 50 mg/lit). Treated water can also be used for Aquaculture (flora & fauna). On a household level Vertical Gardens, Grey water Towers and Evapotranspiration Bed can also be used for safe treatment and disposal of grey water. The treated water can also be used in the industries which do not need water for potable purposes like in furnaces etc.

The treated water can be used for Surface Groundwater Recharge or Subsurface Groundwater Recharge. For safe treatment and disposal of the wastewater natural technologies like Soil Aquifer Treatment and Short Rotation Plantation can be used. For safe disposal of grey water, Leach Fields or Soak Pits can be used.

5. Water Storage and Distribution:

In addition to the existing 33 ELSRs and 6 GLSRs in the city, another 17 ELSRs of capacity 14100 KL to cover entire city core area and 15 ELSRs of capacity 6250 KL to cover recently added 15 Gram Panchayats are approved for construction that is estimated to cater to the purpose of water storage and distribution in the city till 2035.

The connection to the Saturated zone of Nellore city should be increased on priority. Later the connections to the Growth zones can be increased as after identification of the water sources. In the Growth zone, infrastructural work related to distribution of water should be done keeping in mind the future increase in the population.

6. Supply of water on 24x7 basis:

To ensure continuous water supply without break for 24 hours a day, 7 days in a week and for 365 days in a year, *adequate quantity of supply, adequate size of distribution network, adequate pressure of water even at the farthest end of the system, extensive metering and adequate vigilance* is very important. Therefore, to achieve continuous supply of water without break following recommendations are put for immediate implementation

- Provide adequate number of bulk meters at strategic locations to ensure regular monitoring of water flow
- Withdraw the system of free supply of water through street and public stand posts
- Initiate metering system towards all the services like industrial, institutional, commercial, domestic, public and semi-public, etc
- Minimize leakage losses at all levels
- Create consumer redresser cell
- Disconnect all illegal connections
- Set up efficient O&M
- Awareness to the public and the officials on water scarcity and its value

7. Increase water treatment plant capacities

North of River Penna comprising of 5% of the total Nellore population was earlier served through an infiltration gallery but later through ground water sources as dried up. The recently commissioned 5 MLD infiltration well and rising main is expected to take care of the demand till another decade.

The South of River Penna which is currently served by HWW and Kothuru Phase I is sanctioned with a 122 MLD WTP that is expected to serve the city water demand till 2031. This project is currently under execution and is expected to be ready by end 2019. In addition to this it is also proposed to augment 122 MLD WTP with another 30 MLD WTP under Phase II to serve the city water demand till 2035. Public Health Engineering Department has also sanctioned 32 ELSRs in the city for the water storage and distribution.

Considering the aforementioned 2 water treatment plants would serve till 2035, it is also recommended to initiate below listed projects proposed by Lahmeyer GKW consultants in their study in 2011 that would add another 148 MLD to serve the city water supply demand till 2050 (demand in 2050 is estimated to be 383 MLD).

- Construction of 18 MLD WTP near Kothuru - Phase II
- Construction of 65 MLD WTP near Kondlapudi – Phase I
- Construction of another 65 MLD WTP (Phase II) near Kondlapudi as augmentation to the Phase I

8. Water Metering

100% water metering has to be initiated in the city. The existing unmetered connections and the new connections should be fitted with meters and metering of water should be done. Once the connections are installed with water meters, water pricing on volumetric bases can play vital role in effective implementation of water meters and will also lead to increase in the cost recovery.

Water audits should be conducted for various colonies and zones to keep a check on illegal or unmetered tapping of water and leakages. Leakage control can play a vital role to reduce transmission and distribution losses, which are usually high in a centralized water distribution system.

Metering alone can ensure 20% reduction in water consumption. This has been proved in practice where metering system has been introduced. Flow meters may also be installed at all un-metered supply points to provide complete monitoring of flows into each supply zone and district metered area. Consideration will be given to the type of meter, duly comparing their effectiveness, installation cost and maintenance cost. Domestic meters are covered by IS 779 and bulk meters are covered by IS 2373. The ULBs must have a dedicated staff who will take immediate action on repair/replacement of defective meters.

Collecting Full Cost of Operation & Maintenance through Volumetric Tariff: Water and wastewater tariffs determine the level of revenues that service providers receives from users in centralized or semi-centralized systems. Water pricing is seen as an important economic instrument for improving water use efficiency, enhancing social equity and securing financial sustainability of water utilities and operators. In a uniform volumetric charge, or constant volumetric tariff, all water units are priced the same independent of the use, and consumers pay proportionally to their water consumption. With this type of tariff, all consumers (domestic, industrial and commercial) pay the same unit rate, and their water bill corresponds directly to the quantity of water consumed. The constant volumetric tariff can be designed as a single tariff or as a two part tariff combined with a fixed charge. Volumetric price schemes present several advantages: first of all is easy to understand for consumers - because it is how most other commodities are priced – furthermore it sends a clear signal to the consumers about the cost of supplying them with additional water. Moreover, the tariff incorporates the concept of water conservation as the water bill increases with consumption.

9. Conservation of Water (Awareness programmes for Citizens)

In addition towards the steps in improving municipal water supply system, NMC should also develop a comprehensive awareness drive in collaboration with local NGO’s, CBOs, schools and other institutions for promoting water conservation in the city. The community needs to realize that water is an important limited commodity and hence needs to be conserved. There are various ways by which water can be conserved at household level by using water efficient devices/products or by adopting minor changes in the behavioural practices for efficient water usage. Programmes for farmers may also be conducted for promoting sustainable agricultural practices such as drip irrigation, reuse of treated wastewater for irrigation etc.

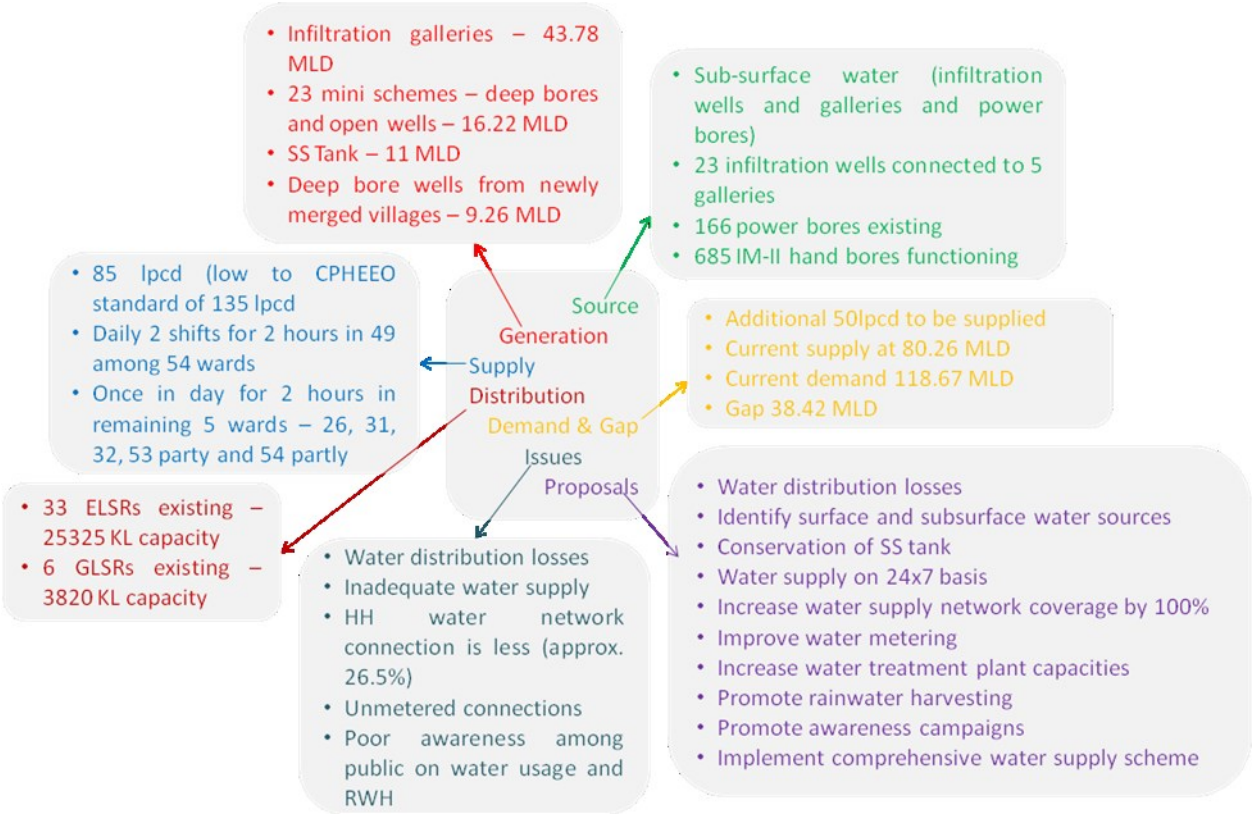


Figure 23: Water supply scenario in Nellore City

Goal 2: Access to safe Sanitation:

As per the field investigations conducted under Rajiv Awas Yojana (RAY) program in 2011, it is found that 22% of HHs still doesn't have individual toilets facilities in their premises and around 6% out of 22% depends on the public and community toilets located in their areas while remaining 16% practice open defecation. Open urination is usual practice in commercial areas, which suggests the need for greater awareness generation and creation of public toilet facilities in busy commercial areas.

The table below summarizes the issues presently posing serious threat in Nellore because of poor sanitation facilities:

Table 44: Parameters for sanitation services

Parameter	Units	Norm	Baseline	Timeframe to achieve norms		
				Short	Medium	Long
Open Defecation (OD)						
Reduction in % of pop. practicing OD	%	0	16	✔		
Reduction in No. of open urination spots	No.s	0		✔		
Reductin in No. of OD spots	No.s	0	11	✔		
Toilet Coverage						
HHs with toilet facilities	%	100	78	✔	✔	✔
Access to public toilets	Floating Pop.	200	12	✔	✔	✔
Access to community toilets	Slum Pop.	50	3	✔	✔	✔

Various strategies are proposed to address the access to safe sanitation facilities in slums in Nellore. These strategies are of high priority and forms basis of a sustainable City Sanitation Plan for Nellore.

Table 45: Proposed strategies for sanitation facilities

S. No	Issues	Proposed solutions	Explanation
1	78% individual toilet connections in slums	Encourage individuals to build their own toilets	Awareness raising towards encouraging people to have their own sanitation facilities. It will also require access to funds for supporting the construction of toilet facilities.
2	inadequate community toilets	• Management system for community/shared toilets • Community Led Total Sanitation Program	•Formation of a team to look manage the construction, operation, maintenance and upgrading of community toilets in slum areas. • Provide Community Led Total Sanitation Program
3	Inadequate public toilets	• Management system for public toilets • Toilets for floating population, slums and other impoverished areas	• Formation of a team to manage the construction, operation and maintenance and upgrading of public toilets at the commercial areas and at the huge population floating areas like bus stands, railway stations, etc. • Construction of public toilet facilities in slums and other impoverished areas where open defecation is practiced.
4	No UGD	Provision of UGD in the entire city	Implementation of approved comprehensive underground sewerage scheme
5	Inadequate toilet facilities in schools	School sanitation in accordance with National School Sanitation Initiative (NSSI)	Upgrading the sanitation facilities in schools and educational institutes and to create awareness among the students.
6	Low awareness on good sanitation practices	Capacity building and awareness programs	• Awareness raising towards encouraging people to have ownership towards creating their own sanitation facilities • Upgrading the sanitation facilities in schools and educational institutes and to create awareness among the students.
7	open defecation	Eradicate open defecation	Toilet facilities to reach entire HHs in slums

S. No	Issues	Proposed solutions	Explanation
8	No eco-friendly technologies for sanitation facilities	Eco friendly technologies consist of Urine Diversion Dehydration Toilets and Biogas Linked Pour Flush Toilets.	Eco friendly technologies consist of Urine Diversion Dehydration Toilets and Biogas Linked Pour Flush Toilets.

