Environmental Status Report of Navi Mumbai Municipal Corporation 2013-14

The Energy and Resources Institute

...towards global sustainable development

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Foreword

The environment is what sustains us, and thus maintaining its quality is of direct importance to the quality of our lives. Over time, it has been observed that in most of the urban areas, air quality and water are the most affected resources. Anthropogenic activities, population explosion and increasing demand for natural resources leads to exploitation and degradation of the environment. In this background an ESR (Environmental Status Report) is a wholesome tool that gives a complete picture of the status of the resources in a city.

Although NMMC (Navi Mumbai Municipal Corporation) has been documenting an ESR for more than 14 years, this year we are glad to present the report in the DPSIR (Drivers, Pressure, Status, Impacts, and Responses), framework as endorsed by the MPCB (Maharashtra Pollution Control Board), Government of Maharashtra, guidelines released in 2009. Also the report documents baseline EPI (Environmental Performance Index) and the municipal level carbon footprint for NMMC area. A dedicated section has been presented on the budgetary allocation made by the corporation specifically for the environment related infrastructure and activities.

In the year 2012, NMMC has launched the Eco-City Program with TERI (The Energy and Resources Institute), through which it aspires to undertake concrete sector specific initiatives which shall primarily aim at reducing the overall carbon foot print of the city and also various strategies to be implemented at residential, industrial and commercial sector which would have long term positive implications. Since the program is target oriented we shall soon execute the action plan with dedicated efforts. A special budget for the next financial year has already been allotted for the same as NMMC truly aspires to become the first Eco-City of the country.

Also, NMMC has been taking a lot of pro-environment initiatives to sustainably manage the resources of the city. Some of the flagship initiatives include the lake vision project, scientific closure of landfill site at Koparkhairne and Cell- I & Cell-II at Turbhe, reuse of sewage treated water for irrigation at recreational gardens, mechanical road sweeping to restrain the spread of suspended particulate matter and so on. The highlights of the year 2013-14 include that, the NMMC was awarded with the National Urban Water Award 2011 for contracting Operation and Maintenance services by Central Government of India. Further, NMMC is proud to move into a new head quarter which is a 'Green Building', thus setting a role model for others to follow. The building has also bagged 3 records registered in LIMCA books for three features of the building 1.longest post tension beam slab, 2. largest glass reinforced concrete dome and 3. the tallest flag pole for the national flag.

This report has identified some areas where NMMC needs to take action especially for reducing the air pollution in terms of NOx and PM (Particulate Matter), water pollution in the *Nallahs* and holding ponds, water supply to the city which is currently 1.8 times higher than the service level benchmark and so on. Also the NMMC would like to focus on conservation of decentralised resources like wells and further keep strict vigilance on the lakes and water bodies under the Lake Vision project. Appropriate waste to energy technologies would be promoted and implemented to effectively manage the solid waste of the city in the near future.

I believe that this report shall be a useful tool not only for the corporation but also for the citizens of Navi Mumbai and we shall always aspire to enhance the performance of the corporation.

Shri. A. L. Jarhad I.A.S
Municipal Commissioner, NMMC

Contents

Abbreviations

APMC	Agricultural Produce Market Complex
AQI	Air Quality Index
BEST	Brihanmumbai Electricity Supply and Transport
BOD	Biochemical Oxygen Demand
BPO	Business Process Outsourcing
CAAQMS	Continuous Ambient Air Quality Monitoring System
CAGR	Compound Annual Growth Rate
CBD	Central Business District
CIDCO	City and Industrial Development Corporation
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CSIR	Council of Scientific & Industrial Research
DO	Dissolved Oxygen
EPI	Environmental Performance Index
ESR	Environmental Status Report
FAO	Food and Agriculture Organization of the United Nations
FO	Furnace Oil
HSD	High Speed Diesel
IOCL	Indian Oil Corporation Limited
IT	Information Technology
LDO	Light Diesel Oil
LPCD	Liters per Capita per Day
LPG	Liquefied Petroleum Gas
LULC	Land Use and Land Cover
MCZMA	Maharashtra Coastal Zone Management Authority
MIDC	Maharashtra Industrial Development Corporation
MLD	Million Liters Per Day
MMR	Mumbai Metropolitan Region
MPCB	Maharashtra Pollution Control Board

MRSAC	Maharashtra Remote Sensing Application Centre
NAAQMS	National Ambient Air Quality
NAAQS	National Ambient Air Quality Standard
NAMP	National Air Monitoring Program
NEERI	National Environmental Engineering Research Institute
NMMC	Navi Mumbai Municipal Corporation
NMMT	Navi Mumbai Municipal Transport
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
PDS	Public Distribution System
PM_{10}	Particulate Matter below 10 micrometers diameter
$PM_{2.5}$	Particulate Matter below 2.5 micrometers diameter
PNG	Piped Natural Gas
PUC	Pollution Under Control
PVC	Polyvinyl chloride
RSPM	Respirable Suspended Particulate Matter
RTO	Regional Transport Office
SO_2	Sulphur Dioxide
SO_x	Oxides of Sulphur
STP	Sludge Treatment Pool
tCO_2e	Tons of Carbon Dioxide Equivalent
TERI	The Energy and Resources Institute
TTC	Trans-Thane Creek
ULB	Urban Local Body
US-EPA	United States Environmental Protection Agency
WHO	World Health Organization

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List of Awards Received by NMMC

- 1st prize under the Sant Gadgebaba urban cleanliness campaign twice(2002-2003 & 2005-2006) with cash reward of Rs 50,00,000/-
- National Water Award-2008 constituted by Urban Development Dept (Government of India), Administrative Staff College of India, Hyderabad and FCCI for successful implementation of 24x7 water supply in Navi Mumbai.
- Ranked 1st in the state for the year 2007-2008 & 2008-2009 in implementing the SARVA SHIKSHA ABHIYAAN campaign of the Government of India. (Education for All).
- National Urban Water Award-2009, by Hon. President of India for "Services to Urban Poor."
- Vasundhara Award – 2009 by Hon. Chief Minister of GOM for excellence in city environment.
- Best City Award for Improvement in Waste Water and Sanitation Services under JNNURM (2009).
- Government of India National Urban Water Awards (NUWA) 2010 for "Improved Customer Satisfaction, Governance, Public Disclosure and Transparency".
- Government of India National Urban Water Awards (NUWA) 2010 for "Sanitary Improvements and Safe Disposal Practices, Integrated Storm Water Disposal System".
- Indian Municipal Vision-2020 Award for "WISITEX Green Urban Development Award of the Decade".
- Sant Gadge Baba Nagri Swachata Abhiyan special Award - 2008-09 from Government of Maharashtra for best Sanitation practices in city.
- EPC World Award for Outstanding Contribution in Urban Civic Amenities (STP Project).
- Best practices award for NMMC centre of Education and Training for Handicap by Social Justice & Special aid department of Government of Maharashtra.
- Best Urban ICT award for E-Governance project of NMMC by Government of Maharashtra.
- First prize award for Family Welfare Programme, TB prevention & Control program and Second award for Mother Child Health Care Programme in Maharashtra state.
- National Urban Water Award 2011 for contracting O &M services.

Executive Summary

Navi Mumbai has been developed as a twin city to the Megacity of Mumbai. In the course of development a lot of emphasis has been given to sustainably manage and monitor the resources in the city. The NMMC (Navi Mumbai Municipal Corporation) is well equipped with state of art technologies specifically pertaining to water supply, sewage treatment, transport, health facilities and so on to cater to the urban population.

However, the city is rapidly developing and in the last decade it has recorded a growth by more than 51%[1], and as per Census 2011, the total resident population of Navi-Mumbai was about 11.20 Lakhs (11,20,547). This increase in population coupled with growth in industrial, economic activities and infrastructure, as driving force, triggers pressure on the resources like Water, Air and Land. This pressure alters the normal state of the resources either in terms of resource availability (land and water supply) or pollution loads (water and air pollution). Taking this into consideration this report has been collated as per the DPSIR (Drivers, Pressure, Status, Impact and Response) framework proposed by MPCB (Maharashtra Pollution Control Board) guidelines 2009. The Environmental Performance Index (EPI) has also been calculated for the first time for NMMC area in this report.

Environmental Indices for Navi Mumbai

To have a comprehensive overview of the environmental performance and the state of resources NMMC regularly calculates three indices, EQI (Environmental Quality Index); UII (Urban Infrastructure Index); and QOLI (Quality of Life Index). For the year 2013-14 the EQI (70.69%), UII (79.06%) and QOLI (74.88%) have improved as compared to the previous year by around 0.4%. Overall improvement of EQI is attributed to the improvement of water quality of surface drains, lake water and decrease in number of cases reported for Tuberculosis. While the increase in value of UII is attributed to commissioning of new 450 MLD water treatment plant, development of roads & circles, development in fire fighting services and completion of garden redevelopment work.

This year NMMC has also calculated the EPI, endorsed by MPCB. The calculator takes into consideration 65 data variables which are compared against the state level and national level benchmarks or averages as may be applicable. The baseline EPI score for NMMC area was determined to be 656.50.

Also to estimate the global impact in terms of the GHG (Greenhouse Gas) emissions NMMC has documented its municipal level carbon inventory in terms of CO_2 emissions. The total GHG emissions from Navi Mumbai city were estimated to be around 2.8 MMTCDE (Million Metric Tons CO_2 equivalent) and per capita emissions were around 2.51 $tCO2_e$ (Tons CO_2 equivalent), as against the national average of 1.50 tCO_2e.

[1] Census of India, 2011

Air Quality

The trend of Air quality in NMMC area has shown improvement in recent years. This is a result of the regular monitoring and corrective measures implemented by NMMC. However, due to high degree of urbanization and vehicular traffic, it has still remained a challenge to contain concentration of certain ambient air pollutants like PM (Particulate Matter), $PM_{2.5}$ and PM_{10}, within prescribed limit. To monitor and record the concentrations of various air pollutants like SO_2 (Sulphur dioxide), NO_X (Oxides of Nitrogen), PM (Particulate Matter), Ozone, CO (Carbon Monoxide), Methane and so on, NMMC has installed four CAAQMS (Continuous Ambient Air Quality Monitoring Stations) at Airoli (fire station), Vashi (fire station), Turbhe (near dumping ground) and Koparkhairne (near Teen Taki).

The concentrations of SO_2 in ambient air in NMMC area was well under the permissible limits (50µg/m^3) at all the monitoring stations. The pollutants which need attention are PM and NO_X. During the year 2013-14, the concentration of NO_X was found to be within annual permissible limits (40µg/m^3) at Turbhe and Koparkhairne while at Airoli and Vashi the annual NO_X concentrations were 48 and 44µg/m^3 respectively, which was higher than the annual permissible limit.

The concentration of PM ($PM_{2.5}$ and PM_{10}), were found to be higher than the annual permissible limits (40 and 60 µg/m^3), except at Airoli CAAQMS. The annual average concentrations of PM in ambient air at Koparkhairne ($PM_{2.5}$ - 64 µg/m^3, PM_{10}-134 µg/m^3), Turbhe ($PM_{2.5}$ – 54 µg/m^3, PM_{10} - 151 µg/m^3) and Vashi (PM_{10} - 108 µg/m^3) were almost 2 times the permissible limits. NMMC has already taken strategic actions to minimise the same.