1. Access to Individual Toilets:

In general, individual household toilets are preferable to community/public toilets, particularly because this option promotes ownership and secure maintenance and proper operation. However, given the conditions of slums in Nellore, the construction of individual toilets is difficult because of lack of space in their premises. In areas with space availability one of the most favourable and viable option to improve sanitation is to encourage the slum dwellers to construct their own private toilets. Providing funds, incentives or technical assistance for construction of toilets will motivate community to take up such initiatives. The appropriate toilet design for meeting the needs of slums can be selected based on the following criteria:

- Suitability and preference of the beneficiary population
- Availability of space within the household for a private toilet
- Affordability of the user households
- Ease of operation and maintenance
- Sustainability of the system

Considering the high density and space constraint in the slum in Nellore, shared communal or public toilets are considered to be the most appropriate solution. Communal/public toilets may be of various types, including the following:

- Pit latrines (several compartments over one toilet pit)
- Pour-flush toilets discharging to a septic tank with infiltration drainage
- Pour-flush toilets discharging to some sort of sealed holding tank
- Pour-flush toilets with septic tank discharging liquids only to a sewer network
- Pour-flush toilets with discharge of solids and liquids to a sewer network
- Urine-diverting toilets with separate collection of faeces in raised vaults

Moreover, for the high density areas of the city, access to toilet facilities should be increased as per the immediate implementation plan. Considering that the sewerage construction is going to be implemented in the city soon, conventional Pour Flush Toilets or Low Flush Toilets shall be promoted. The municipal corporation should provide incentives to people who are building and using toilets for proper sanitation. NMC can avail various schemes for providing the incentives.

In the agricultural zones, ecological sanitation practices like Bio digester (Bio-Toilets), Urine Diversion Dehydration Toilets (UDDT), compost toilets, etc can also be promoted. These toilets not only help to convert the human waste into soil conditioner (manure) but are also cheap and easy to operate and maintain.

Bio-Toilets: Bio toilets also called as bio digesters degrades night soil and produces colourless, odourless, and inflammable biogas containing 50% - 70% methane. The bio-digester tank in every toilet is filled with inoculums containing four types of bacteria. The water trap system in

the toilet prevents air from getting into the tank, the human waste is processed by anaerobic bacteria in seven chambers in the tank and the methane gas is produced. Each unit approximately costs around INR 10,000/-.

Compost toilet: It is a type of dry toilet that uses a predominantly aerobic processing system to treat human excreta, by composting or managed aerobic decomposition. These toilets generally use little to no water and may be used as an alternative to flush toilets. They have found use in places where no suitable water supply or sewer system and sewage treatment plant is available to capture the nutrients in human excreta. Composting toilets produce a compost that may be used for horticultural or agricultural soil enrichment.

Urine Diversion Dehydration Toilets (UDDT): Urine-diversion dehydration toilets (UDDTs) are simple, low-cost, on-site sanitation facility that makes use of desiccation (dehydration) processes for the hygienically safe on-site treatment of human excreta. Urine-diversion dehydration toilets divert all liquids in order to keep the faeces as dry as possible. Adding wood ash, lime, dry earth etc. after defecation helps in lowering the moisture content and to raise the pH, which enhances pathogen die-off during storage. Separately collected urine is rich in nutrients and low in pathogens and can be used as fertilizer. Faeces from UDDTs can be composted or stored and dried before using them as soil amendment for crop production. UDDTs can be an option for families and communities of farmers located in agricultural zone of Nellore, with the agricultural land for the up-take of urine and faeces. The approximated cost of 1 unit (double vault) is INR. 25000/- – 30000/-.

2. Implementation of a management system for the construction, operation, maintenance and upgrading of community toilets in slums:

Construction of community toilet: Shared or community toilets are the most appropriate solution in slum areas, because of the notably high-density with a high proportion of tenants. A programme shall be carried out by the NMC, in order to cover the sanitation needs of the slum dwellers. This can be done in the frame of different programs for the rehabilitation of the Urban Impoverished Programs, such as:

"Swachh Andhra Mission", that aims at open defecation elimination, eradication of manual scavenging, modern and scientific municipal solid waste management, to effect behavioral change regarding healthy sanitation practices, generate awareness about sanitation and its linkage with public health, capacity augmentation for ULB's and to create enabling environment for private sector participation in capital expenditure and operation and maintenance.

Under the mission, Nellore Municipal Corporation has identified and approved for the construction of 9269 individual toilets in slums. More information can be found at: http://sac.ap.gov.in/sac/UserInterface/Application/Reports/StateReport.aspx

Rajiv Awas Yojana (RAY): The national government approved the scheme in June 2011 with the launch of the phase-1 to facilitate affordable housing for slum dwellers. According to the plan, the centre would provide financial assistance to States willing to assign property rights to slum dwellers for provision of shelter and basic civic and social services for slum re-development and for creation of affordable housing stock under the RAY scheme. As per the Cabinet Committee on Economic Affairs decision, the Centre will bear 50% of the cost of slum re-development. More information can be found at:

http://mhupa.gov.in/w_new/RAY%20Guidelines-%20English.pdf

Central Sector Scheme of "Urban Statistics for HR and Assessments (USHA)", which aims at the development and maintenance of a national database, MIS and knowledge repository relating to urban poverty, slums, housing, construction and other urbanization related statistics. Funds and grants are offered for ULB in order to support with the sample surveys, socio-economic research studies and training. More information can be found at:

http://mhupa.gov.in/w_new/USHAGuidelines.pdf.

Integrated Housing & Slum Development (IHSDP) Scheme, it is a program under which the Ministry of Housing & Urban Poverty Alleviation (MoHUPA) caters to housing and basic amenities and services to the urban poor and slum dwellers. The scheme applies to all cities\towns, excepting cities\towns covered under JNNURM. The target group under the scheme is slum dwellers from all sections of the community through a cluster approach. Allocation of funds among States will be on the basis of the States' urban slum population in the country. More information can be found at:

http://india.gov.in/outerwin.php?id=http://hpurbandevelopment.nic.in/PROJECT/IHSDP.HTM.

Operation and Maintenance of Community Toilet: Operation and maintenance of community toilet is the most important for sustenance in the long run, following is recommended:

- Pay & Use basis: One time monthly pass system on fixed rate basis should be planned out in consensus with the community and the ward councillor. A caretaker to be appointed to take care of daily cleaning and other activities like purchasing of cleaning materials and keeping all the records
- Maintenance by the Municipal Corporation: The Nellore Municipal Corporation shall be responsible for maintaining the toilet and overall in-charge of the O&M of the toilet block.
    - Involving a private party like Sulabh International for operation and maintenance

- Institutionalize appropriate monitoring systems involving community, officials from NMC and private party

3. Construction of Public Sanitation Facilities

Being a railway junction for many cities and having a National Highway passing through the city connecting Tamil Nadu and Andhra States, Nellore experience high numbers of floating population. Considering this, Nellore Municipal Corporation needs to construct few public toilet blocks at various places like railway stations, bus stands, markets and tourist places, etc. These toilet blocks can be built on the Built Operate and Transfer (BOT) basis in order to ensure the quality of construction and operation and maintenance. Public toilet blocks should also provide more number of urinals and less number of toilet seats. Water saving urinals can also be fitted in the public toilet blocks which can make it easy to operate and maintain.

4. School Sanitation Planning

A focus on school sanitation stems from the facts that clean toilets, water supply and health environment is a basic necessity for overall growth and development of students. Furthermore, a responsible school with all the sanitation facilities should also support children in developing skills, attitudes and knowledge on public health and hygiene. As discussed in previous chapters, there is an immediate need to fill the gaps in the existing infrastructure i.e construct additional 164 toilet seats and 54 urinals to meet the demands of existing student strength.

Additionally, it is recommended that the schools in Nellore should enroll in the National School Sanitation Initiative, a program carried out in collaboration by the Ministry of Urban Development (MoUD), Ministry of Human Resource Development (MoHRD), Central Board of Secondary Examination (CBSE) and GIZ to effectuate a quantifiable achievement in the provisions and practices of sanitation in the country. For more information visit: www.schoolsanitation.in

5. Adopting Community Led Total Sanitation Approach

Community Led Total Sanitation (CLTS) is an innovative methodology for mobilising communities to completely eliminate open defecation (OD). CLTS approach is basically based on community participation where the communities are usually facilitated to conduct their own appraisal and analysis of open defecation and take their own action to become open defecation free. It is a grassroots approach to sanitation and is active in more than 15 countries. It focuses on the behavioural change needed to ensure real and sustainable improvements – investing in community mobilisation instead of hardware, and shifting the focus from toilet construction for individual households. By raising awareness that as long as even a minority continues to defecate in the open everyone is at risk of disease, CLTS triggers the community's desire for collective change, propels people into action and encourages innovation, mutual support and appropriate local solutions, thus leading to greater ownership and sustainability. The steps identified under CLTS include:

- Selection: selecting a community and developing a better-defined sense of the community
- Mobilization: educating the community regarding the consequences of living in a focally contaminated environment. Some of the triggering activities include defecation area

transect, mapping of defecation areas, calculations of faeces and medical expenses, triggering disgust and indignation.

- Post-Monitoring: once the communities typically pledge to improve their sanitation by either becoming open-defecation free or by adopting improved sanitation technologies, there is a danger that these pledges do not come to fruition without follow-up work.

In highly dense areas and slums where there is no availability of area to construct an individual toilet seat, Municipal Corporation can opt for community toilet block. Projects like construction of community toilet block should be carried out in accordance with Community Led Total Sanitation technique. This approach will also help to reduce open defecation in Nellore.

The recommendations to improve the sanitation of the city is summarised in the table below:

PHASE	YEAR	Actions
Short Term	Within 5 years	• Detailed ward level survey to review condition of existing facilities • Rehabilitate all facilities which do not comply to the design considerations (repairs and up-gradation of public toilets) • Identify possible construction sites for new infrastructure • Construction of new facilities (toilet seats as well as urinals) mainly focusing on core city area and schools • Institutionalize O&M and M&E procedures • Conduct awareness generation campaign on health and hygiene aspects of public sanitation • Promotion of individual household toilets through subsidies/incentives • Identify community to implement CLTS Approach
Mid-Term	Within 6-10 years	• Prepare Sanitation DPR • Augment existing infrastructure as per the demand • Ensure provision of 1/35 seat/user ratio for residential areas and 1/100 for tourist area • Promotion of ecological technologies like UDDT
Long-Term	Beyond 10 years	• Augment existing infrastructure as per the demand

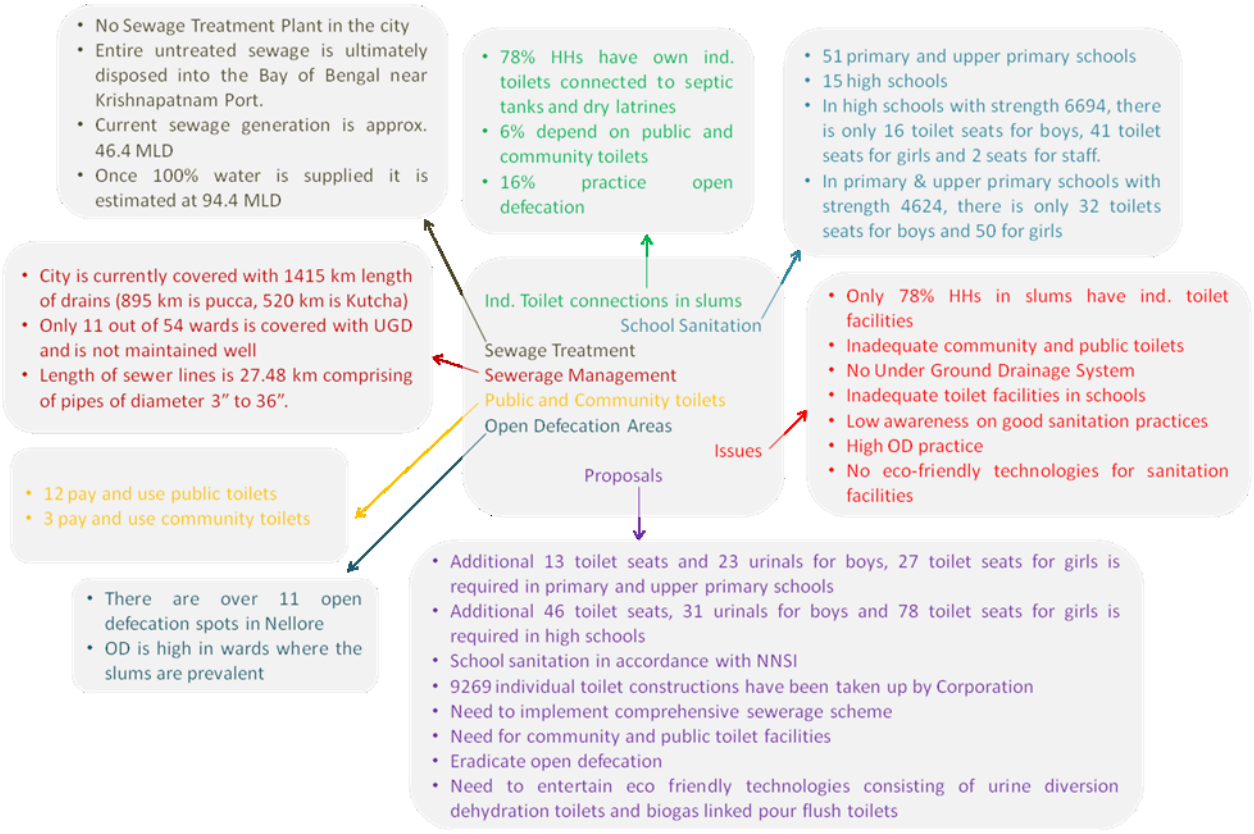


Figure 24: Sanitation scenario in Nellore city

Goal 3: Sewerage System and Waste Water Management

As mentioned in the previous chapter, 11 out of 54 wards are covered with underground drainage system in the city serving a population of nearly 60,000 i.e. 8.7% of the entire city population. The available network is designed inappropriately without proper disposal and treatment facilities demanding a comprehensive sewerage system for the city. However, considering the current sewerage facilities and ground situation in the city, a comprehensive sewerage scheme is proposed and is approved for implementation by the GoI.

The baseline situation and the time frame for achieving prescribed norms for sewerage system is as discussed with officials from NMC is addressed in the table below.

Table 46: Parameters for Sewerage System and Wastewater Management

Parameter	Units	Norm	Baseline	Timeframe to achieve norms		
				Short	Medium	Long
Underground sewerage network area	%	100	2	✔	✔	
HHs with sewerage connections	%	100	8	✔	✔	
Wastewater collection efficiency	%	100	0	✔	✔	✔
Quality of wastewater treatment	%	100	0	✔	✔	✔
Recycling and reuse	%	20	0	✔	✔	✔
Cost recovery	%	100	0	✔	✔	✔
Septage Management	%	100	0	✔	✔	✔

Various strategies are proposed to address the issues prevailing out of poor sewerage network in the Nellore City. These strategies are of high priority and the starting point for a sustainable City Sanitation Plan for Nellore.

Table 47: Proposed strategies for Sewerage Management

S. No	Issues	Proposed solutions	Explanation
1	No separate system to carry sewage and storm water	Required comprehensive UGD scheme	Implement comprehensive UGD scheme approved for Nellore city
2	No comprehensive storm water drainage scheme	Required comprehensive UGD scheme	Implement comprehensive UGD scheme approved for Nellore city
3	Poor maintenance of open drains	• Need for periodic cleaning of drains • Need for proper management of debris removed after cleaning/desilting work • Eradicate choking of open drains due to dumping of garbage and other solid wastes	Proper solid waste management proposals need to be placed
4	Improper septage management	Proper septage management	• Septic tank sludge management, schedule for de-sludging of septic tanks, treatment of the sludge and its safe disposal. Sludge thickening, large scale anaerobic biogas digesters, sludge dewatering.
5	No sewerage and wastewater management systems	Sewerage and wastewater management system for • Saturated areas (highly dense) • Developing areas • Scattered settlements	• Waste water management for highly dense areas in using Activated Sludge Process, Sequencing Batch Reactor, Solid free sewerage system. • Wastewater and sludge management for developing areas: Simplified sewers, Up-flow Anaerobic Sludge Blanket Reactor, Trickling Filter, Membrane Bioreactor, Bio-towers, Decentralized Treatment Systems, etc. • Wastewater and sludge management for scattered settlements and agricultural areas: Ecological Sanitation principles, Urine management, Faeces management.
6	Wastewater let into available water bodies	Minimization of sewage generation and reuse of treated waste water	• Separate collection & treatment of grey water for reuse purpose for non potable purpose, awareness activity for water conservation.

Considering that the city has been approved for implementation of 100% sewerage system, few strategies are proposed for proper operation and management of the existing and the proposed sewerage system in the city.

1. Sewerage Management System and Sewage Treatment

Considering that the existing sewerage system is in dilapidated condition, and to avoid insanitary conditions that are prevailing due to lack of proper sanitation facilities in the city, there is a need to collect domestic sewage, transmit, and treat and disposal sewage safely. With this consideration the government has approved to implement a Comprehensive Sewerage Scheme at an estimated cost of INR. 580.85 Crores covering entire Nellore City. This scheme is designed only for domestic waste water according to the population of that specific region and hence the storm water drains will not be joined to these drains. It is recommended to have separate drainage system for domestic waste water and storm water as the degree of treatment and the process of treatment are different for both these types of water.

For the implementation of the approved comprehensive sewerage scheme, the city is divided into 17 sewerage zones (refer table 48) taking into cognizance the general slope of the area and the availability of the municipal lands for locating the pumping stations and sewage treatment plants. Gravity sewerage network is adopted for the flow from each zone to reach respective pumping stations and trenchless technology is adopted at the floating areas like bus stands, railway crossings, national highway – 5, commercial areas, etc.

Table 48: Sewerage zones

North of River Penna	1. Janardhan Reddy Nagar	
South of River Penna	2. Dirver's colony 3. Vedayapalem, 4. Gautham Nagar 5. State Warehouse 6. Sardar Patel Nagar (Ritwick Layout) 7. SHAR Colony 8. Kondayapalem 9. Gomati Nagar	10. Citizens resource center 11. Sri Krishna Puram 12. Harinathapuram 13. Balaji Nagar 14. N.T.R. Nagar 15. Head water works 16. Subedhar Pet School 17. Sri Ram Nagar

Of the several technologies available to treat the sewage as per CPHEEO norms like intensive waste stabilization pond (WSP), Activated Sludge Process (ASP), Biological Filters (Trickling Filters), and technically advanced systems like Up-Flow Anaerobic Sludge Blanket (UASB) process, Sequential Batch Reactor (SBR), Moving Bed Bio Reactor (MBBR), Fluidized Aerobic Bioreactor (FAB), and Membrane Bio Reactor (MBR), the Nellore city has opted SBR technology to treat the sewage.

The SBR technology typically eliminates the need for separate primary and secondary clarifiers in most municipal systems, which reduces operations and maintenance requirements. The O&M costs associated with SBR system is similar to a conventional activated sludge system. Typical cost items associated with wastewater treatment systems include labour, overhead,

supplies, maintenance, operating administration, utilities, chemicals, safety and training, laboratory testing, and solids handling. Labour and maintenance requirements are less in SBRs because clarifiers, clarification equipment, and RAS pumps are not necessary. Though the SBR system best suits for the need of Nellore city, the corporation should be responsible in monitoring and checking the performance of the system as the controls, automatic valves, and automatic switches, and other important systems are delicate and require more maintenance than required in other systems. An increased level of sophistication usually equates to more items that can fail or require maintenance. The level of sophistication is very advanced in larger SBR technologies requiring a higher level of maintenance on the automatic valves and switches.

In the vicinity of Nellore city there are number of educational institutes scattered near the agricultural areas. Therefore, at such areas if the approved Comprehensive UGD Scheme is not covered, it is then recommended to have an institutional level Decentralized Waste Water Treatment Plants (DeWATS) wherein the treated water can be locally reused either for irrigation purpose or to meet the institutions own water need. In case the segregation of grey water and black water is done, then for treatment of grey water on a decentralized level technologies which can be used are Compost Filters, Constructed Wetlands, etc.

At the outer periphery of Nellore City where the houses are scattered, the conventional gravity system with centralized treatment is not feasible, therefore, it is sustainable to implement an ecological sanitation program, in which different technical options could be constructed to allow the separated collection of urine and faeces and its separated treatment.

The following section explains the principles of ecological sanitation and logistics involved:

An ecological Sanitation principle is a holistic approach to sanitation and water management based on the systematic closure of local material flow-cycles. The concept thus recognizes human excreta and water from households not as waste but as resources that can be recovered, treated where necessary and use it safely.

Infrastructure needed for agricultural areas of Nellore City: This system requires a urine-diverting user interface, which are usually called “Urine Diversion Dehydration Toilets” or UDDT. Urine is collected through the front outlet and conveyed to a collection vessel (a tank in larger, more expensive systems or a jerry can in similar, simpler systems), a garden or possibly a soak pit, if the urine is not brought to use. Through the rear outlet the faeces are collected in a container located underneath the toilet. Some urine diverting squat pans are also equipped with an additional outlet for anal cleansing water (beige water), which is then treated, in a separate flow stream.

Urine Management: The urine can be used as a fertilizer for crop production. In larger systems, urine must be sanitized through storage; while at the household level, the urine can be used directly but the time from fertilizing until harvesting should be at least one month. Urine shall be applied as nitrogen rich fertilizer to kitchen gardens, agricultural plantations or orchids after providing appropriate storage time. As urine will be collected throughout the year, going for fruit trees, flowers, etc. that requires regular fertilization throughout the year is advisable. If such plants can’t be identified, going for a polyculture of plants having different growth pattern and therefore require nutrient application at different times of the year may

be an option. Hygiene and sanitation guidelines on how to safely use urine as a fertilizer for crop production have been published by the WHO.

Faeces Management: Dehydration is the simplest way of treating the faecal fraction, although they can also be mixed with organics and composted. By dehydrating the faeces with or without the addition of a drying or pH control agent (e.g. ash, lime, etc.), the faeces can be sanitized and used, or disposed off, safely. Faeces should be kept as dry as possible and covered continually to aid in drying and form a barrier between the faeces and vectors.

2. Septic tank/Sludge/Septage Management

In absence of any systematic municipal sanitation network, on-site sanitation facilities are most commonly developed by the residents themselves, as in the case of Nellore too. Those are little concerned about the problems with sludge removed from their facilities. Sludge or Septage management is usually limited to a de-sludging service that is provided by municipal agencies or the private sector, proper solutions for sludge disposal are generally lacking. This situation may have less serious impacts when the population density is low. However, in urban areas with dense population, the negative impacts on the urban environment become too high and actions have to be taken. Instead of leaving the responsibility completely to individuals, the public relevance of sludge management must be recognized and a strategy for better management of sludge be developed. Sludge management is an integral as well as indispensable part of every sanitation plan, which builds on on-site sanitation facilities. It is definitely irresponsible to promote septic tanks without providing solutions for regular de-sludging of the facilities and for safe management and disposal of the sludge. 100% of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed of safely. In order to achieve this goal, the following activities shall be undertaken:

- Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible.
- Promoting recycle and reuse of treated waste water for non potable applications wherever possible will be encouraged.
- Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.).
- Ensuring that all the human wastes are collected safely confined and disposed of after treatment so as not to cause any hazard to public health or the environment.

Management of On-site sanitation need attention as these appears to be an area of neglect where limited attention has been accorded to proper construction, maintenance and management and safe disposal of Septage from septic tanks and pit latrines. The problems associated with on-site sanitation facilities can be summarized as follows:

- Lack of awareness/knowledge on planning and designing on-site systems and its installations, operations and maintenance among the system owners, public and urban local bodies.
- On-site systems are not built to national standards, but rather constructed and installed in ad-hoc manner leading to issues in its performance and failure and higher environmental risks.
- Poor O&M like infrequent de-sludging, clogged absorption fields, and hydraulic overloading causes system failures.

- Institutional mechanisms for inspection, monitoring, and other regulatory measures are non-existing, or even if present, are not effectively enforced.

A human excreta is made of feces and urine. The fecal matter comprising of pathogens or disease-causing organisms is very dangerous when come in contact to the human beings and environment. Therefore, there is a need to manage it efficiently. Pit latrines and septic tanks are systems that permit safe collection and confinement of fecal matter on-site in a cost effective manner. These when properly constructed and maintained, these on-site systems can also convert the pathogens infested feces into harmless matter to a great extent.

The United States Environmental Protection Agency (USEPA) has identified a number of critical problems associated with programs that lack a comprehensive management program, as presented in figure 18.