Water Resource

The NMMC area has abundant water resources in terms of surface as well as ground water. The surface water resources including one dam, 24 lakes and ponds, 11 holding ponds and creek front of about 22km, while the ground water resource include 132 wells. The population in NMMC is dependent on these resources not only for water supply and recreation, but also for the vital environmental and physical services they provide in terms of controlling the flood, regulating surface runoffs, regulating the urban heat island effect and so on. NMMC regularly monitors the water quality for all the water bodies in NMMC area.

Owing to the initiatives implemented under the Lake vision project, the water bodies and lakes in the NMMC area have been maintained in fairly good condition as per the quality analysis reports maintained by Environmental Laboratory of NMMC. All the water bodies (lakes and ponds) were in healthy state in the year 2013-14. The only cause of concern is the water quality of *Nallahs* and holding ponds in NMMC area. They were detected to be polluted with high levels of COD (Chemical Oxygen Demand) and Chlorides. This could be attributed to the release of untreated effluents from the TTC (Trans Thane Creek) industrial area.

NMMC supplies water 24X7 to nearly 75% of the area of the city while the remaining area is catered to water supply for about 4-8 hours per day. Around 435 MLD (Million Litres per Day) water is supplied from Morbe dam to the treatment plant at Bhokarpada. In the year 2013-14, on an average, NMMC billed about 337 MLD (19% losses) water with net per capita

supply of about 250 LPCD (Litres Per Capita Per Day), 1.8 times the service level benchmark of 135 LPCD recommended by Ministry of Urban Development, Government of India.

NMMC area has 7 active STP's (Sewage Treatment Plants). Six STP's have secondary treatment facilities with an aggregate capacity of about 424 MLD, while there is one aerated lagoon of 17 MLD capacity at Nerul. The processing at lagoon shall be soon terminated and connected to a nearby STP. It estimated that around 210[2] MLD of sewage is generated in the NMMC area. However the present operational load on these STP's is about 180 MLD, indicating that around 30 MLD of sewage is left untreated into the creek. NMMC regularly monitors the inlet and outlet water samples for bacteriological and chemical parameters. In the year 2013-14, the efficiency of the STP's were about 96% in terms of reducing the BOD (Biochemical Oxygen Demand) levels and 85% to reduce the COD levels. The average effluent water quality released from the STP's was well within the standards for all the parameters.

Land use and Land Cover

As per MRSAC (Maharashtra Remote Sensing Application Centre), the total area under NMMC's jurisdiction was estimated to be approximately 108.63 sq. km. The land use pattern of the city consists of Built Up area (56%), Forests (24%), Wetlands (12%) and the remaining area is broadly classified under water bodies or agriculture.

Navi Mumbai has a coastline has rich mangrove coverage, spread over approx. 49.78 sq. km. Mangroves play a valuable role as natural barrier against possible natural calamities like cyclones, floods and tsunamis. They also play a vital role by reducing carbon footprint owing to its carbon sequestration potential. The mangrove coverage in NMMC area is estimated to sequester about 7280 Metric Tons of CO_2 emissions annually[3]. However, owing to urbanization the land resource in NMMC area is exposed to various pressures arising from anthropogenic activities and demands. Mining, dumping of debris, destruction of mangroves and so on are the pressures on land resource. In the year 2013-14 about 4800 tons of illegal debris dumping was caught by the flying squad team appointed by NMMC. Mining and quarrying activities induce pressure on the land resource as well as significantly increase the PM levels in the air. In NMMC jurisdiction about 9.6 lakh sq.m area is under lease for mining/quarry activities.

NMMC has designed & proposed several measures such as green building, vigilance against dumping, restoration of quarry sites, raising awareness about biodiversity and so on in order to reduce the current pressures, and conserve land resources.

Biodiversity and Gardens

Navi Mumbai is bestowed with high biodiversity due to presence of several habitats ranging from like low hills with tropical semi-evergreen to mangroves forests. Navi Mumbai is currently home to approximately more than 168 species of birds, 80 species of reptiles and amphibians, 140 species of butterflies, 125 species of marine fish and 800 species of flora. Various migratory birds such as the Flamingos are observed to visit mangrove and mudflats of the city for breeding and feeding purposes increasing the bio wealth of the city.

[2] Source: ACE, NMMC

[3] Singh et al (2012). Carbon Sequestration In Mangroves Ecosystems, Journal of Environmental Research And Development, Vol. 7 No. 1A.

There are about 199 gardens in NMMC area which further add to the aesthetic beauty of the city and also provide habitat for various flora and fauna. NMMC has also developed green cover patches along the major roads and junctions in Navi Mumbai.

Solid Waste Management

NMMC has designed a specific solid waste management strategy for effective disposal of municipal waste thereby reducing the adverse impacts caused by its accumulation and in appropriate disposal. Around 650 MT waste is generated from the residential, commercial and industrial areas comprising mainly of biodegradable waste. Waste from the roads is collected through sweeping while household waste is collected by door to door collection. NMMC has recently introduced mechanical sweepers for effective cleaning of roads. Biomedical waste is collected from various hospitals and dispensaries by private contractors and disposed of at the hazardous waste disposal facility at Taloja. Domestic solid waste (wet & dry) from NMMC area is transported to the sanitary landfill at Turbhe on daily basis. The leachate from the waste is also regularly treated & disposed of scientifically. NMMC has also taken several initiatives such as scientific closure of dumping ground at Koparkhairane and has also proposed an E waste recycling plant, and various waste to energy technologies for further treatment and disposal of municipal solid waste.

Health

The health related infrastructure in NMMC area in terms of number of hospital beds per 1000 population is 3.3, which is better than the global average of about 2.7 beds per 1000 population. Also there is significant number of health professionals, hospitals, medical dispensary and so on in the city. Due to the timely measures taken by NMMC to prevent diseases like Dengue, and TB (Tuberculosis), and the number of cases reported for these diseases has declined in the past few years. In the year 2014 and 2013 mere 7 and 9 suspects were tested for Dengue however no positive cases were detected. Similarly for Tuberculosis 574 cases were reported as against 2132 cases in the previous year (2012) which indicates reduction by almost 73 %. However for Malaria about 396 cases were reported in the year 2013-14 as against 207 in 2013-13 that is almost double the number of cases. Nerul and Karave UHP's were reported with 39 and 33 cases for Malaria.

Eco City Program

NMMC in collaboration with TERI (The Energy and Resources Institute), is working towards the Navi Mumbai an Eco-City program. The program aspires to develop Navi Mumbai as India's first 'Eco City' on the principles of sustainable development. The major objective of the project is to appropriately utilize and conserve the natural resources within the municipal limits and promote sustainable development in the city.

Under the program, TERI has compiled the Carbon footprint estimation of NMMC and developed an action plan focussing on three sectors of the city, residential, industrial and government. As a part of the phase II of the project NMMC shall implement the strategies recommended in the action plan, with equally focus on research, implementation and outreach.

NMMC Head Office - A Green Building

The new NMMC head office at Belapur CBD was inaugurated on February 18, 2014.

Given the need of the hour and to set an example for the building & construction industry NMMC has constructed its headquarters on the principles of green building wherein they have implemented several features such as

- Rainwater harvesting system consisting of 13 pits with a capacity to store up to 80,000 liters of water.
- Reflective tiles fitted on the terrace to reduce the load on electric consumption by air-conditioners.
- STP of 0.15 MLD capacity to treat sewage generated in the building.
- Recycled water is used for toilet flushing & gardening purpose.
- Biomethanation Plant for scientific disposal of canteen waste.
- Grass pavers are fitted on the ground to allow percolation of water.
- Use of Double Glazed Unit glass to reduce heat transfer & increase energy efficiency
- Pneumatic plumbing system to reduce load on water flow.
- Recycled wood has been used for furniture in the building

Picture No. 1: New NMMC Headquarters at Belapur – A Green Building

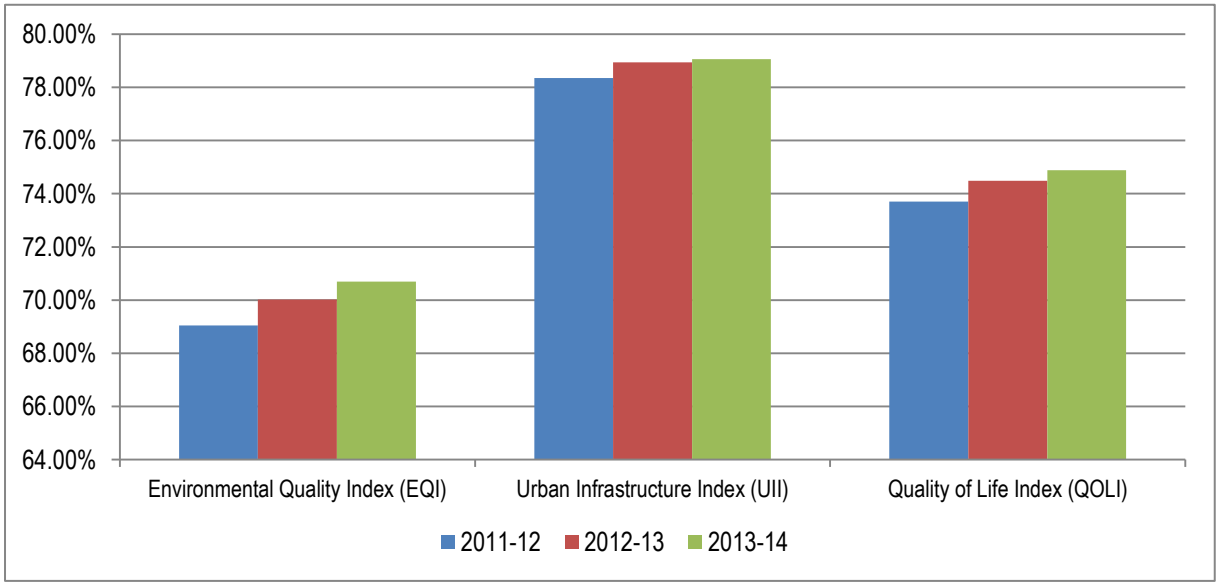
Environmental Indices for Navi Mumbai

The information on environmental parameters is often too complex and too technical to non-environmental professionals. The problem is further complicated as environment covers broad spectrum of areas. The goal of assessing status of environment is planning for sustainable development while maintaining quality of environment.

Many indices have been developed globally to determine an index (absolute value) using various parameters. These indices can be used to determine a baseline value and then a trend could be developed for the following years to track the development and address the gaps specifically. Three indices have been regularly calculated by NMMC, viz EQI (Environmental Quality Index); UII (Urban Infrastructure Index); and QOLI (Quality of Life Index). This year NMMC has also calculated the EPI (Environmental Performance Index), endorsed by MPCB (Maharashtra Pollution Control Board).

The basis of computation of Indices has been presented in Annexure I. Overall improvement of EQI is attributed to the improvement of water quality of surface drains, lake water and decrease in no. of cases of Tuberculosis. While the Increase in value of UII is attributed to commissioning of new 450 MLD water treatment plant, development of roads & circles, development in fire fighting services and other garden redevelopment work. The improvement of EQI and UII has indirectly improved the QOLI for citizen of NMMC by 0.40% .

Sr. No	Index	2011-12	2012-13	2013-14
1	Environmental Quality Index (EQI)	69.05%	70.02%	70.69%
2	Urban Infrastructure Index (UII)	78.35%	78.94%	79.06%
3	Quality of Life Index (QOLI)	73.70%	74.48%	74.88%



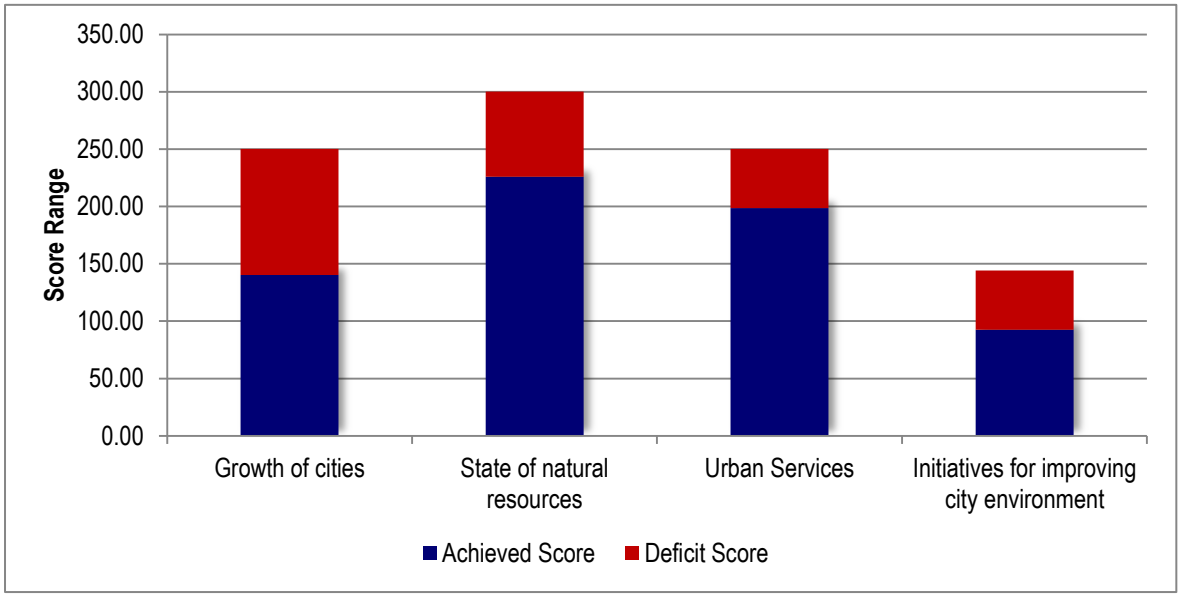
Environmental Performance Index

The EPI (Environmental Performance Index) is a method of quantifying and numerically marking the environmental performance of a city. The MPCB guidelines provide 65 data variables, which are to be analysed as a preliminary step to calculate the EPI. The data output gets aggregated to give the score of four thematic indicators, which is further used to calculate the EPI. The four thematic indicators are (1) Growth of city (2) State of resources (3) Urban services and (4) Initiatives taken to improve the city environment.

A definite score has been allotted to the 65 data variables (Annexure -II) depending upon the benchmarks set according to the national, state or the defined average as per international standards. For example, the population growth is one of the key indicators of the environment and if it exceeds the limits, it exerts pressure and adversely impacts the environment and, hence, the score given would be less in such a situation. Vice -a-versa, a pro-environment initiative is given better score. Hence, better the EPI score better is the state of environment of that city.

To calculate this EPI, the MPCB has developed a computer-based software programme in MS™ Excel. This EPI takes into account the 65 data variables of which 57 questions have to be answered and fed into the software, which then reveal the EPI of the city. This software is primarily used to calculate the score for the four thematic indicators. The baseline Environmental Score for NMMC area was determined to be 656.50 out of 944.

Gap Analysis		
Environmental Score	**Achievable Score**	**Achieved Score**
Thematic Indicators	**944**	**656.50**
Growth of cities	250	140.00
State of natural resources	300	225.60
Urban Services	250	198.50
Initiatives for improving city environment	144	92.40



Carbon Footprint Estimation

Carbon Emissions (or Green House Gas, GHG emissions) are a major concern in the world today, owing to the growing global concern about anthropogenic climate change. A carbon footprint is historically defined as "the total sets of greenhouse gas emissions caused by an organization, event, product or person."

The city level carbon footprint- a baseline value of the GHG emissions for NMMC area for the year 2011-12 mainly from residential, transport and industrial sectors has been estimated by TERI. The total GHG emissions from Navi Mumbai city were estimated to be around 2.8 MMTCDE (Million Metric Tons CO_2 equivalent) and per capita emissions were around 2.51 $tCO2_e$ (Tons CO_2 equivalent), as against the national average of 1.50 tCO_2e. The higher per capita emission could be attributed to the presence of TTC (Trans-Thane Creek) industrial belt within the city limits as well as lesser population of the city as compared to other cities.

Around 70% of the total GHG emissions (1986.18 thousand tCO_2e) were because of electricity consumption followed by emissions from usage of petroleum products having a share of around 26% (752.47 thousand tCO_2e) of the total emissions in Navi Mumbai. Given the fact that NMMC has world class infrastructure for managing its waste (municipal solid and sewage), the GHG emission from waste attributed to a mere 4% (106.76 thousand tCO_2e). The industrial sector accounted to almost 43% (1217.93 thousand tCO_2e) of the city level emissions. Of the total emissions from the industrial sector, 90% (1095.07 thousand tCO_2e) of the emissions were on account of electricity consumption.

Eco City Program

As a response to the environmental indicators and to minimize the local and global impacts from NMMC area, the corporation has undertaken the 'Eco-City program in collaboration with The Energy and Resources Institute (TERI). The program aspires to develop Navi Mumbai as India's first 'Eco City' on the principles of sustainable development. The major objective of the project is to appropriately utilize and conserve the natural resources within the municipal limits and promote sustainable development in the city.

In the first phase of the program a comprehensive action plan for the sectors of residential, industrial and government, has been devised with a multi-pronged approach of having Research, Training, Outreach and Policy Intervention for each of the three stake holding blocks. The project aspires to have target oriented implementable projects dealing with the various stakeholders of the city.

Promoting and implementing green building features in the building byelaws, integration of renewable energy technologies and adopting energy efficiency practices and promoting the conservation of local biodiversity shall be top priority amongst the agenda for the program. While as an outreach component sensitizing people, through training workshops, carrying out of awareness activities for efficient management of natural resources across household and municipal level shall be in focus.

As an outreach initiative, development of a prominent exhibition to illustrate the project concept has been initiated. A biomethanation plant of 250kg/day capacity has been installed at the NMMC head office to treat the canteen waste. Such measures shall provide a first-hand experience to the citizens and also encourage them to adopt the same at individual or community level.

Navi Mumbai - City Profile

Navi Mumbai is a city located next to Mumbai, across the Thane creek. Navi Mumbai was conceptualized in 1967 to act as a counter magnet to the Megacity of Mumbai, which was witnessing a huge increase in its population every year. In 1970 CIDCO (City & Industrial Development Corporation,) was incorporated with purpose to plan, develop and maintain the township of Navi Mumbai, as a city of the 21st century. In December 1991 NMMC (Navi Mumbai Municipal Corporation) was constituted by the Government of Maharashtra, for maintaining the developed nodes of Navi Mumbai[4].

Navi Mumbai is one of the world's largest planned townships and has been developed as an environment friendly, beautifully landscaped city with parks, gardens and promenades along waterfronts. Care has been taken to cause minimum harm to the mountains, lakes and green spaces, which cover nearly half of its total area.[5]Today it is a vibrant city on its own, attracting people from all over the country and abroad with its employment and educational opportunities.

Location

Navi Mumbai is a part of Konkan coast, located between mountain ranges and coast line and is located at the centre of Mumbai Metropolitan Region. The jurisdiction of NMMC starts at Digha in north and ends at Belapur in south. NMMC area has been divided in eight zones sprawling 108.63 sq. km. These are Belapur, Nerul, Turbhe, Vashi, Koparkhairane, Ghansoli, Airoli and Digha. On the west side of city is the Thane creek while on the right side it is flanked by the Parsik hill ranges, whereas to the North and South are Thane and Panvel areas. The mean sea level of the city is 3.25 metres, and it is located below the average high tide level of 4.2 meters[6]. The basic details of the city are presented below in Table No. 1.

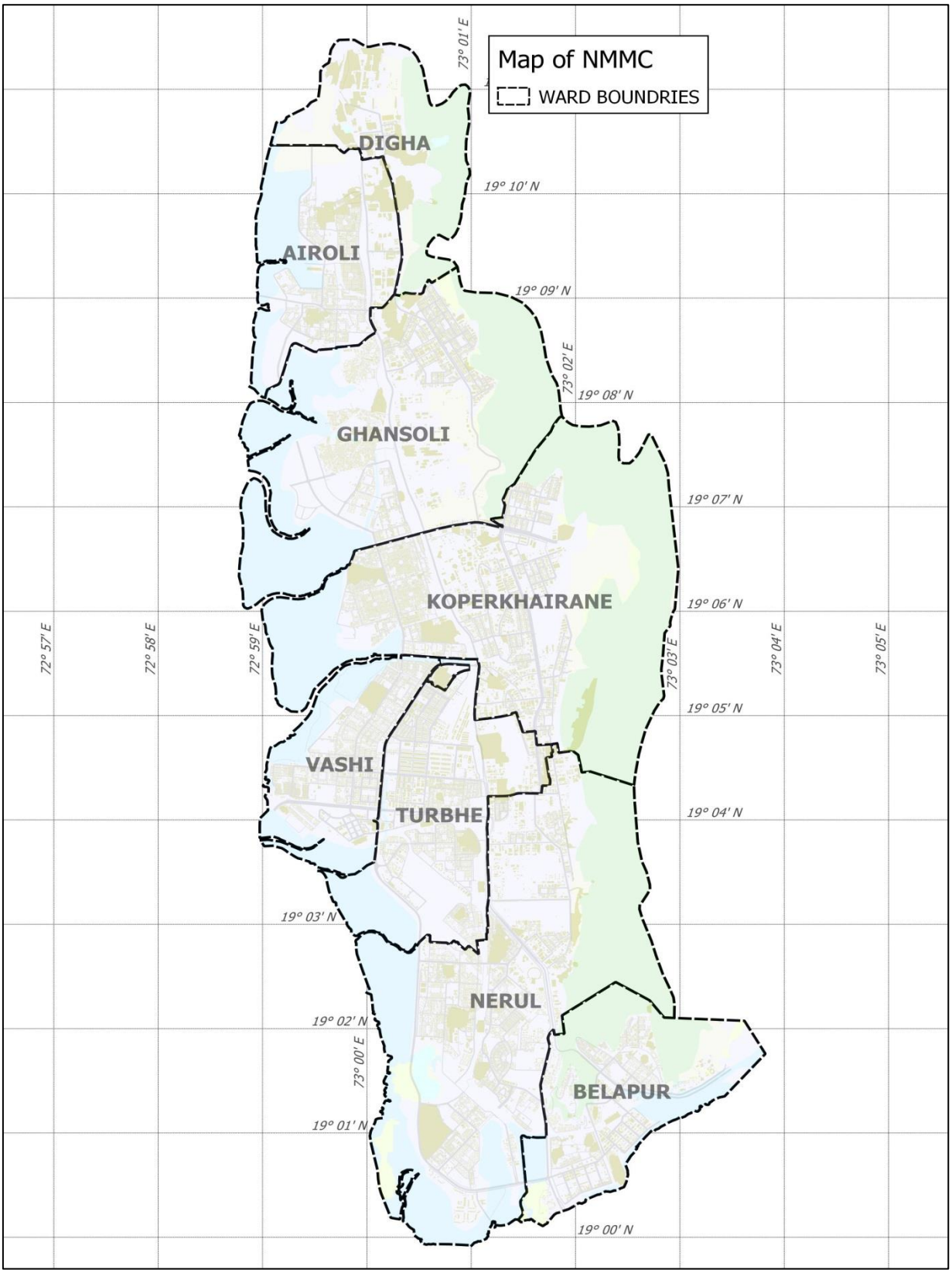
Table No. 1: Basic Details of Navi Mumbai