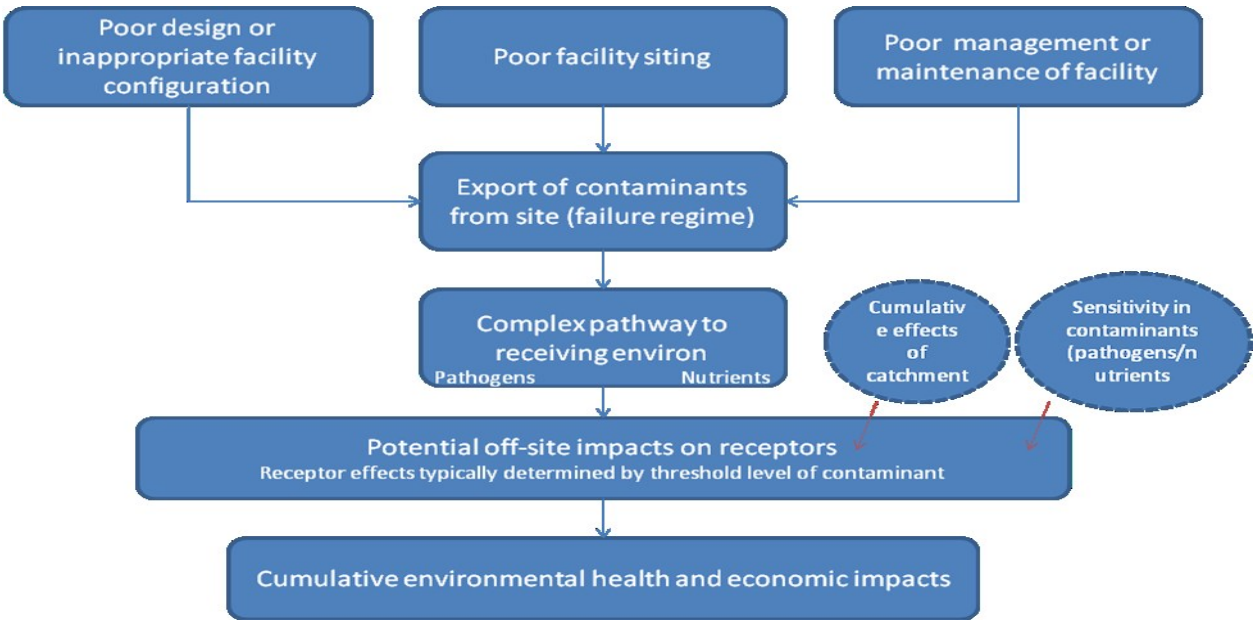


Figure 25: On-site sanitation systems failure and downstream impacts

The pollutants of concern in the effluent of on-site treatment systems and their potential impacts on ground and surface water resources are summarized in table

Table 49: Pollutants in the Effluent of On-site treatment systems

Pollutants in the Effluent of On-site treatment systems	
Pollutant	**Reason for concern**
Total suspended solids	• In surface waters, suspended solids can settle and form sludge deposits that smoother benthic invertebrates and fish eggs and can contribute to benthic enrichment, toxicity and sediment oxygen demand. • Colloidal solids can block sunlight, affect aquatic life and lower the ability of aquatic plants to increase the dissolved oxygen in the water.
Biodegradable organics (BOD)	Biological degradation of organics can deplete the dissolved oxygen in surface waters resulting in anoxic conditions, harmful to aquatic life.

Pollutants in the Effluent of On-site treatment systems	
Pollutant	**Reason for concern**
Phosphorous	Phosphorous would also lead to eutrophicatoin and reduction of dissolved oxygen in surface waters.
Toxic organics	Toxic organic compounds present in household chemicals and cleaning agents can be present in groundwater and contaminate drinking water sources. They can also affect surface water ecosystems and human health through ingestion of contaminated aquatic organisms
Heavy metals	Heavy metals like lead and mercury can be toxic to human and aquatic life. They tend to accumulate in fish and shell fish and if consumed by humans could affect their health
Pathogens	Parasites, bacteria and viruses can cause communicable diseases through body contact, ingestion of contaminated water or shellfish. Transport distances of some pathogens (bacteria and viruses can be quire significant).

Different suitable on-site applications are discussed below

Double Ventilated Improved Pit: This is more appropriate for denser, peri-urban areas. The material is manually emptied (it is dug out not pumped out), so vacuum truck access to the pits is not necessary. The users can remove the pit material after a sufficient resting time of one or more years even though the treatment processes in the pit are not complete and the material is not entirely hygienic. The double VIP technology will only work properly if the two pits are used sequentially and not concurrently. For more information refer annexures.

Twin Pits Pour Flush: the twin pits with pour flush is a permanent technology that is appropriate for areas where it is not appropriate to continuously move a pit latrine. It is a water-based technology and is only appropriate where there is a constant supply of water for flushing. Grey water can be co-managed along with the black water in the twin pits. This technology is not appropriate for areas with a high groundwater table or areas that are frequently flooded. In order for the pits to drain properly, the soil must have a good absorptive capacity; clay, tightly packed or rocky soils are not appropriate. For more information refer annexures.

Septic Tank:
Two compartments septic tanks have been found to be more effective with lower solids concentration in the treated effluent. More information is enclosed in annexures.

Other than placing appropriate on-site technologies, the goal of Septage Management Plan is to provide the local operator with the clear understanding of:

- How often sludge is removed from the facilities
- The preferred method of treatment and disposal of sludge
- The back-up plan when preferred method is unavailable; such as land-filling
- Management of the sludge collection, transport and treatment processes

Most of the septic tanks are actually unlined soak-pits in Nellore, and hence the de-sludging interval varies depending upon the infiltration of the liquid component. Hence, assuming an

interval of 3 months to each septic tank, Nellore will require 3000L capacity vacuum suction pump mounted TATA 407 vehicles.

Most of the wastes either solid or liquid wastes find their way directly into land or water bodies causing land pollution and water pollution. These wastes also emit green house gases like methane and carbon dioxide that adds to air pollution. In order to avoid the direct discharge of the sludge on to the land, a set of decentralized sludge treatment plants will have to be installed in different zones of the town. Decentralized treatment systems of sludge per zone would avoid the long distance transportation of the sludge. The following flow diagram explains the steps involved in sludge processing:

Thickening -> Stabilization -> Dewatering -> Large scale composting -> Reuse or Disposal

The following paragraphs explain the technical options for the steps mentioned above:

Sludge Thickening: The first and the most important step in sludge processing is the sludge thickening. Its primary function is to reduce the water content and sludge volume. The solid concentration of unthickened anaerobically digested primary sludge from primary digester is 8% whereas that of thickened sludge it is 12%. This means that the reduction in volume is 33% approximately. For achieving this volume reduction, technical options are gravity thickening, floatation thickening, centrifugal thickening, gravity belt thickening or rotary drum thickening.

Large-scale anaerobic biogas digester: are reactors used for the conversion of the organic fraction of large volumes of slurries and sludge into biogas by anaerobic digestion. The volumes of the reactors are ranging from several hundred to several thousand m^3. The bio-methanation Plant provides a cost – effective and eco-friendly solution for extracting energy, mainly derived from organic waste. Biogas is produced through the anaerobic digestion (fermentation) of decaying plants, animal matter, human excreta etc. It is naturally occurring emission of bacteria that thrive without oxygen and occurs in three stages of digestion. Biogas produced in anaerobic digesters is burned to generate clean renewable energy. Biogas is recovered and used either directly for heating the reactors or transformed into combined power and heat and fed into the grid or can be used for indigenous application.

Sludge dewatering technologies: Sludge dewatering is a physical/chemical operation to reduce liquid residuals (i.e., sludge) volumes by up to 90%, converting them into a solid “cake”. Municipal and industrial water and wastewater treatment facilities commonly use mechanical sludge dewatering techniques (e.g., belt-filter press, sieve drum, centrifuge, dissolved air flotation, gravity belt thickeners, etc.) to facilitate the dewatering of their sludge, usually resulting in a substantial net savings in sludge disposal costs. Mechanical sludge dewatering options are available as short-term or long-term remedies but are capital and energy intensive for facilities already operating on a tight budget.

Other options for sludge treatment include planted and unplanted drying beds: Drying beds are either planted or unplanted sealed shallow ponds filled with several drainage layers and designed for the separation of the solid from the liquid fraction of (faecal) sludge from wastewater treatment systems. Sludge is dried naturally by a combination of percolation and evaporation. When plants are present, evaporation is enhanced by transpiration (evapo-

transpiration). The percolate still contains pathogens and needs to be collected for treatment or controlled reuse. After treatment in planted drying beds (humification beds), the dried sludge, a nutrient-rich soil amendment, can be directly used in agriculture. If unplanted sludge drying beds are used, additional treatment by composting may be foreseen.

Safety concerns while collecting, handling and transporting Septage from on-site installations is detailed in the annexure enclosed.

3. Minimization of Waste Water and Reuse

To minimize liquid waste generation, people should be made aware of the sanitation techniques like ***UDDT***, ***Low Flush Toilet*** and ***Water Saving Urinal*** which consume very less water compared to conventional sanitation techniques. Out of 135 lpcd, 30 litre (22.23%) of water is used for flushing hence minimizing water use for flushing will lead to less generation of liquid waste.

Another way of minimizing the sewage generation is segregation of the grey water and black water. Water coming from bathroom and kitchen is termed as grey water as it contains comparatively less organic load where as water coming from toilets is termed as black water which contains comparatively more organic load. Out of 135 lpcd, 85 litre (62.96%) of water per person is used for bathing and washing clothes and utensils. Less degree of treatment is needed for grey water. Hence segregating the grey water from black water and treating it and reusing it for various non potable purposes can help us to save water and reduce the generation of liquid waste.

Goal 4: Storm Water Management

Nellore city has 1130 Km of road length of which only 1415km are provided with drains on both sides instead of the required 2260km. 63% of 1415 km length of drains has pucca drains (895 km), with the remaining 37% kutcha drains (520 km). All the storm water drain carries grey water from the households, since all the septic tanks are designed to handle only the black water. Further, these storm water drains are severely abused with solid waste dumping.

Drain cleaning is handled by the municipal workers who are also responsible for solid waste management. Due to less coverage of areas under door to door collection, awareness and accountability, the drains are choked with solid waste, and hence there is an immediate need to address these inadequacies.

Parameter	Unit	Norm	Baseline	Timeframe to achieve norms		
				Short	Medium	Long
Coverage	%	100	63	✔	✔	
Reduction in water logging areas	No.s	0	2 major	✔	✔	✔

Improving the urban drainage system requires not only capital infusion, but also ongoing funding for operation and maintenance. A single point obstruction in a storm-water drain would have a cascading overall impact. The steps involved in upgrading storm water drainage include:

- Extension of the storm water drain network into surrounding municipal council areas
- Clearing all encroachments that come in the way of the storm water drain network in the city
- Aligning the drain network and checking blockage and overflowing of drains
- Reviewing existing storm water drains, ensuring connectivity of primary, secondary and tertiary drains

The storm water management is emerging as vulnerable pollution hotspot as solid waste dumping, grey water flows, overflows from septic tanks, sewage contamination and poor maintenance threaten to create adverse health and environmental impacts. The city is currently approved for the construction of underground drainage system covering entire city, which is expected to reduce the problem pertaining out of poor solid waste management activities. Though the city is provided with underground drainage system, the storm water drains that meant to carry excess rain and ground water from impervious surfaces cannot be addressed in isolation, and need to be managed along with initiatives on SWM and waste water flows covering the following actions

- Identification and elimination of large point sources of grey water, septic tank overflows and solid waste disposal along the drain network through focused clean-up drives and awareness campaigns to
    - Minimize grey water flows,
    - Eliminate dumping of solid waste through effective waste collection practices
    - Prevent littering/dumping waste in drains.
- Identification of potential for setting up water retention zones within and in the vicinity of Nellore Municipal Corporation through restoration and creation of water bodies, given the city topography and orientation / flows along the storm drains.
- Rehabilitation of existing networks covering lining of open drains, bar screens against storm water flow at strategic points in the network to reduce clogging and facilitate easy removal, covering of open drains with precast cement slabs in commercial areas (with manholes for maintenance and cleaning) and removal of encroachments along drains.
- Development of new drains in uncovered areas to provide city wide access to minimize problems arising from water logging.

Specific actions to be implemented with respect to Storm water management are listed below. As indicated above, large scale investment program on storm water drain should be necessarily preceded and complemented with initiatives on a war-footing on Solid Waste Management and Waste-Water flows as ineffective management of these aspects render any investments in Storm water drains ineffective and useless.

On immediate basis citizen awareness is therefore a critical issue, where citizens and NGOs can play a key part in monitoring development in the region to ensure that drainage is not obstructed, and dumping of debris and MSW in drains does not occur.

As on immediate basis, the Nellore Municipal Corporation shall prepare a comprehensive plan and preparation of project estimate for providing storm water drainage facilities for the entire municipal area of the city for construction, conveyance, treatment and disposal arrangements for storm runoff.

Major activities to upgrade storm water management in Nellore are recommended in the table:

Phase	Year	Actions
Short term	Within 5 years	• Cleaning of drains and removal of silts • Preparation of DPR specially for storm water management • Installation of grating points for collection of solid waste entering into storm water drains • Conduct feasibility study for treatment measures • Database management – detailed mapping of natural and built storm water drains
Mid term	Within 6-10 years	• Removal of unauthorized structures and encroachments on natural drains • Construction of road side drains as per the drainage designs • O&M and M&E systems
Long term	Beyond 10 years	• Augmentation of storm water drainage system

Goal 5: Solid Waste Management

Realizing that with increasing population, the amount of waste will also increase proportionately in future, there is an immediate need for Nellore Municipal Corporation to improve its services and gear up for meeting the demands of its citizens in near future. As discussed in the previous chapters, the city is required to procure additional 385 pushcarts, 15 autos, and 6 new dumper placers for secondary transportation or increase in no. of trips of the available vehicles, 278 secondary bins, 1 compactor and 1 tipper or increase in no. of trips of the available vehicles, and add 149 workers to the existing available workers.

The table below summarizes the issues presently posing serious threat in Nellore because of operational inefficiencies:

Table 50: Parameters for SWM

Parameter	Units	Norm	Baseline	Timeframe to achieve norms		
				Short Term (Within 5 years)	Medium Term (Within 5-10 years)	Long Term (Within 15 years)
HHs coverage (door to door)	%	100	40	✔		
Waste collection efficiency	%	100	85	✔		
Source segregation	%	100	0	✔		
Resource recovery	%	80	0		✔	
Scientific disposal	%	100	0		✔	
Cost recovery	%	100	-		✔	

(As per the discussion with officials from NMC)

Various strategies are discussed and proposed to address the inefficiencies in solid waste management in Nellore. These strategies are of high priority and a step towards clean Nellore City

Proposed system improvements

The system improvements shall focus on the following aspects of MSWM system:

- Segregation of Waste:
  As per the Draft MSW (Management & Handling) Rules, 2015, it is the duty of waste generators to segregate waste into at least 3 types viz. dry waste, wet waste and domestic hazardous waste and store it separately. Citizens need to be made aware and sensitized towards segregation. It is recommended for NMC to distribute bins in the city and promote segregation at source. Segregating waste at source will ensure that waste is less contaminated and can be collected and transported for further processing.

No. of households in city	159362
No. of bins to be distributed	318724 (2 bins each to HH)

Organization of door to door collection of waste (with community participation) in entire city: Presently, only 40% of households are being covered under door to door collection of waste. NMC needs to scale the service to cover entire city in the immediate next step. The primary waste collection system in residential areas shall be a mix of motorized door to door collection (auto), manual waste collection in areas inaccessible by vehicles and individual disposal at the community waste bins. The commercial establishments including hotels and restaurants should be covered by door to door collection and through secondary waste storage depots provided in vicinity. The vegetable and meat waste to be collected separately through door to door collection.

- Street Sweeping and Drain Cleaning: The length of roads in the city being at 1130 km stretch, considering that one worker shall cover 500m it is proposed to engage 2260 workers specifically to carryout street sweeping and drain cleaning. Workers engaged in street sweeping shall also be engaged in drain cleaning along the same beat. It will be made sure that drain silts and street sweeping will not be mixed with the MSW at secondary points and transferred directly to transfer station of landfill site.
- Secondary Collection and Transportation: The main objective of the secondary collection system is to store the waste temporarily and transport it as quickly as possible. As proposed in previous chapter, it is recommended to procure additional 278 bins of 3 cum capacity in order to store the waste. It is also desirable that placement of bins is in accordance with the need and requirement of the city so as to also avoid open kachchra/dumping points. In order to promote single handling system, it is desirable to discontinue any current open (land) and static (masonry bins) collection system.
- For Nellore, considering the existing situations, it is recommended to procure 6 more dumper placers to the available vehicles for 100% secondary transportation or recommended to increase the trips by each available vehicle for secondary transportation. It shall also be ensured that the waste is transported to the waste processing and disposal facility by closed vehicles to avoid littering and the route shall be optimised as far as possible.

Final disposal at the dumping point: Considering the existing situations, it is recommended to procure 1 compactor and 1 tipper to transport the existing 100% waste from transfer station to the final dump site or it is recommended to just increase one trip by each available compactor and tipper for waste transportation from transfer station to the final dump site.

Based on local conditions and socio-economic status of the city, following are some of the strategies that can be adopted by NMC to move towards sustainable waste management.

Table 51: Proposed strategies for SWM

S. No	Issues	Proposed solutions	Explanation
1	Lack of awareness among public	Waste avoidance	A national level adoption of policy of product manufacturing and packaging using less material, minimizing the use of virgin plastic, household level waste management awareness, polluters pay principle, etc.
2	No segregation at HH level	Practice and achieve 100% segregation at HH level	Corporation to distribute different coloured bins to the HHs for waste segregation. When you segregate waste into two basic streams like organic and inorganic, the waste generated is better understood and consequently recycled and reused with higher potential for recovery.
3	DTD collection efficiency is less	Zero bin program	A zero bin program ensures 100% DTD collection and segregation of waste that allow various financial profits to the corporation and to the public by providing manure and recyclables to the workers.
4	Inadequate machinery and manpower	Need to procure machinery and manpower immediately	the city is required to procure additional 385 pushcarts, 15 autos, and 6 new dumper placers for secondary transportation or increase in no. of trips of the available vehicles, 278 secondary bins, 1 compactor and 1 tipper or increase in no. of trips of the available vehicles, and add 149 workers to the existing available workers.
5	Principles of land filling as per MSWM rules is not followed	• MSWM rules to be followed •Waste transformation (without resource recovery) prior to disposal	Managing the landfill sites, development of the new landfill sites on scientific basis, capping existing dumped garbage etc.

S. No	Issues	Proposed solutions	Explanation
6	No resource recovery	• Resource recovery through material recycling •Maximize on market opportunities in resource recovery technologies	• Sorting of waste into dry and recyclable waste, bio waste, garden waste and inert waste. The municipal solid waste processing plant of higher capacities to be planned on the build and operate contract, construction of various biogas, vermin-composting and mechanical composting projects.
7	No intermediate stations	Decentralized stations for SWM is required	Having an intermediate station between collection point and processing point for increasing the efficiency of the system.

The description of the above listed proposed strategies is as follows:

1. Waste avoidance:

The foremost goal of an ULB should be to reduce the amount of waste that is being generated and needs to be handled. Promoting waste avoidance or reduction is important because it will help in conserving resources, while also reducing disposal costs and pollution.. The Integrated Solid Waste Management (ISWM) Hierarchy below prioritizes waste minimization as the most preferred waste management strategy that should be adopted by ULBs.

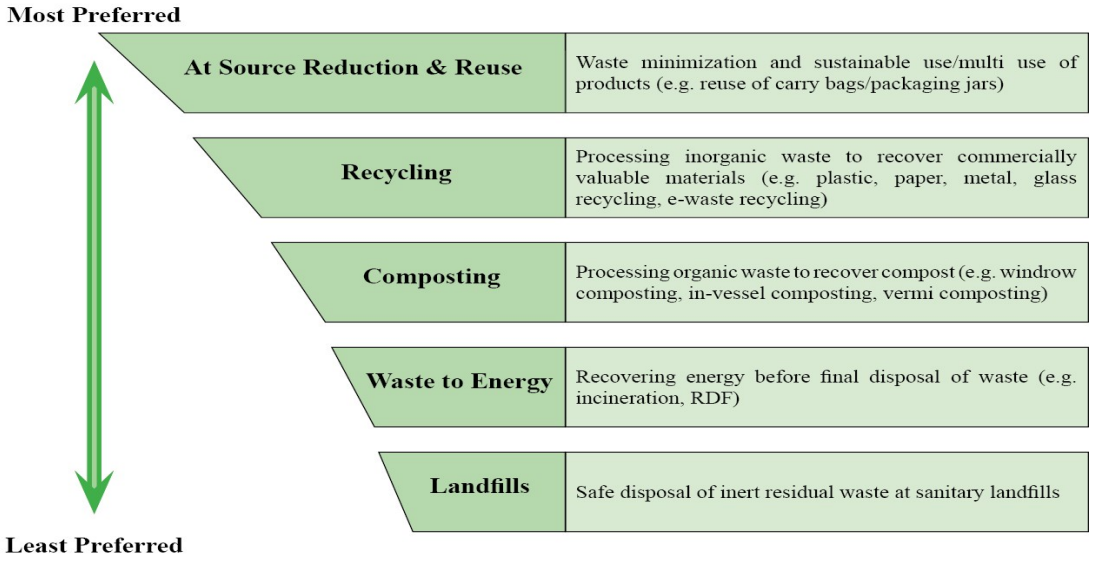


Figure 26: Integrated Solid Waste Management Hierarchy

At the local level, Nellore Municipal Corporation can promote waste minimization by framing rules and local bye laws and enacting local ordinances banning use and/or sale of certain types of products and packaging that cannot be reused, repaired, recycled, or composted.

Some of the strategies that can be adopted by NMC to minimize/avoid waste generation include:

- Conducting awareness generation and education programs with focus on 'at source' reduction programs like household level composting; yard waste composting etc.

- Conducting campaigns for reducing the use of specific non-recyclable, non-reusable or toxic material like promoting the use of rechargeable batteries instead of single use batteries
- Replacing disposable materials and products with recyclables and reusable materials and products (e.g. banning the use of plastic bags).
- Introducing incentives for communities practicing 3Rs i.e Reduce, Reuse and Recycle
- A household management system should be put in place, levying fees for waste management services that penalize generators in case of increase in waste quantities. This is driven by the "polluters pay" principle, in which the amount of money to be charged to each property will depend on the number and size of bins assigned to each property.
- A strong solid waste minimization and management at the "community" level should be carried out, especially in developing areas, where new middle class residential areas are being constructed. In this new areas, it should be compulsory to have their own waste management station for the sorting at source, recycling at source and processing at source (e.g. yard composting) which helps in waste minimization.

2. Zero bin program:

One of the medium term goals of the Nellore Municipal Corporation is to become a bin less city. In order to promote non-usage of secondary bins or prevent open dumping of waste at nook and corners of the road, it is advisable to synchronise primary collection and secondary collection of the city, thereby avoiding the need for secondary storage bins/ depots.

Segregated waste at the household level shall be collected by primary collection vehicles, which directly transport this waste to secondary collection vehicles. Secondary collection vehicles are parked at specific locations for the entire duration of time taken for primary collection daily. Separate vehicles/chambers within a vehicle should be provided, to ensure segregated transportation of waste.

Nellore Municipal Corporation shall develop an approach based on zero-waste as an efficient model, which includes reduction, reuse, recycling solutions, information and education campaigns based on a strategic interaction of regional/local governments and other stakeholders to address ongoing issues in handling, transporting, processing, and disposing of the wastes in an environmentally conducive manner. This program shall be initially implemented in one ward on a pilot basis and shall be expanded to the entire city as it gives experiences to the workers who were already involved to replicate in new areas without flaws and very efficiently and swiftly.

This program involves 100% door to door collection of waste along with the source segregation, where the organic waste shall be sent to the decentralized (ward-level) compost plant composting while the dry recyclables shall be sent/sold off to the recycling companies. This initiative will reduce the financial expenditure in collecting and transportation of waste for the corporation as it reduces the involvement of fuel vehicles allowing it only for secondary transportation.

Program outcomes:

- Ensure 100% door-to-door collection of waste and source segregation from households, commercial and institutional establishments in the identified ward/division
- Ensure motivated and productive workforce with a dignified and safe working environment among the sanitary workers
- By the end of the project, the ward will be transformed into a Bin Free Ward by removing waste collection bins/containers along the roadsides and at the street corners by implementing 100% door-to-door collection
- Reduced littering even after removal of roadside bins/containers
- Ensure dedicated collection of wet organic wastes on a daily basis and transport it for processing plant
- Material recovery through composting of organic waste.. The compost so produced shall be given back to the residents to boost their morale in effective source segregation.
- Reduce cost in secondary transportation of waste thus leading to saving of financial resources for the ULB

Financial implication:

For a ward with 3500 HHs, by providing only pushcarts for waste collection and transportation, the corporation is estimated to save approximately 1818 litres of diesel per month for its transportation to the final dump site i.e. around INR. 100000/- at diesel price INR 55/- per litre. It is also estimated that around 4.36 tons waste can be processed for manure and approx. 1 ton of manure can be produced every month.