Longitude	72°58′ to 73°03′E
Latitude	19°00′ to 19°12′N
Mean Height above Sea Level	3.25 Metres
Total area under NMMC jurisdiction	108.63 Sq. km

Source: IMD & NMMC ACE

[4] http://www.nmmconline.com/
[5] NMMC Environmental Status Report 2012-13.
[6] Personal Interaction, Engineering Department, NMMC

Map No. 1: Wards of NMMC along with latitude and longitude



Demography

As per the Census of India -2011, the population of Navi Mumbai is more than 11.20 lakhs (11,20,547), the population density is 10,415 persons per sq km. Average literacy was found to be at 79.25%. The working population of Navi Mumbai is 4.55 lakhs. The details of the population are given below in Table No. 2.

Table No. 2: Demographic details of Navi Mumbai

Population (Census of India-2011)	11,20,547
Population Density (As per census data-2011)	10,315 persons per sq. km
Average literacy (As per census data-2011)	Total: 79.25% Male- 82.25% Female- 75.67%.
Working Population (As per census data-2011)	Total: 4,55,485 Male- 3,61,222 Female- 94,263
Sex Ratio (As per census data-2011)	837 Females per 1000 Males,

Source: Census of India-2011

Climate

Navi Mumbai has a tropical climate and receives a significant rainfall. The average annual temperature in Navi Mumbai is 27 °C. The average annual rainfall is 2464 mm. In winters, the average (non-extreme) temperature is between 18°C to 31°C while summer temperature ranges from 24°C to 32°C. Out of total rainfall, maximum rainfall is received during June to October as depicted in Figure No. 2. Average annual rainfall is 1600-2500 mm and humidity is 61-86 %. Basic climatic parameters are presented in Table No. 3[7][8] and the average temperature recorded in Navi Mumbai is presented in Figure No. 1.

Table No. 3: Climatic parameters of Navi Mumbai

Temperature Range (Average Minimum and Maximum Temperatures)	Winter: 18°C-31°C Summer: 24°C-32°C
Four Year Average Annual Rainfall (2010-2013)	2661.74 mm

Source: IMD & NMMC CAAQMS

[7] Environmental Status Report- Navi Mumbai-2012-13
[8] Indian Meteorological Department

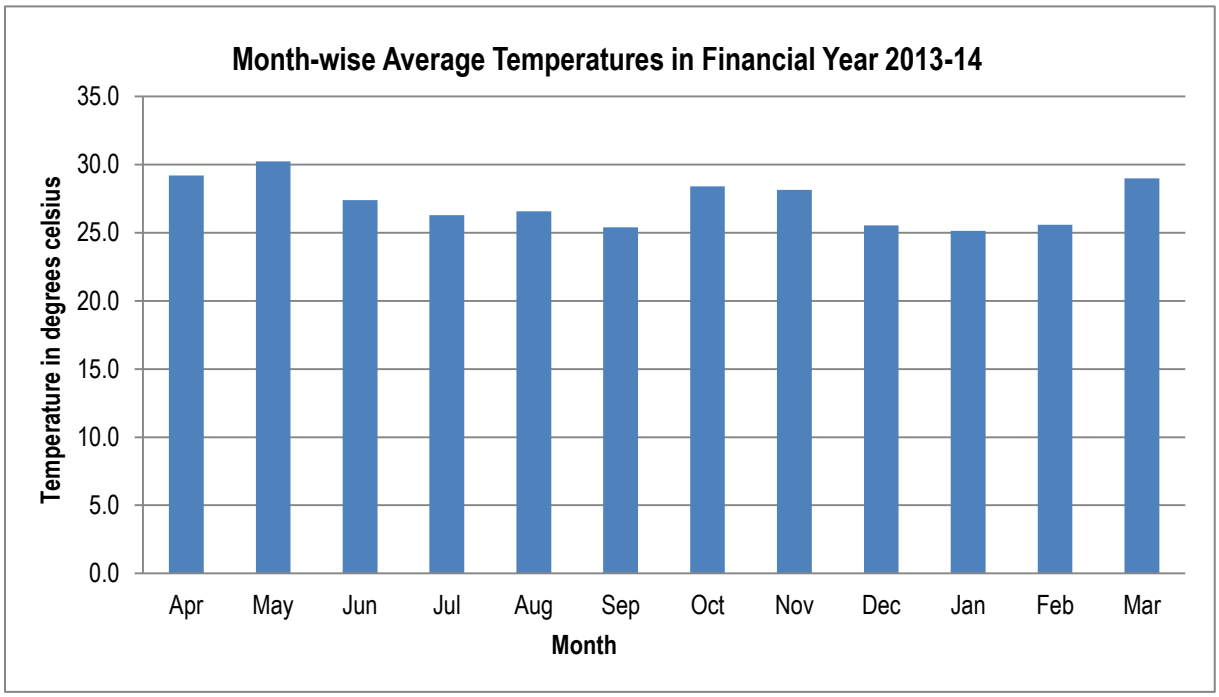
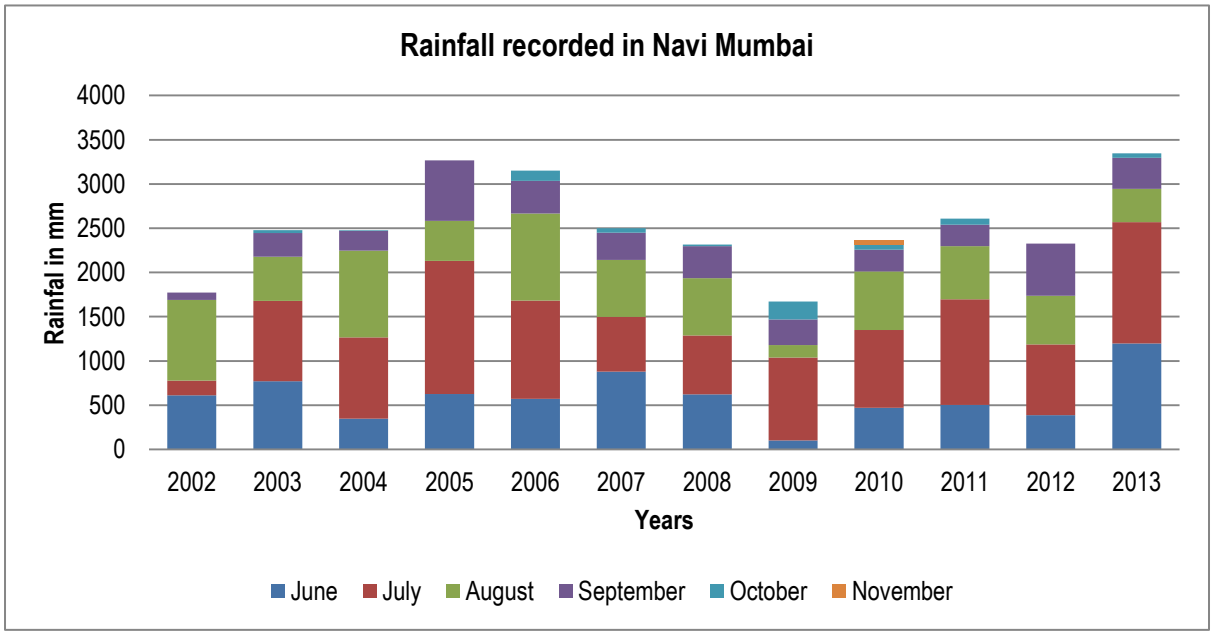


Figure No. 1: Average temperature in Navi Mumbai, 2013-2014

Source: NMMC

Figure No. 2: Rainfall recorded in Navi Mumbai for the past 12 years



Source: NMMC

It can be seen that the highest rainfall recorded was in the last year, 2013; followed by 2005 which saw the July 26, 2005 massive downpour and floods. Figure No. 3 describes the recorded rainfall in Navi Mumbai in 2013. As we can see, the highest rainfall was in the months of July, as expected due to the monsoon season.

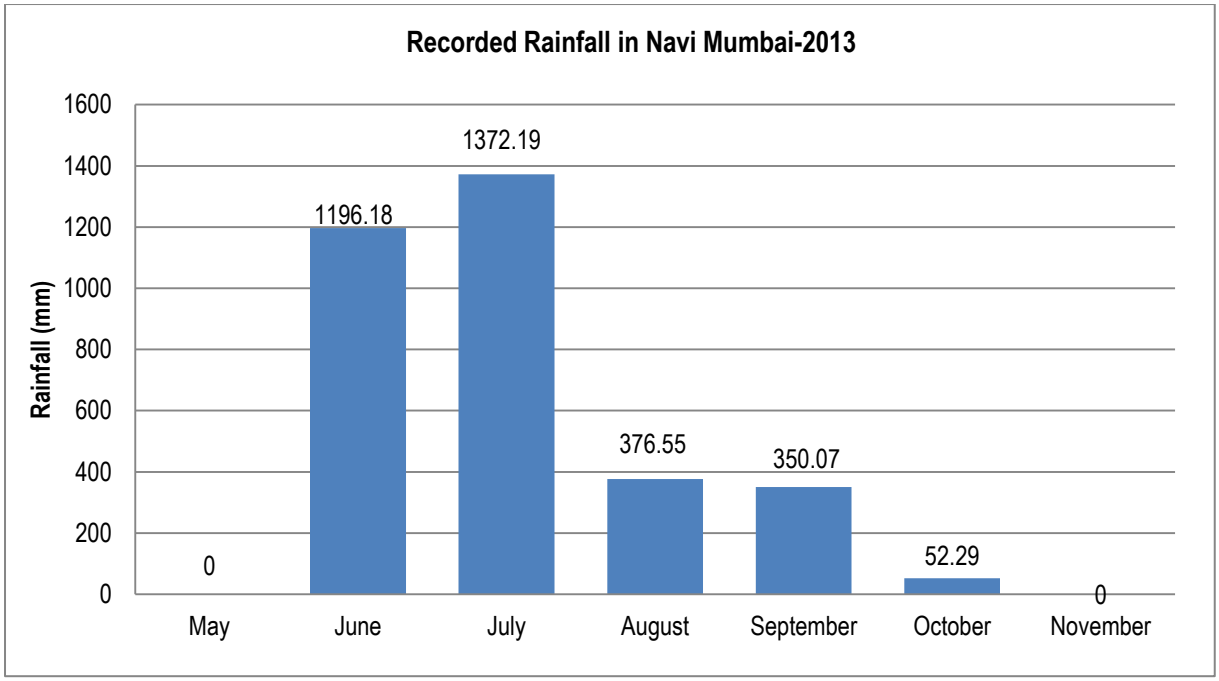


Figure No. 3: Recorded Rainfall in Navi Mumbai in 2013

Source: NMMC

Connectivity

The Mumbai suburban railway network covers most of the populated region of the city. The most important suburban stations are Vashi, Nerul, Belapur & Panvel.

Brihanmumbai Electric Supply and Transport (BEST), Navi Mumbai Municipal Transport (NMMT), Kalyan- Dombivali Municipal Transport (KDMT) and Khopoli Municipal Transport (KMT) buses travel all over Navi Mumbai and connect the cities of Thane, Kalyan-Dombivli, Badlapur, Panvel-Khopoli, Uran, and so on. NMMT AC Volvo and BEST AC buses are available from Mumbai to Navi Mumbai and vice versa. The number of NMMT buses has gone up in 2013-14 to 356 from 336 in 2012-13. The year wise trend for the number of operational buses owned by NMMT is presented in Figure No. 4[9].

In terms of internal connectivity (intra nodal transport) there is a 9 km long six lane Palm Beach Road connects Vashi to CBD Belapur running parallel to the creek on the western side while there is the Thane Belapur road on the eastern side. Within each node, the auto rickshaw is the preferred mode of transportation.

[9]Environmental Status Report- Navi Mmbai 2012-13

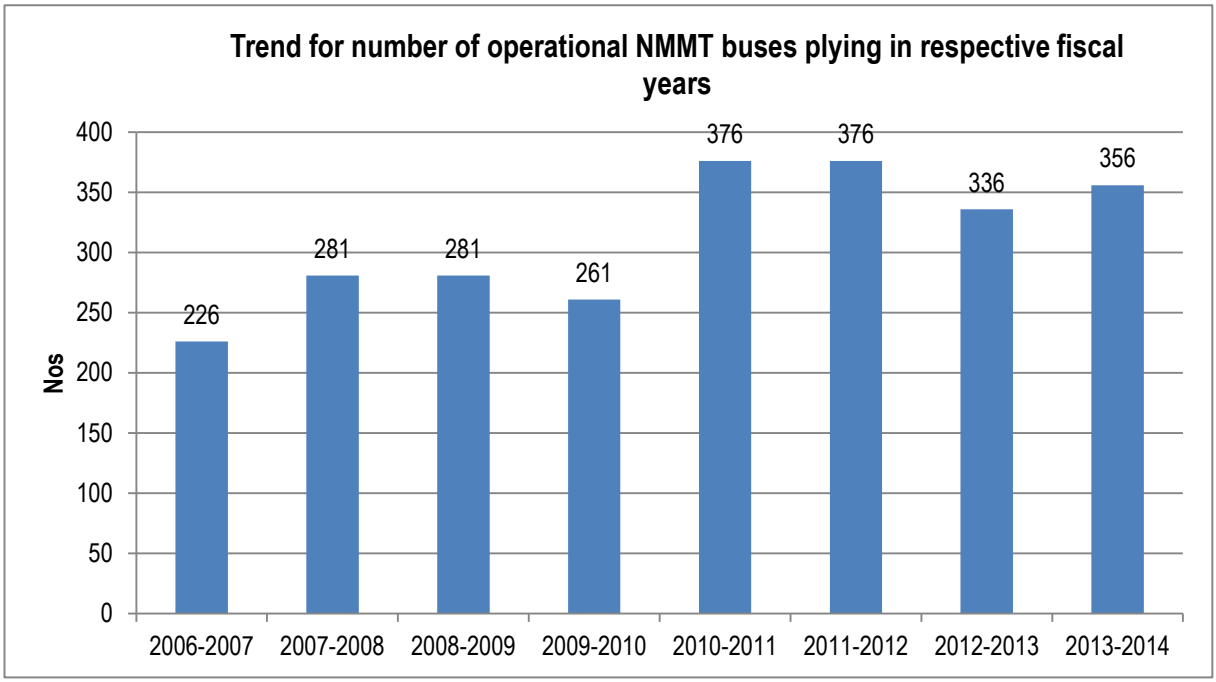


Figure No. 4: Trend for number of operational NMMT buses plying in respective fiscal years

Source: NMMT

As we can see from Figure No. 4, the number of NMMT buses operational in the year 2013-14 increased to 356 from 336 as compared to 2012-13. Further, as per data from NMMT the number of passengers travelling per month has fallen sharply by about 13% of what it was in 2012-13. The distance travelled per day per bus has also reduced by about 9% from 2012-13.

There are many proposed measures for improving connectivity in Navi Mumbai. The proposed Navi Mumbai Metro, and a number of road projects like the proposed trans-harbour link between Mumbai (Wadala) and Navi Mumbai (Ulwe), Airoli Ghansoli highway, elevated corridor on Palm Beach road, and so on are expected to enhance the status of this city by forming yet another link with Mumbai, and ease the traffic mobility.

Waterways between Navi Mumbai's major nodes and south Mumbai should be re-started, the advantages of these are manifold: reduction of load on trains and roads and reduction in travel time to about half.

Drivers

Urbanization, which indicates growth and transformation of villages to towns and to cities, and then cities into megacities, is an on-going process. Although each and every city has its own identity, the main drivers for this development include population growth, demand for market places and growth of markets, increase in the demand for means of transportation and its infrastructure, demand for residential and recreational spaces, demands of the luxurious lifestyle associated with urbanization, and so on. Population growth is one of the most crucial drivers of urbanization. Moreover, to meet the growing demands imposed by the population, parallel development of allied business sectors, such as manufacturing units of commodities and construction industry catering to the needs of housing, businesses, and infrastructure required for transport, also takes place. It is interesting to note that these days educational institutions are also regarded as industry set ups, and this is particularly an important driver in the case of Navi Mumbai. The growth of the industries, results in proportionate expansion of the business sector and economic growth of the city. This in turn, attracts the inflow of population from other towns, villages and even developed cities thus setting a continuous and ever expanding cycle.

The growth and expansion of the city is highly dependent on availability of natural resources and manmade resources at the same time, all the urban activities also influence the state of the natural resources. Thus, population, industrial, economic and spatial growths are all interlinked as well as interdependent. They are the primary driving forces in the growth of any city and hence these topics have been clubbed together under the topic **—Drivers**, while compiling the environmental status report for Navi Mumbai city.

Similarly, availability of resources like Air, Water, and Land are key factors in the growth of cities and have been analysed in separate chapters in terms of the current **—Status** of the resource, the**—Pressures** being exerted on them and the **—Impact** of various urban activities on these resources, whereas the **—Response** section deals with the initiatives taken by NMMC to address the pressure and reduce adverse impacts.

Population growth

The population of Navi Mumbai as per the Census 2011 is around 11.20 lakhs (11, 20,547) as compared to population of 2001 which was 7.03 Lakhs (7, 03,947). In the last 10 years, the city's population has grown to more than 1.6 times, as can be seen in Figure No. 5 below. The population growth rate in Navi Mumbai is very high due to influx of migratory population which could be attributed to ample job opportunities, higher income leading to better lifestyle, and other facilities available in the city. It is projected that the population of Navi Mumbai might reach 1.8 million by 2021, and about 2.38 million by 2031[10].

[10] NMMC City Development Plan 2006

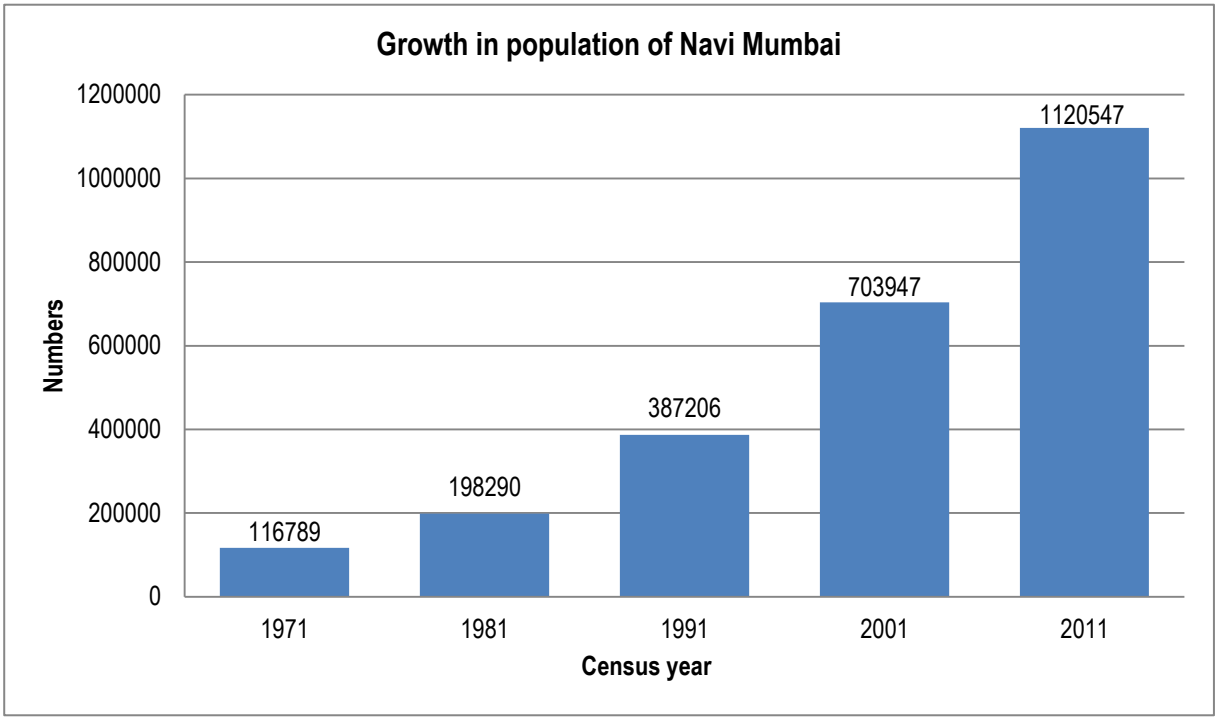


Figure No. 5: Growth in population of Navi Mumbai

Source: Census of India Data

Industrial and Commercial growth

Navi Mumbai's proximity to Mumbai and development of the industrial belt in Thane Belapur Industrial Belt has attracted a large population to the city. The employment base of Navi Mumbai was planned to encompass manufacturing (industry), trade and commerce (wholesale and warehousing), as well as service sector (office) jobs.

The industrial Sector was the principal economic driver for Navi Mumbai in its first decade in the form of large petrochemical industries. A number of small and medium industries flourished along with the large plants generating a large number of employments for skilled as well as unskilled workers. At present, Chemical, Pharmaceutical, Engineering, Textile Processing, Petrochemical, Electronics, Oil and Processing, Paper, Plastic, Steel and Food Industries in the Thane Belapur Industrial Belt of Navi Mumbai offer job opportunities of various kinds, to engineers to mechanics and clerks to peons. As a result, a large number of people from the service class and middle class have shifted to Navi Mumbai.