Explanation and Calculation:

Autos: Rs. 550/- in one day

- Auto on an average transports 300kg from HHs to the secondary bin in its each trip.
- To cover 3500 HHs from ward, 4 autos are required (considering 1 auto covers on max. 1000 HHs).
- On an average each auto makes 25 kms to collect waste from each HH and dump at the secondary bin. (25 kms as from the parking point to start and end in a day)
- Average auto mileage at 10kms per litre, auto expenses includes around Rs. 550/- (at diesel rate Rs. 55 per litre).

Secondary Bins: Rs. 1467/- in one day

- Dumper placer on an average transports 2300kg from bins to the transfer station in its each trip.
- To transport 4500 kg of waste from the ward, it needs two dumper placers.
- On an average each dumper placer travels 40 kms to start from parking point, transport the waste and reach the parking point again.
- Therefore, 80kms by 2 dumper placers at Rs. 1467/- (considering that it makes 3 kms per 1 litre)

Compactors from transfer station to dumpsite: Rs. 1100/- in one day

- Compactor carries on an average 4650kg in its each trip. Therefore, need 1 trip to transport 4500 kgs from the ward.
- Compactor travels around 80 kms in each trip (from parking point to the dumpsite to the parking point). Dumpsite is around 30 kms from transfer station.

- Compactor consumes 1 litre of diesel for 3 kms. Therefore, it costs Rs. 1100/- for transporting.

Therefore, cost that can be reduced by removing bins in the wards and just by controlling vehicle trips is estimated at nearly Rs. 1,00,000/- per month (auto costs per month + dumper placer cost per month + compactors cost per month). This can be expanded and can be implemented in the entire city that would turn the entire city into zero bin city. In addition to this the ward workers gains profits by selling the recyclable waste and citizen profits by manure. Also maintenance costs will be reduced to the corporation.

3. Resource recovery through material recycling

It is recommended to NMC to set up small material recovery facility where sorting of waste can take place. Material recovery facilities (MRFs) are an essential part of a zero waste management program as it receives separates and prepares recyclable materials for marketing to end-user manufacturers. The primary objective of setting material recovery facility is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenues in the market. MRFs can also process wastes into a feedstock for biological conversion through composting and anaerobic digestion. The desirable sorting streams at household level are:

- Dry recyclable materials e.g. glass, paper, plastics, cans etc.,
- Bio-waste and garden waste,
- Combined MSW (mixed waste).

Centralized sorting is desirable but expensive where recyclable materials are collected in a mixed state. Hand sorting from a raised picking belt is extensively adopted in several countries but is not desirable.

3. Decentralized stations for Solid Waste Management

Decentralized transfer stations can beone of the most suitable techniques for cities like Nellore. A totally decentralized collection and transfer system is recommended where each ward or a group of ward will have a transfer station from where the municipal solid waste in compacted form will be transported for processing and disposal.

4. Maximize on market opportunities in Resource Recovery Technologies

With the aim of reducing the land requirement for landfilling the waste, resource recovery technologies such as composting, biomethanation, electricity generation from incineration and landfill gas recovery should be implemented to enhance its market attractiveness.. Other suggestions to increase the economic benefits are:

- Promoting decentralized composting at household level
- Decentralized bio-methanation plant of 10 TPD for hotel, vegetable and fruit market waste
- Development of independent processing facility for ‘E Waste’ on BOT/PPP basis.

5. Waste Disposal (without resource recovery)

At the end of all sorting processes, prior to this disposal, waste may need to be subjected to transformation by mechanical treatment, thermal treatment or other methods to make it suitable for land filling. The following are aspects that have to be taken into account:

- Account for all Land Disposal Uses: Land disposal is an essential part of every solid waste management system. Regardless of the extent of recycling or resource recovery, there are always some wastes that must be put in a land disposal site (e.g., ashes from incineration, non-compostable residuals). In virtually all developing countries there is an urgent need to close existing open dumpsites and implement sanitary landfills. Identify land and plan for dumping of inert material and rejects (30% of total waste generated) for next 30 years
- Capping of existing dumped garbage site should be carried out. This will include capping, leachate collection & treatment, dislodgement & compaction of waste & treatment dislodgement & compaction geo-membrane, methane gas trapping & land reclamation. Development of this proposed capped site should be planned for next 15 years.

Management Information System:

NMC is collecting and processing data electronically thereby avoiding day to day human intervention, and reducing human errors. Data thus stored is also readily available. Short Messaging Services (SMS) prevailing in the city shall be scaled to 100% coverage and participation. ,

Short Messaging Services (SMS) can also be used to register a complaint from the citizens thereby maintain a electronic complaint redressal system as well. .

The table below briefly discusses goals and actions recommended for Nellore Municipal Corporation.

Table 52: Goals and actions recommended for SWM

PHASE	YEAR	Actions
Short Term	Within 5 years	• Initiate primary segregation , storage and door to door collection system (for remaining 60% households) • Introduce user charges • Procurement of gears/equipment for street sweeping, and waste transportation • Set up material recovery facility • Promote decentralized solid waste management practices • Conduct awareness generation and sensitization towards segregation, 3Rs (reduce, reuse, recycle) • Enforcement of application of Polluter pays Principle/penalty for littering as per Draft MSW (M&H) Rules 2015
Mid-Term	Within 6-10 years	• Augmentation of SWM system to meet the demands of growing population • Regular O&M involving in entire system of SWM • Identify land for landfilling purpose • Replacements of components as per the maintenance plan • Regular M&E of entire SWM system

PHASE	YEAR	Actions
Long-Term	Beyond 10 years	• Augmentation of SWM system to meet the demands of growing population • Regular O & M involving in entire system of SWM • Replacements of components as per the maintenance plan

The figure below depicts the immediate attentions to be taken for improving sanitation facilities in Nellore City.

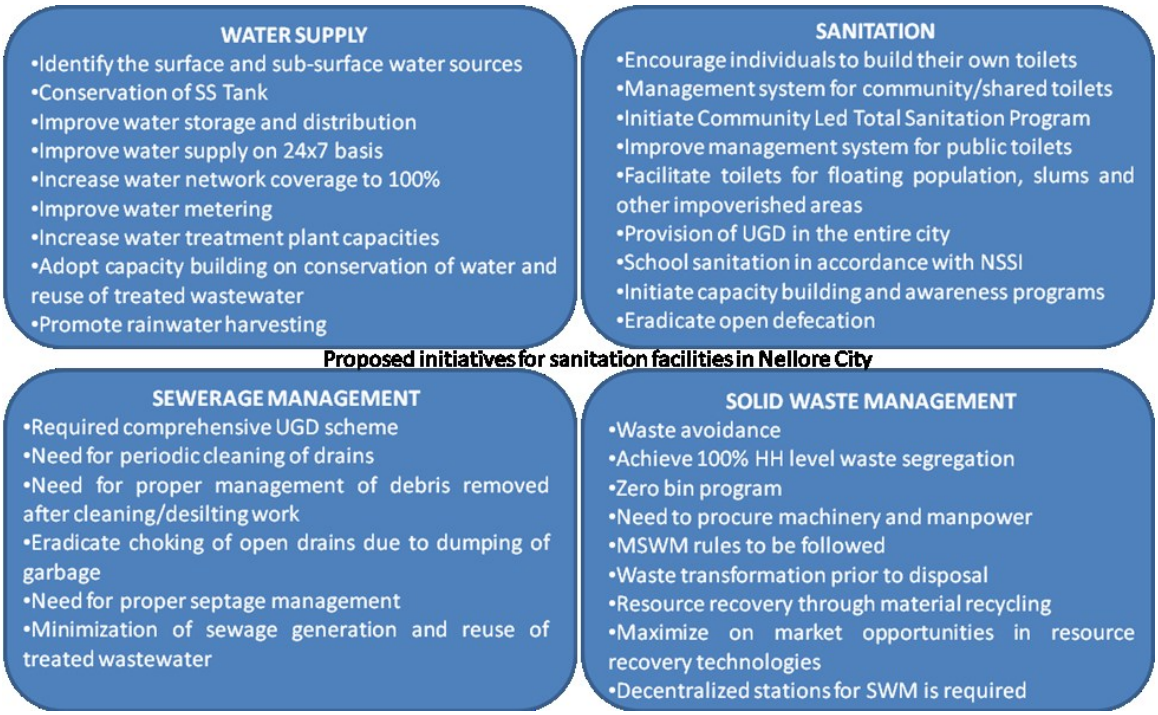


Figure 27: Proposed initiatives for improving sanitation facilities in Nellore City.

8.2 Implementation Plan: Software Component

It has been realized over the years that merely providing sanitary infrastructures does not guarantee their use, nor results in improved sanitation and hygiene. Earlier approaches to sanitation prescribed high initial standards and offered subsidies as an incentive. But this often led to uneven adoption, problems with long-term sustainability and only partial use. It also created a culture of dependence on subsidies. In order to achieve the goal of sustainable sanitation, the software intervention (awareness generation and sensitization) and strengthening and capacity building of human resources becomes equally important.

8.2.1 Capacity building for ULB staff

In order to achieve the goal of sustainable sanitation, there is a need to strengthen the institutional linkages, mandates, capacities and interface of the municipal council at the town, zone and ward level. This is critical for the management and sustainability of the processes initiated under the preceding set of suggested actions. The capacity of the local urban bodies in India varies widely across States and cities. As in the majority of councils/corporations across the country, in Nellore too there are problems of staff shortages and lack of

appropriate skills. The problem becomes more aggravated at the zonal levels. The status of the sanitation staff finds special mention even in the NUSP. They are a critical link in the efficiency of the entire city sanitation system. A systematic institutional development exercise is required. Broadly, the issues with existing capacity can be categorized into the following:

- Lack of personnel with appropriate skill sets
- Inadequate skill sets of personnel already deployed
- Lack of appropriate institutional framework
- Capacity gaps at the apex level

Capacity building will need to be done at three levels - city level, zone level and ward and lower level i.e. clusters. Capacity building shall focus on specific orientation on health, hygiene and sanitation practices as well as planning and monitoring mechanisms required to implement the CSP at the ward/cluster level. Implementation of the capacity building shall be done through a variety of methods such as exposure visit/cross visit, workshops, training, and learning by doing and technical assistance. The capacity building needs of sanitation managers should be given priority.

8.2.2 Formation of monitoring and supervision cell

It is a common practice that State and National governments support urban local bodies in putting in place infrastructure, with different levels of finance and implementation support. However, it has been observed and proven that, over a period of time, the responsibility of the maintenance of the infrastructure is not assumed by any institution, leading to deterioration and lack of use, which in turns make the project a dead investment. No agency concerned in the city vicinity would be in a position to monitor it. This has been a crucial issue in sanitation, which has hampered the growth in terms of sanitation and also has pushed the cities to look unhygienic by redundant services. Therefore, having a sound institutional arrangement would enable the infrastructure to be used in a proposed manner to its fullest capacity coupled with a monitoring and supervision and community mobilization through awareness programmes on various health and sanitation issues.

The first important step before implementing the project design (hardware and software) is to create a Project Monitoring Unit (PMU). This cell should be integrated within the Nellore Municipal Corporation and responsible for the successful implementation of the projects. It would be advantageous if the head of the cell is experienced in grassroots movements and particular in the work of community based organizations (CBOs). The stakeholders of the cell and their responsibilities are the following:

- Special cell in NMC: The organizational framework needs to be created to look after hardware activities (engineering activities) as well as software activities like community mobilization and community development activities. This cell will assist CBO's in their O&M activities. The NMC will act as a coordinating agency between the different stakeholders. Furthermore, the NMC is expected to provide the required funds and to make sure that land is made available for toilet construction.
- Sanitary engineering wing: It will be directly responsible for new infrastructure as well as repairing the old infrastructure, if necessary. The entire process of construction such as planning, designing and construction activities needs to be planned and implemented in consultation with community and community development cell of NMC.