The Trans Thane Industrial belt developed by MIDC (Maharashtra Industrial Development Corporation) in the mid-sixties witnessed a sharp growth of industries in terms of number of units, capital deployed, employment and turn over. Most of the industrial units continue to be high capital intensive industries. This is followed by setting up a large number of chemical industries such as Polyethylene Plastic and Resins, Synthetic Tanning Agents Leather, PVC Products etc. The Thane Belapur Industrial belt had 72 industrial units in 1974. This increased to 533 in 1984 and 1931 in 1990. In a recent assessment, there were about 2,300

industrial units with an employment of over one lakh and an annual turnover of more than INR 10,000 crore[11].

As far as industrial pollution is concerned, all major and medium industries have full-fledged effluent treatment plants and small scale industries have provided primary effluent treatment plants. The effluents from the industries are discharged into a common effluent treatment plant at Turbhe and then the treated effluent is discharged into a creek.

All the air pollution industries have provided emission control systems such as scrubbers, dust collectors and stacks of sufficient height. The breakdown of industries within the NMMC area, according to their size and pollution classification is given below in Table No. 4.

Central Business District (CBD) was constructed at Belapur on 575 hectares of land, which is 20 times larger than the area of Mumbai's CBD - Nariman Point. It not only houses several economic and government administrative and private companies' offices but also a home to some the country's prominent IT- BPO establishments. The average per capita income of Navi Mumbai city has increased from INR 10,000 in 2008 to INR 14,000 in 2014.

The new economic policy adopted by Govt. of India created new opportunities for white collar jobs in the form of IT (Information Technology) and ITES (Information Technology Enabled Services). Higher education institutes, especially engineering colleges in Navi Mumbai created a large pool of talented people necessary for IT and BPO (Business Process Outsourcing) sector. Most of the Government jobs are concentrated in CBD Belapur (32%) while the IT-BPO establishments are located in Vashi (37%).

Table No. 4: Category and type wise number of industries in NMMC area

Type of Industry	Classification			Total
	Red	Orange	Green	
Large	100	65	32	**197**
Medium	23	47	26	**96**
Small	579	465	1130	**2174**
Total	**702**	**577**	**1188**	**2467**

Source: MPCB

[11] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx

Agriculture Produce Market Complex (APMC), Vashi

Thirteen major wholesale Agricultural Produce Markets from Mumbai were shifted to APMC Vashi. Necessary facilities of godowns, offices, banks, truck terminal, concrete roads and a special storm water drainage have been provided to facilitate economic activities. Divided into different separate sections on the basis of the commodities, the APMC provides separate markets for fruits, vegetables, sugar, jaggery and onion-potato market. The APMC market at Navi Mumbai is one of the biggest agricultural markets in Asia.

Built on a 7.92 hectare plot, the APMC has an estimated annual trade turnover of INR. 60 billion, and generates employment for about 1 lakh people. The APMC Market has given a very different identity to Navi Mumbai city. Farmers from all over the state bring fruits and vegetables to the APMC market for sale in Mumbai/Navi Mumbai areas.[12]

Picture No. 2 Infrastructure of APMC, Vashi

Source: http://afternoondc.in/city-news/no-chief-security-officer-at-vashi-market/article_59377

[12] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx

International InfoTech Park (IIP), Vashi

Realizing the growing importance of Information & Technology, the Government of Maharashtra identified select areas suitable for the growth and development of this industry in the State. Vashi was one such location. Inaugurated on 14th June, 1998, the International InfoTech Park (IIP) is located in the commercial complex at Vashi Railway Station. It has more than 6 lakh sq. ft. of built-up premises which offers 50,000 jobs directly and indirectly.

Picture No. 3 International Technology Centre

Source: http://www.cidco.maharashtra.gov.in/NM_Railway_Infrastuture.aspx

Malls & Retail Stores

Navi Mumbai has seen major retail brands setting up shop in the various malls that have come up recently. Vashi has maximum malls namely Inorbit, Raghuleela, Centre One, Palm Beach Galleria, City Centre and so on. In addition to this there are many medium to small format retail outlets in Navi Mumbai. CIDCO has also developed shopping complex in all sectors for the benefit of all.

Jawaharlal Nehru Port Trust

JNP is the biggest container handling Port in India, handling around 60% of the country's containerized cargo. In its role as the Hub Port on the Western Coast of India, JNP is ranked 24th among the top 100 Container Ports in the World.

Education Industry

Navi Mumbai is located in the Mumbai-Pune knowledge corridor, and there has been a big thrust on developing educational institutions here. From primary schools and kindergartens, to secondary schools, colleges and professional institutes, Navi Mumbai has plenty of all. There are 254 pre- primary schools, 49 Anganwadis, 284 Primary schools, 149 Secondary schools and 68 colleges

Urbanization and spatial growth

Land resources are essential for production of food, fiber, fuel and other biotic materials for human use and for satisfying human needs. They also provide biological habitat for plants, animals and micro-organisms. Man has been completely dependent on these land resources since ages. With the growing population the demand for these resources has increased over time. 16 percent of arable land is degraded and the percentage is increasing (FAO, 1997). Traditional systems of land management are either breaking down or are no longer appropriate, and the management and technology needed to replace them is not always available. A major factor contributing for this change is urbanization.

Urbanization invites population migration from other cities or peri-urban areas in search for opportunities which directly induces a demand for resources. The projections indicate that almost 60% of the world population will be urbanized by 2030. Growing urbanization requires a proper infrastructural development which is again dependent on land resources. An increased demand for resources leads to over exploitation of natural resources which further leads to the threat of depletion. The essential challenge is to address the pressure in a way which does not cause further deterioration of resources and leads to sustainable development.

NMMC has seen a considerable increase in its population over the years, which has resulted in an increase in usable floor space to accommodate the population. A rise of 31% in the number of properties can be observed in the 7 year period since 2007-08 as shown in Figure No. 6. The increase in residential properties is significant. For the year 2013-14, out of total properties of 277622, 80% of the total properties consist of residential buildings followed by commercial buildings with a 18% share and the MIDC commercial properties with the least share of 2% (Figure No. 7). Such an increase in new constructions could impact natural resources in future.

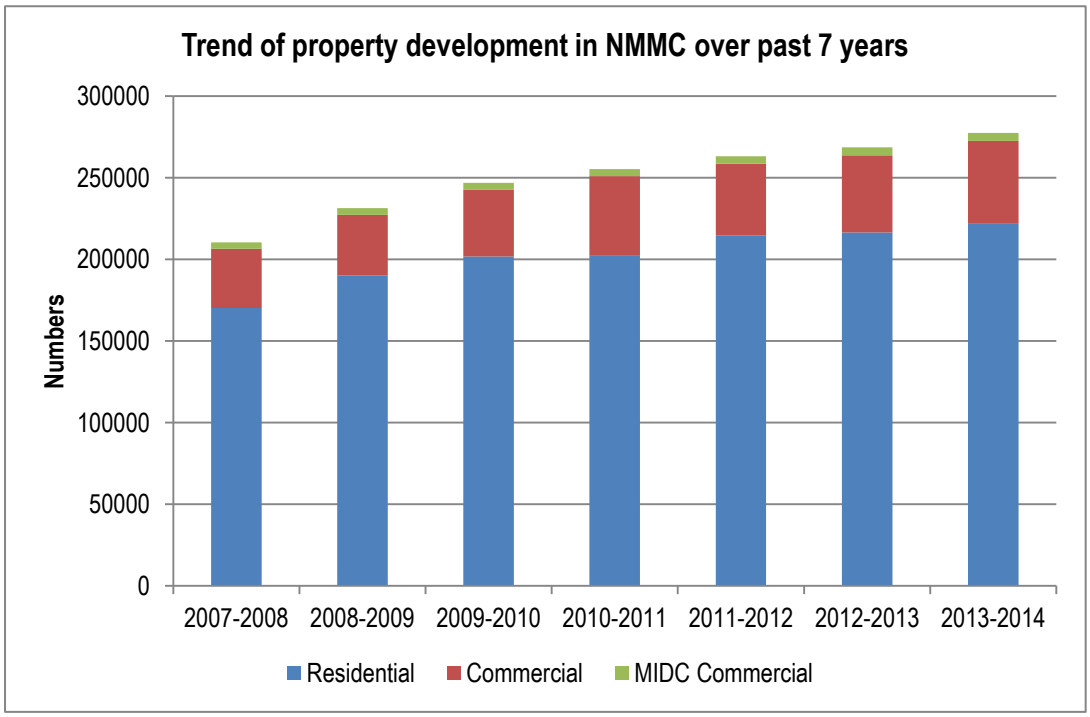


Figure No. 6: Trend of property development in NMMC over past 7 years

Source: Town Planning Department, NMMC

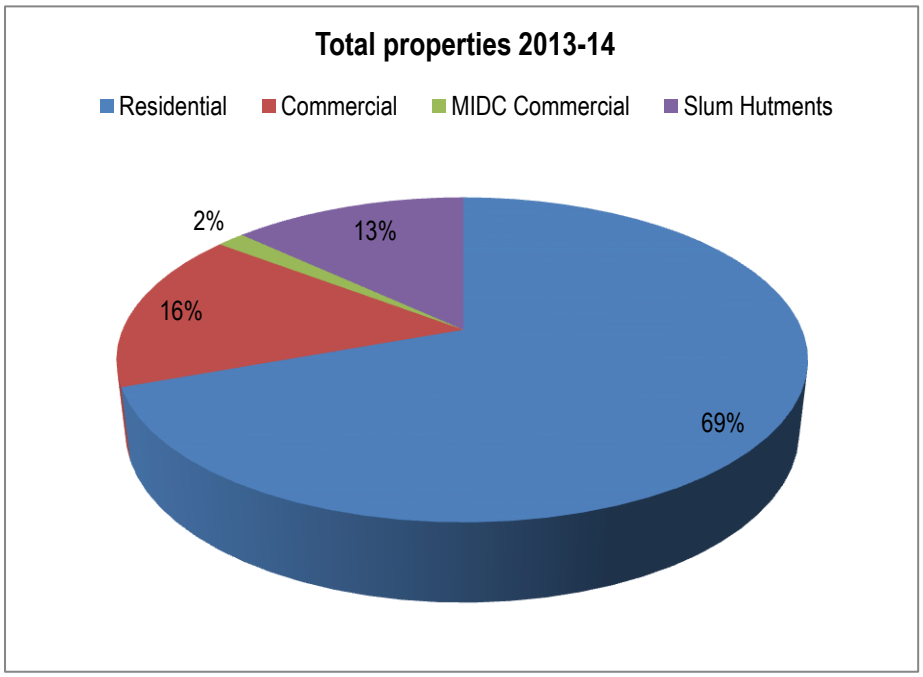


Figure No. 7: Sector-wise breakup of properties in NMMC for 2013-14

Source: Town Planning Department, NMMC

Air Quality

Among all the important resources around us air plays a crucial role in our environment. Good air refers to clean, dust-free, stench-free and unpolluted air. Poor air quality affects plants, animals, ecosystem and particularly humans. Air pollutants can enter into human body through respiratory system which can result in irritation of nose and air passage and also impact lung capacity. Unhealthy people are more likely to be affected by air pollution. WHO (World Health Organization) in its Ambient Air Pollution Database Report has cited that Air quality in most cities worldwide that monitor outdoor (ambient) air pollution fails to meet WHO guidelines for safe levels, putting people at additional risk of respiratory disease and other health problems. In April 2014, WHO issued new information estimating that outdoor air pollution was responsible for the deaths of around 3.7 million people under the age of 60 in 2012.