- Stand-by technical aid: This group shall be a pool of technical experts in sewage systems and will come into action in case of damaged material, problems with sewer lines, clogged toilets, broken washbasins, etc. which cannot be mended by the caretakers.
- Septage Management Plan team: This unit is in charge of accomplishing an appropriate transportation system of wastewater and sludge within the whole sanitation system and also organizes the transportation of sludge from those places which are not connected to the sewer-lines. Furthermore, this unit has to coordinate and this team will also take care of treatment of sludge.
- Sanitation Inspector: The Sanitation Inspector will run the O&M-unit through the supervisors heading each unit. Main task of the Inspector is to organize any provision needed at toilet blocks and for the wastewater conveyance system. Furthermore the sanitation inspector is in charge of ensuring proper maintenance of facilities in his jurisdiction. The direct supervision of facilities lies in the hand of the supervisor of each unit. Nevertheless, the sanitation inspector will have to perform unannounced checks to different sites to ensure compliance with monitoring norms.
- Supervisor: The supervisor is responsible for the schedule of the shifts of his team and will be their contact person regarding claims, damages etc. Furthermore, the supervisor takes care of the distribution of the required equipment (according to the manual) to his team – the material being provided by the Sanitation Inspector of the District.
- Caretakers: The member of CBO who will be assigned for the actual O&M of the toilets will attend beforehand a specific training to learn about the standard that is expected by NMC.

Having described the stakeholders with their responsibilities integrated within the recommended NMC sanitation cell, it is important to highlight other actors strongly connected and involved in the new sanitation system:

- Local Councilors: Political will is important for the success of any project. Local councilors bring with them the political strength to the project implementation and management. They also act as local champions bringing community together.
- Construction contractors: Private contractors have to be strongly accountable for constructing high quality sanitation facilities in local communities.

In order to achieve the above described structure, and to form a CBO, the local authority will have to take the lead. As described above, the start up phase will concentrate on the grassroot level. It is strongly recommended to collaborate with agencies which can look back on years of experience and numerous success stories. The following chart presents the institutional set up for O&M of sanitation facilities, based on the CLTS approach:

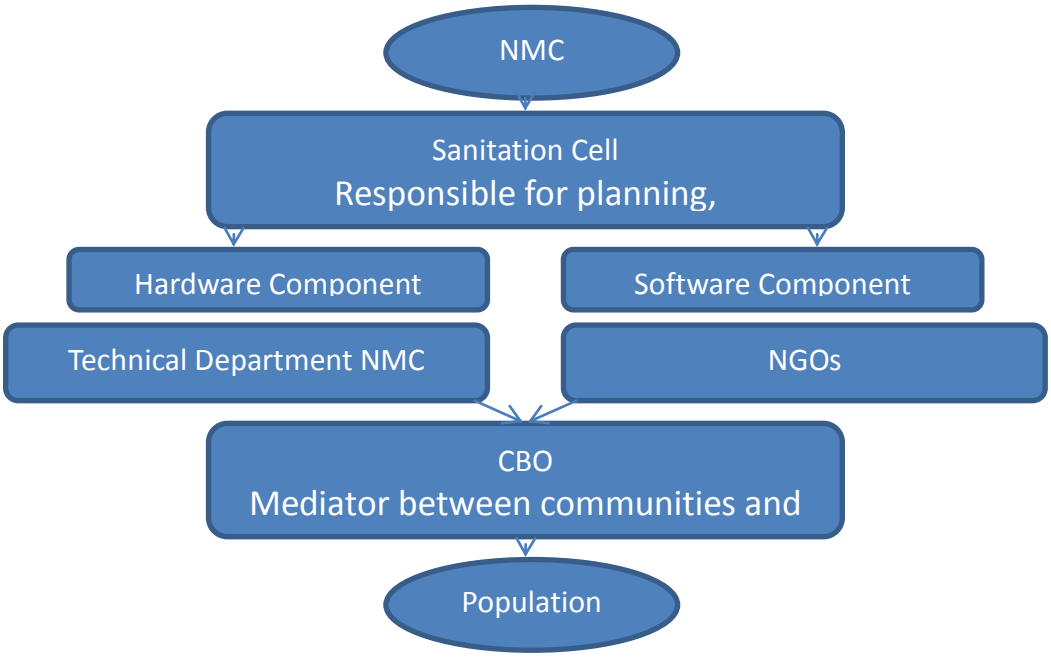


Figure 28: Flowchart for framework of sanitation cell

8.2.3 Awareness generation activities focusing different stakeholders

National Urban Sanitation Policy 2008, by the Ministry of Urban Development, Government of India has outlined constitution, roles and responsibilities of City Sanitation Task Forces envisaging multi stakeholder involvement. Some eminent persons from the town (from fields of academics, NGOs, media, art, business etc.) could be included into this task force. Awareness generation activities can be spearheaded by Special cell in NMC.

A set of powerful mnemonics related to sanitation could be one of the ways of beginning the process of developing sanitation consciousness- say something like 'Swachh Nellore'. The messages that need to be put across to the stakeholders are as follows:

Table 53: Awareness activities for different stakeholders

Sr. No.	Stakeholder group	Issues to be addressed	Themes/Messages	Channels of communication
1	ULB (officials, engineers, health and sanitation inspectors, administrative officers etc)	Lack of knowledge in managerial skills Need to enhance capacity of the officials in provision of basic services like water supply, sanitation, solid waste management etc.	Anti open defecation campaigns	Trainings and capacity building workshops

Sr. No.	Stakeholder group	Issues to be addressed	Themes/Messages	Channels of communication
		Lack of coordination between departments and external agencies (NGOs)		City Sanitation Task Force meetings, CSP workshops
		Lack of public/citizen inputs, comments, suggestions in basic services for sanitation, health and hygiene		Having a transect walk, periodical surveys, public meetings, press conferences, news paper advertisements fresco paintings, leaflets, radio channels and cable TV channels.
2	Slum dwellers	Practice of open defecation	Beautiful slum/toilet contest, slum sanitation programs, Clean street program	Focus group discussions, CLTS activities, capacity building of NGOs working in slums, Meeting with the local councilors, formation and development of CBOs.
		Practice of open dumping		
		Improper use of toilets		
		Choking of drains		
		Lack of cleanliness in community		
		Inadequate water supply (quality & quantity)		
		Lack of ownership of the facilities		
3	Educational institutes	Poor facilities for sanitation and water	Sanitation ratings, Green & Sustainable campuses, water and sanitation audits, celebration of World water day, Global hand washing day, World toilet day etc	Trainings and capacity building workshops for teachers and students, administrative officials. Awareness campaigns for behavioural changes(under NSSI)
		Lack of awareness among teachers and students		
		Lack of operational and maintenance of facilitation		
		Lack of cleanliness		
		Lack of coordination between ULB and school management		

Sr. No.	Stakeholder group	Issues to be addressed	Themes/Messages	Channels of communication
4	Residential communities in urban areas	Lack of coordination between ULB and communities Practice of open dumping Lack of cleanliness and hygiene Wastage of water Lack of segregation of household waste	Clean colony competitions, Celebration of World water day, Global hand washing day, World toilet day etc	Awareness campaigns focusing on water conservation and reuse and solid waste management, Documentary shows, Meetings with the corporators/ULB and residents, organizing walk to the zonal office with local councilors/officials
5	Residential communities in rural areas	Practice of open defecation Practice of open dumping Lack of cleanliness and hygiene Inadequate water supply (quality & quantity) Lack of sanitation facilities Lack of segregation of household waste lack of awareness regarding reuse options	Total sanitation campaigns, programs like Nirmal Gram Puraskar	Awareness campaigns focusing on water reuse and solid waste management, Documentary shows, Meetings with the corporators/ULB and residents, organizing walk to the zonal office with local councilors/officials
6	Industries	Lack of knowledge regarding waste water management and reuse Inadequate sanitation facilities Lack of proper effluent disposal Lack of green industrial belts Lack of awareness regarding self health and hygiene	Celebration of World Environment Day focusing on development of green industrial zones	Meetings with ULB and industrialists for reforming industrial waste disposal standards, workshops for industrial staff, Environmental impact assessment reports
7	Commuters and floating	Practice of open dumping	Clean city - Healthy city	Appointing specific personnel like security

Sr. No.	Stakeholder group	Issues to be addressed	Themes/Messages	Channels of communication
	population	Practice of open defecation	program	guards of community centers/corporators/traffic police/NGO volunteers, Imposing fines, informative posters in public places
		Lack of cleanliness of public places		
		Inadequate sanitation and hygiene facilities		

8.2.4 Awareness generation implementation plan

Table 54: Awareness generation implementation plan

Phase 1 (1-12 months) Awareness Raising Phase	Phase 2 (12-24 months) Process Phase: Feedback	Phase 3 Compliance phase: (24-36 months) Consolidating gains and sustaining behaviour Change
Short (1 to 12 month) phase aimed at generating high awareness and taking steps to build trust among stakeholders. 1. Health and Hygiene and Government programmes and processes-Goals of City Sanitation Plans for all stake holders 2.Policy resolutions for various concerns 2. Status of community toilets, solid waste management, water supply and drain cleaning. Setting goals and exploring all avenues of improvement including community participation and consultation with officials. 3. Regular upkeep & maintenance of water bodies 4. Industries and slaughter houses be made aware of the compliance waste management.	12-24 month phase to enhance trust between stakeholders. Information and educational approaches are employed to stress the importance, among other things, of properly designed community toilets, septic tanks and periodic septic tank inspections and de-sludging every 3-5 years. Seeking feedback from the residents on status of community toilets their design, solid waste management practices etc. Imposition of user fee on commercial establishments for improved municipal services.	Offering awards and imposing penalties for undesirable behaviours. This phase is a continuing education and promotional phase. Mobilized public opinion is important to push for compliance. Continue promotional activities to trigger the actual adoption of the practices being marketed. Building sustaining process to open channels of communication between NMC and citizens. Compliance should be sought from industries and slaughter houses. Imposition of user fee on commercial establishments for improved municipal services.

9 FINANCING OPTIONS AND BLOCK ESTIMATES

9.1 Financial Options

Expansion of sanitation systems will not be possible unless an institution or group of individuals, preferably the intended users, is willing to pay for the new facilities required. Even when facilities have been provided, they will fail sooner or later unless funds are available to cover their ongoing operation and maintenance. So, it will be impossible to first provide and then sustain services to cities as a whole unless the finances of those who are responsible for providing and managing them are sound. Most conventional financing goes to established services in already served areas and to conventional technological and administrative systems. This approach is not going to fulfil the sanitation target of the MDGs and beyond. To revise the current trend of an ever-growing sanitation backlog in poor urban areas we need not only to invest more and more wisely, but also finance in much more creative ways.

Every proposal for a sanitation service, and its non-technical components, needs financing. The amounts required can be estimated in the early stages of strategic planning, and should include costs to be incurred by the municipal government and other parties. The strategy will consider both the initial capital and recurrent financing needs. The sustainability of most sanitation systems depends on having adequate recurrent funds for operations and maintenance. Financing is often regarded as the defining factor in sanitation development. This is true, especially if a city relies only on the local government budget. However, with a good citywide sanitation plan, a municipal government will plan to access finances from other sources, such as central government, provincial government, the private sector and the public. Furthermore, since the nominal amount of municipal budget is small, sanitation budgets are correspondingly small. The citywide sanitation strategy can propose a larger allocation from the municipal budget and recommend optimizing use of funds from other sources. Increasing the municipal budget allocation for sanitation requires commitment from all relevant decision makers, both in the legislative and executive bodies. Approval from the local legislature is key, and such support can be gained if the sanitation working group designs awareness-building activities for all decision makers. Thus, strategies for developing funding for sanitation needs to be supported by strategies for developing non-technical components, especially community participation, policy and regulation, and institutions. Without the support of these components, the sanitation working group would have difficulty in obtaining additional financing for sanitation development. These mutual linkages will be described in the citywide sanitation plan.

9.1.1 14th Finance Commission:

The 14th finance commission has grants to the local bodies towards supporting and strengthening the delivery of basic services like water supply, sanitation including Septage management, sewerage, storm water drainage and solid waste management, street lighting, local body roads and footpaths, parks, playgrounds, burial and cremation grounds. The 14th finance commission is meant to only spend the grants on the basic services within the functions assigned to them under relevant legislations.

9.1.2 State Finance Commission:

The State Finance Commission plays a vital role in cities achieving open defecation free status. The SFC grants help the cities to take care of the salaries of the municipal employees apart from providing funds for the other basic services to the urban citizens apart from urban poor.

9.1.3 Swachh Bharat Mission

In April 1999, the GoI restructured the Comprehensive Rural Sanitation Programme and launched the Total Sanitation Campaign (TSC) which was again renamed as Nirmal Bharat Abhiyan (NBA). On 2nd October, 2014, the prime minister of India launched Swachh Bharat Mission that aims at eradicating open defecation by 2019, thus restricting the NBA. The programme has funds allocated under NBA which were not utilized and also received funding and technical support from World Bank, corporations as part of Corporate Social Responsibility (CSR) initiatives, and by state governments under Sarva Siksha Abhiyan and Rashtriya Madhyamik Shiksha Abhiyan schemes. The program plans to construct 12 crore toilets in rural India by October 2019.

During 2013-2014, the GoI has sanctioned Rs. 40 Cr towards strengthening SWM, IHHL & CTBs, IEC activities and Capacity Building to the state of Andhra Pradesh and during 2014-2015 it has sanctioned Rs. 30 Cr to the state of Andhra Pradesh towards constructing IHHL.

9.1.4 Jawaharlal Nehru National Urban Renewal Missoin, GoI, JnNURM

Under the Ministry of Urban Development, there are several components which have funding options for sanitation. The Urban Infrastructure and Governance (UIG) component has funds for building sewerage network and the Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT) component has funds for developing and strengthening sanitation related activities like Storm Water Drainage, Sewerage, SWM and Water Supply.

9.1.5 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Under the AMRUT scheme, the GoI of India has funds for developing and implementing projects related to Water Supply and Parks/Green spaces. The aim of this programme is to encourage reforms and fast track planned development of identified cities. Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability of ULBs/ Parastatal agencies towards citizens.

9.1.6 Ministry of Housing and Urban Poverty Alleviation (MoHUPA), GoI

Ministry of Housing and urban poverty alleviation provides large amount of finance for the Urban Slums in India. The Ministry has several poverty alleviation programs which cater to the needs of housing in turn catering to the issue of sanitation by constructing toilets in the housing structure.

9.1.7 Rajiv Awas Yojana (RAY)

Rajiv Awas Yojana is a scheme sponsored by the Ministry of Housing and Urban Poverty Alleviation. Rajiv Awas Yojana (RAY) for the slum dwellers and the urban poor envisages a 'Slum-free India' through encouraging States/Union Territories to tackle the problem of slums in a definitive manner. The goals of RAY will be driven and incentivized by the provision of central support for slum redevelopment and construction of affordable housing conditional to a set of reforms necessary for urban development to become inclusive. This specific program also would enable the city to achieve complete sanitized situation as the major problem of sanitation arises from slums and Ray would take care of this issue.

9.1.8 ULBs Finance

The ULB also has considerable income for creating some provision for sanitation scheme in the city. As the State Municipalities act also specifies some of the duties to be performed under sanitation, some amount can be exclusively earmarked in the municipal budget to take sanitation in a mission mode till the city achieves the Open Defecation free status.

9.1.9 Ministry of Social Justice and Empowerment, GoI

Ministry of Social Justice and empowerment is also funding in a significant way to take care of the welfare of manual scavengers and their family. Relieving these people would not fetch the adequate results as the livelihood option would bring them back to the same work as they occupied before. The ministry has plan for rehabilitation of the families through several ways. Adequate amount of finance can be availed from this ministry to eliminate manual scavenging in existing places and rehabilitation of the families who has practiced before.

9.1.10 Sarva Shiksha Abhiyan (MoHRD), GoI

Ministry of Human resource Development is a potential source of financing as school sanitation is also a major component in the city sanitation plan. The SSA component has funding for school sanitation. The ULB with the support of the education department should make efforts to pool in money for school sanitation. The ministry has also come out with a manual on school sanitation along with GIZ.

9.1.11 Ministry of Tourism

The ministry of tourism is also a potential financing option for city sanitation if visitors are in good number. The ULB can build more public toilets and cater to the needs of the cities living population would allow the city to look more beautiful and attract large number of tourists.

9.1.12 International Agencies

The ULB should make combined efforts in bringing more international agencies to fund city in terms maintaining its sanitation and catering to the needs of the urban poor. Advocacy for greater focus on sanitation with governments and in integrated financing and project support facilities has to be explored.

9.1.13 Public Private Partnership

Public Private Participation is another potential area which has been explored by the ULBs to an extent but not to the maximum. PPP has a great potential as the population is willing to pay for the services. Till now few public toilets have been constructed with PPP but many more community as well as public toilets can be built. This would relieve the city from capital investment and reduce the burden in bringing finance. As a response to an insufficient provision of basic urban services and a lack of access to finance and other resources by ULBs that aim to increase access to sanitation services, a number of PPP options can emerge. These include: service contracts; performance-based service contract; joint sector company to implement and finance the project; a management contract for operations and maintenance (O&M); and construction cum build-operate-transfer (BOT) contract. Ministry has come out with a guidance note on Guidelines on India: Urban Water and sanitation Services, sector reform and successful Public-Private Partnerships.

9.1.14 NGOs

NGOs have played a significance role in transforming sanitation sector in India. There are several NGOs which are ready to invest and look after Operation and maintenance. There are some NGOs which are working on partial cost by the NGO and then partial by the beneficiary through installments and bank.

9.2 Block Estimates

The block estimates for each of the different goals has been prepared in accordance to the implementation plan. The general assumptions made for each of the goals are given below:

- Capital costs at current costs, and no inflation correction has been adopted
- O&M cost at current costs, and no inflation correction has been adopted
- Assumed costs for each of the goals based on discussions with different stakeholders and costs assumptions used in different DPRs/CDPs.

9.2.1 Goal 1: Water Supply

The implementation strategy for water supply concentrates on providing the population with adequate water quantity at the requisite quality, and hence, the same reflects in the estimates. Further, it's also elementary to ensure that the water supplied, after it's said utility, should be converted to a form wherein the same could be reused and recycled.

Adequate attention has also been provided to conservation of the lake in Nellore. Water metering has also been a highlight component since it will ensure optimal water utilization and minimize wastage.

The estimate also caters line items to both preparation of DPRs and Master Plans, as required from time to time to ensure implementation of suggested strategies, and also towards operation and maintenance.

Table 55: Cost estimation for Water Supply

Goal 1.Water Supply		Terms. (In Crores)		
S. No.	Implementation Parameter	Short	Medium	Long
1	Project Development (Master Plan/DPR Preparation)	0.5	0.5	0.5
2	Comprehensive water supply scheme (122 MLD WTP)	556.7	-	-
3	Augmentation of 122 MLD WTP by 30 MLD		-	-
4	Construction of 18MLD WTP near Kothuru (Phase II)	-	18	-
5	Construction of 65MLD WTP near Kondlapudi (Phase I)	-	-	65
6	Construction of 65 MLD WTP (Kondlapudi Phase II)	-	-	65
7	Conservation of lake (Nellore Tank)*	3	3	-
8	Rainwater Harvesting (Govt. buildings including Govt. schools – for 1 MLD)	0.05	0.05	-
9	Reuse of treated water (116, 142, 168) MLD**	46	57	67
10	Water metering	-	-	-
11	Operation and Maintenance (@ Rs. 70000/MLD and 15% escalation)	1.16	1.42	1.7
Total		**607.41**	**79.97**	**199.2**
*Assuming a lake conservation cost of Rs. 300 lakh/MLD **Assuming a recharge/reuse of groundwater facility at Rs. 40 lakh/MLD				

9.2.2 Goal 2: Access to Sanitation

The implementation strategy for access to sanitation strongly focuses on the elimination of open defecation, and hence towards provision of public/community toilets to blighted population. Further, a strong emphasis is also ensured towards school sanitation. It's logical to explore ecological, onsite wastewater management systems, more as demonstration, and also to provide basis for exploration of implementation of such systems for stand-alone properties.

The estimate also caters line items to both preparation of DPRs and Master Plans, as required from time to time to ensure implementation of suggested strategies, and also towards operation and maintenance.

Table 56: Cost estimation for access to sanitation facilities

Goal 2. Sanitation Facilities		Terms. (In Crores)		
S. No.	Implementation Parameter	Short	Medium	Long
1	Project Development (Master Plan/DPR Preparation)	0.5	0.5	0.5
2	Community and Public toilets (615) seats	4.61	5	5
3	Individual toilets in slums (9269)	69.51	5	5
4	Toilets in schools (164 toilet seats + 54 urinals)*	1.37	-	-
5	Ecological technologies for on-site management	1	1	1
6	Operation and maintenance – PPP model for all toilets	1	1	1
Total		**77.99**	**12.5**	**12.5**
*Assuming a per seat cost of Rs. 0.75lakh and urinal of Rs. 0.25 lakh.				

9.2.3 Goal 3: UGD and wastewater treatment system

As an immediate action point, it is important to provide adequate attention to manage the Septage generated for the numerous septic tanks the city now has. This definitely is a must, given the context of the town and the timeframe for implementation of underground drainage system, and wastewater treatment system.

Further, immediate attention is provided to set-up wastewater management system for both the highly dense as well as developing areas.

The estimate also caters line items to both preparation of DPRs and Master Plans, as required from time to time to ensure implementation of suggested strategies, and also towards operation and maintenance.

Table 57: Cost estimation for sewerage management

Goal 3. UGD & Wastewater management		Terms. (In Crores)		
S. No.	Implementation Parameter	Short	Medium	Long
1	Project development (Master plan/DPR preparation)	0.5	0.5	0.5
2	Under ground drainage network	580.85	-	-
3	Sewage Treatment Plants (105MLD capacity)*		-	-
4	Sewage Treatment Plant (50 MLD capacity)*	-	50	
5	Sewage Treatment Plant (50 MLD capacity)*			50
6	Operation and Maintenance costs	0.5	1.5	2
Total		**581.85**	**52**	**52.5**
*Assuming an STP cost of Rs. 1 Cr/MLD				

9.2.4 Goal 4: Storm water management

With the provision of underground drainage system, the storm water drains will cater only the storm water, and hence the goal is interlinked with the successful implementation of the goal for UGD. The storm water management also focuses on micro-shed management by involving the lakes, and ensuring on-site rainwater infiltration mechanisms.

The estimate also caters line items to both preparation of DPRs and Master Plans, as required from time to time to ensure implementation of suggested strategies, and also towards operation and maintenance.

Table 58: Cost estimation for storm water management

Goal 4. Storm water management		Terms. (In Crores)		
S. No.	Implementation Parameter	Short	Medium	Long
1	Project development (Master plan/DPR preparation)	0.75	0.75	1
2	Storm water management plan (300 km length)	101.4	-	-
3	Storm water management plan (300 km length)	-	101.4	-
4	Storm water management plan (300 km length)	-	-	101.4
5	Operation and maintenance costs	0.5	0.5	1
Total		**102.65**	**102.65**	**103.4**
*Cost of drain @ Rs. 12 lakh/km				

9.2.5 Goal 5: Solid Waste Management

For achieving complete sanitation for any city, solid waste management assumes adequate importance for the very fact that it's very visible. SWM should be a well planned out integrated approach with efficient collection, transportation, resource recovery and disposal systems based on scientific analysis.

The estimate also caters line items to both preparation of DPRs and Master Plans, as required from time to time to ensure implementation of suggested strategies, and also towards operation and maintenance.

Table 59: Cost estimation for SWM

Goal 5. Storm water management		Terms. (In Crores)		
S. No.	Implementation Parameter	Short	Medium	Long
1	Project development (Master plan/DPR preparation	0.5	0.5	0.75
2	Primary collection (318/day)*	0.5		
3	Primary collection (426/day)		0.65	
4	Primary collection (570/day)			0.9
5	Secondary transportation (318/day)**	1.6		
6	Secondary transportation (426/day)		2.2	
7	Secondary transportation (570/day)			2.85
8	Waste processing – resource recovery (PPP)	15	20	25
9	Waste transformation - Landfills	8	12	14
10	Zone free city (25 wards)	7.5		
11	Zone free city (29 wards)		8.7	
12	Operation and maintenance	10	12	14
Total		**43.1**	**56.05**	**57.5**
*Assuming primary collection at Rs. 0.15lakh/ton **Assuming secondary transport is for a distance of 50km at Rs. 0.5 lakh/ton				