Monitoring of air quality is a prerequisite to the developement of management strategies for safeguarding against damaging effects of air pollution. A network of air quality monitoring stations is chosen across a region for the purpose of vigilance of the spatial and temporal changes in air quality.

At national level, CPCB periodically compares the status of Air quality parameters which indicate the comparative status of various cities. In addition to this, at state level MPCB and at city level NMMC also monitors the air quality parameters. Presented below in Table No. 5 and Figure No. 8 is a comparative performance of various cities in India as per monitoring done by CPCB. (Central Pollution Control Board) collated in the year 2010 under the NAMP (National Air Monitoring Program). As seen in table, although the SO_2 concentration in Navi Mumbai is below the permisssible limit (50. µg/m^3), it is still higher compared to other cities.

Table No. 5: Concentration of key pollutants in major cities of India

City	SO_2		NO_2		PM_{10}	
	Annual Average (µg/m^3)	Air Quality	Annual Average (µg/m^3)	Air Quality	Annual Average (µg/m^3)	Air Quality
Annual Permissible limits	50		40		60	
Chandigarh	2	L	16	L	92 *	C
Noida	11	L	46*	H	132*	C
Bhubhaneswar	2	L	18	L	84*	H
Delhi	5	L	55*	H	261*	C
Ahmedabad	15	L	21	M	95*	C
Surat	16	L	24	M	76*	H
Mumbai	4	L	19	L	97*	C
Navi Mumbai#	20	L	39	M	113*	C

L: Low, M: Moderate, H:High, C: Critical; * : Exceeding NAAQS, # data considerd for monitoring stations of MPCB monitoring stations

Source: State of Air Quality in India-2010; CPCB[13]

[13] http://www.cpcb.nic.in/upload/NewItems/NewItem_192_NAAQSTI.pdf

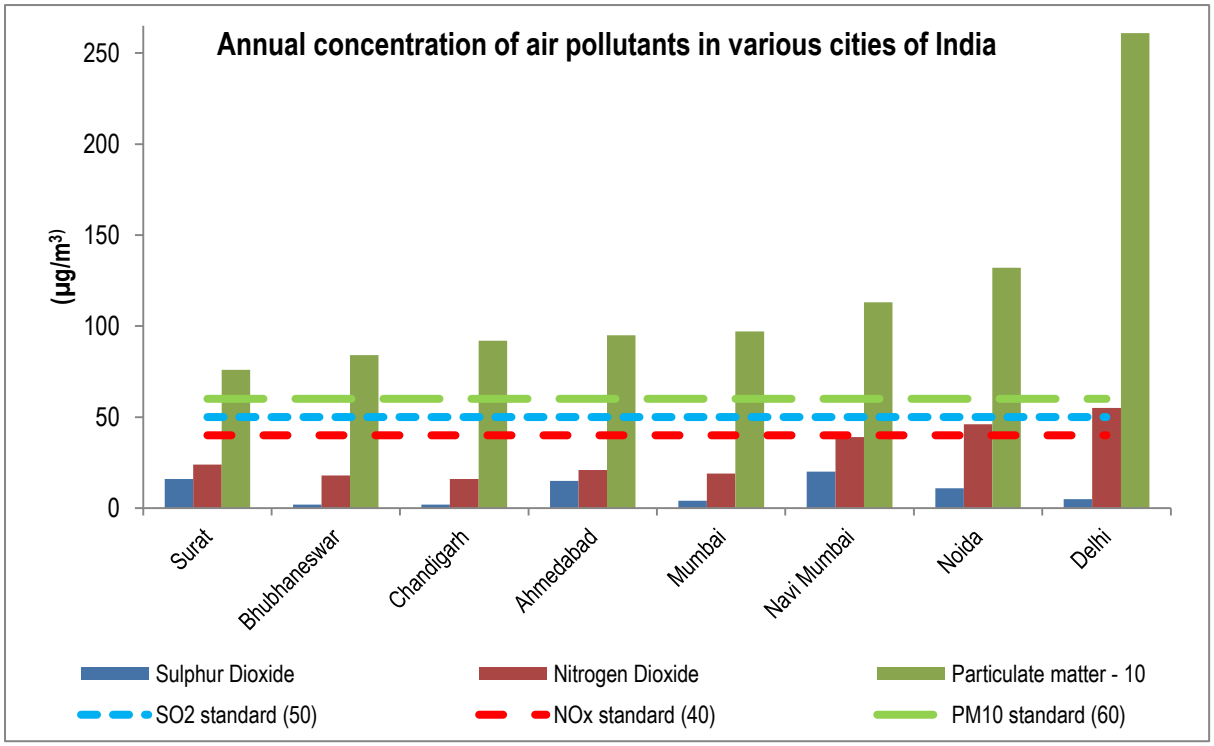


Figure No. 8: Annual concentration of air pollutants in various cities of India

Source: State of Air Quality in India-2010; CPCB[14]

Figure No. 8 gives a comparative analysis of performance of air pollution among major cities of India, including Navi Mumbai and Mumbai, under NAMP. Air quality in terms of Sulphur dioxide and Nitrogen dioxide was found to be within permissible limits in Navi Mumbai, whereas in terms of PM_{10} it ranked 6th among the mentioned eight cities of India in the year 2010.

The following sections elaborate on the status of air quality monitored in NMMC area in the year 2013-14 and the specific actions taken and proposed by NMMC.

[14] http://www.cpcb.nic.in/upload/NewItems/NewItem_192_NAAQSTI.pdf

Status

Air Quality Monitoring Network

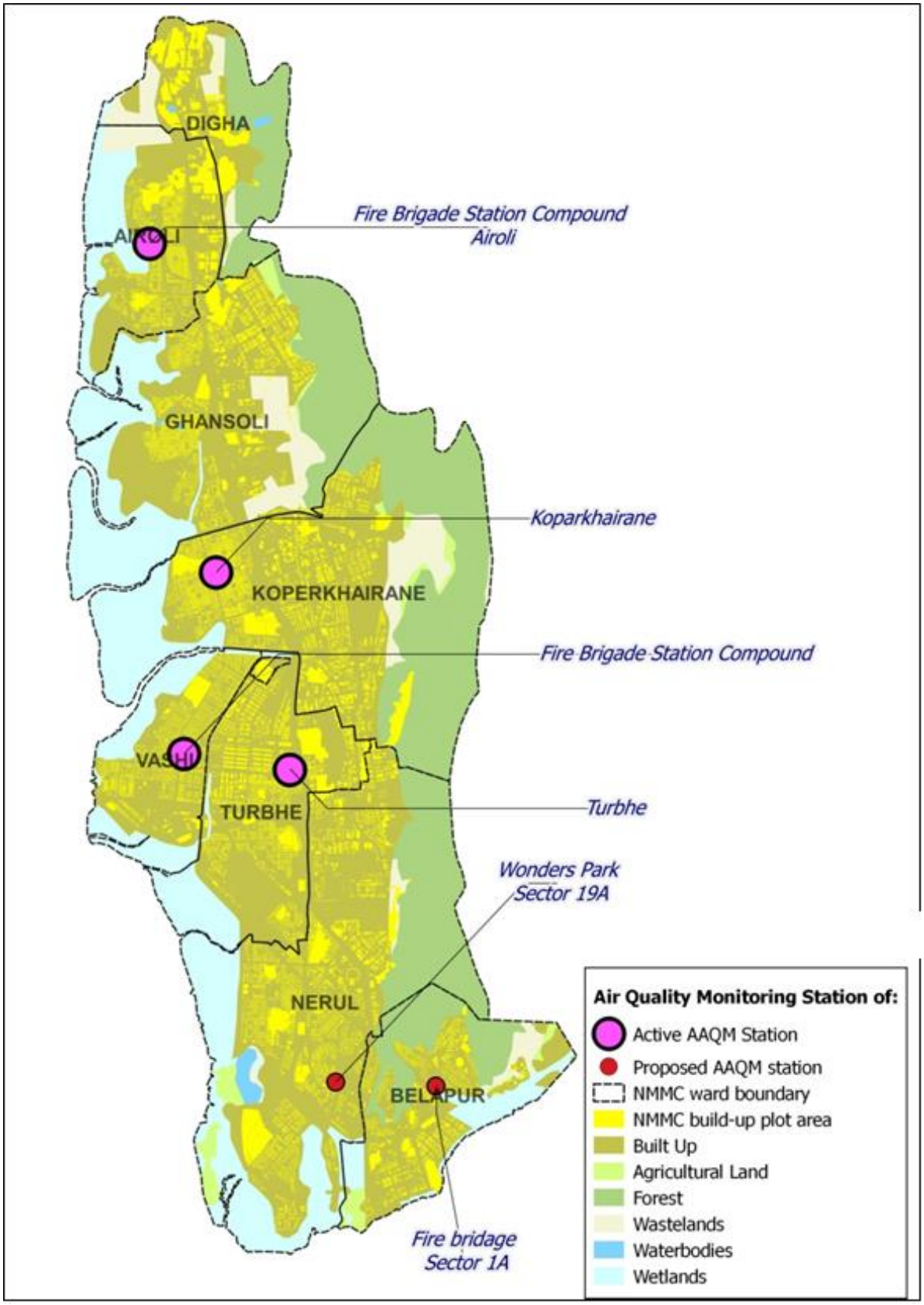
Presently there are 4 active CAAQMS (Continuos Ambient Air Monitoring Stations) at Airoli, Koparkhairane, Vashi and Turbhe in addition to an air monitoring mobile van. Data from continuos monitoring of NMMC for the fiscal year 2013-14 have been collated and analysed to get an overview of the region's air quality status and trends over the past few years.

Table No. 6 provides the tally of active ambient air quality monitoring stations in NMMC region. There are four continuos monitoring stations maintained and operated by NMMC, which monitor air quality parameters in addition to climatological parameters. The spatial representation of these monitoring stations are depicted in Map No. 2. To have an appropriate representation of air quality in the city, NMMC has proposed installation of two CAAQMS, one each at CBD-Belpur and Nerul. Currently the mobile monitoring van is deputed at various locations in these nodes to moitor the air quality.

Table No. 6: Details of CAAQMS in Navi Mumbai Municipal region:

Implementing Agency	Station name	Location	Type	Latitude	Longitude
Active CAAQMS in NMMC area	Airoli	Airoli fire station	Rural and other areas	19° 09' 21.4" N	72° 59' 35.4" E
	Koparkhairne	Teen Taki Area	Mixed	19° 06' 17.4" N	73° 01' 09.3" E
	Turbhe	Turbhe Landfill site	Industrial	19° 04' 42.5" N	73° 01' 34.6" E
	Vashi	Fire Brigade compound	Residential	19° 03' 20.4" N	72° 55' 19.5" E
Proposed CAAQMS	CBD Belapur	Belapur Fire station	Residential	19° 01' 28.7" N	73° 02' 25.1" E
	Nerul	Wonders Park	Residential	19° 01' 32.0" N	73° 01' 36.0" E

Source: Environment Laboratory, NMMC



Map No. 2: Spatial representation of existing and proposed CAAQMS in NMMC area

Source: Environment Laboratory, NMMC

Trend in SO_2 concentrations

SO_2 is highly reactive and a major air pollutant which is emitted by burning of coal, oil and other fossil fuels containing Sulphur. It reacts with the atmosphere to form sulfuric acid (H_2SO_4) causing acidification in lakes, leaching of minerals from soil and also acid rains. SO_2 is also found to be a precursor of PM which is a major health concern. Sulphur dioxide can also affect respiratory systems and cause reduced lung capacity. As seen in Table No. 7 and Figure No. 9 both CAAQM Station (Airoli and Vashi) are found to be within permissible limits as mentioned in National Ambient Air Quality Standards (NAAQS) of 50µg/m³ in the past six to seven years. This indicates that SO_2 pollution in Navi Mumbai is under control.

Table No. 7: Yearly Trend in concentration of SO_2 at AAQMS in Navi Mumbai

Year	Airoli	Vashi
	µg/m³	µg/m³
06-07	-	62
07-08	-	50
08-09	31	22
09-10	23	26
10-11	27	19
11-12	13	19
12-13	21	27
13-14	22	31
Annual Permissible Limit	*50*	*50*

Source: Environment Laboratory, NMMC

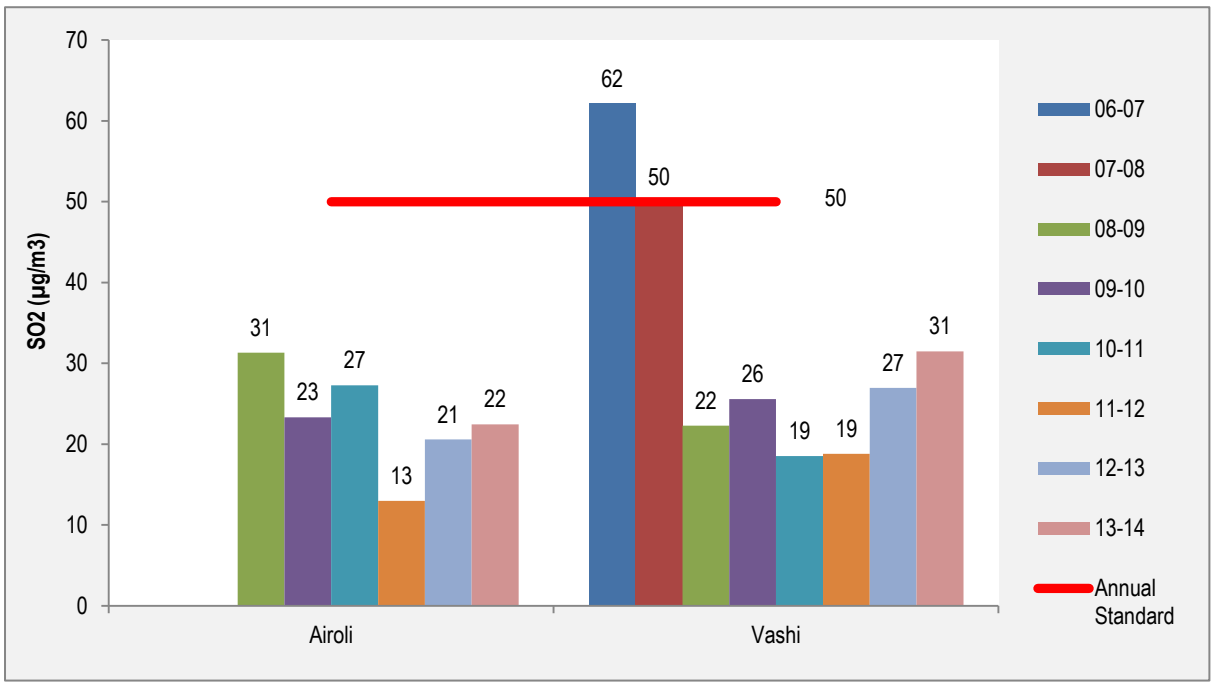


Figure No. 9: Yearly Trend in concentration of SO_2 at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Trend of NO_X concentrations

NO_X is an air pollutant emitted by fuel consumption in processes such as vehicular emission, industrial processes, and domestic emissions. Among chemical species of NO_X, NO_2 has an adverse effect on human health by causing inflammation of lung passage and reduced lung capacity. It is also a contributor to formation of secondary pollutants such as PM and Ozone. Presented below in Table No. 8 and Figure No. 10 is the yearly trend of NOx for two CAAQMS in NMMC region. It is seen from the graph that the NOx concentrations seem to have a declining trend at as per the data recorded at both the monitoring stations. The annual concentration is 53 and 44 µg/m³ at Airoli and Vashi stations respectively in the year 13-14.

Table No. 8: Yearly Trend in concentration of NO_X at AAQMS in Navi Mumbai

Year	Airoli	Vashi
	µg/m³	µg/m³
06-07	-	71
07-08	-	50
08-09	112	51
09-10	89	57
10-11	67	45
11-12	75	43
12-13	43	56
13-14	53	44
Annual Permissible Limit	*40*	*40*

Source: Environment Laboratory, NMMC

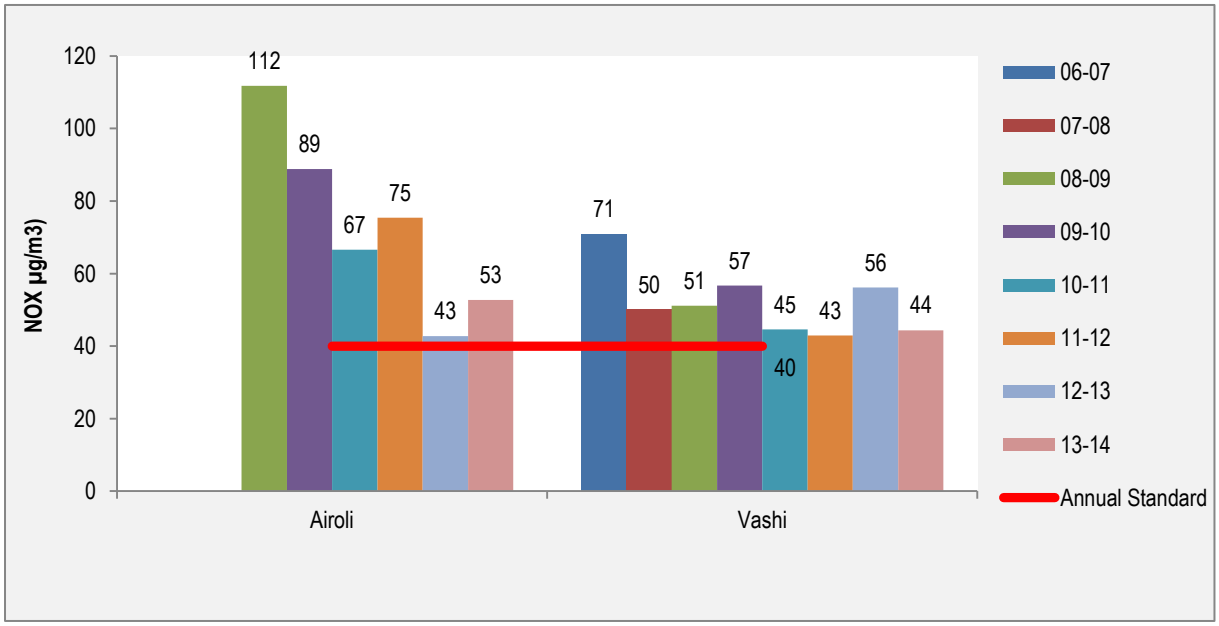


Figure No. 10: Yearly Trend in concentration of NO_X at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Trend of PM_{10} concentrations

Particulate Matter is a complex mixture of fine particles and aerosols, and is also known as particle pollution. It is made up of a number of components, including acids (such as nitrates and sulphates), organic chemicals, metals, and dust particles. Particles that are 10 micrometers in diameter or smaller can pass through the throat and nose and enter the lungs and are commonly referred to as RSPM (Respirable Suspended Particulate Matter). Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

The annual trend of PM_{10} is shown in Table No. 9 and Figure No. 11 the annual concentration of PM_{10} was higher than the NAAQS (60µg/m³) at Vashi; however at Airoli the annual PM_{10} concentrations were within limits for the year 2013-14. Annual concentration at Airoli station in recent year was below the permissible limit for SO_2 whereas at Vashi station it exceeded the permissible limit in all the year.

Table No. 9: Yearly Trend in concentration of PM_{10} at AAQMS in Navi Mumbai

Year	Airoli	Vashi
	µg/m³	µg/m³
06-07	-	**101**
07-08	-	**93**
08-09	**87**	**124**
09-10	**120**	**96**
10-11	**128**	**92**
11-12	**181**	**111**
12-13	**109**	**110**
13-14	53	**108**
Annual Permissible Limit	*60*	*60*

Source: Environment Laboratory, NMMC

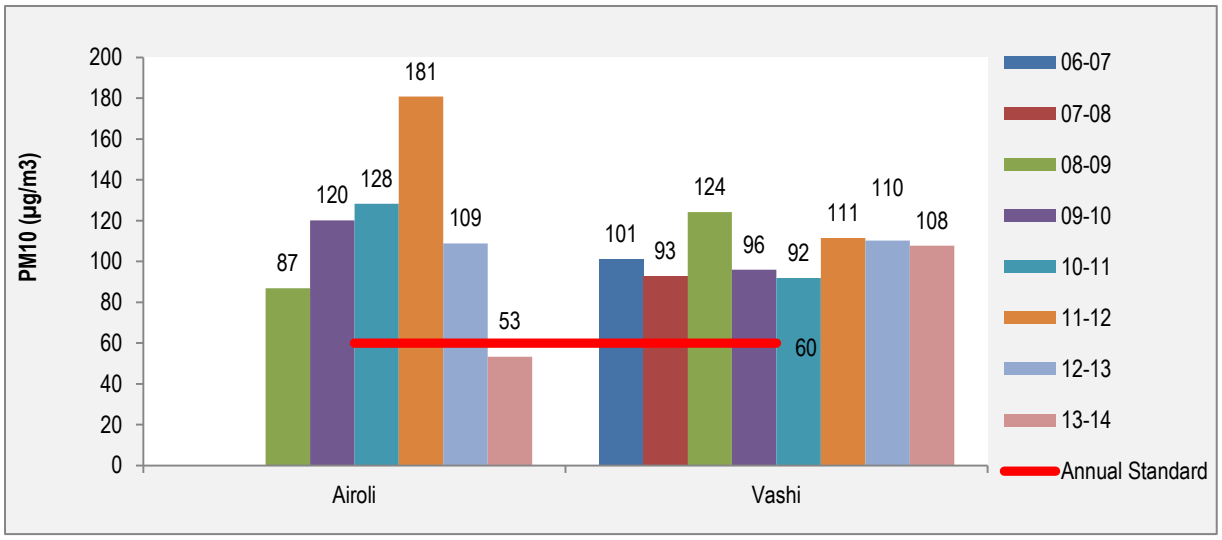


Figure No. 11: Trend in concentration of PM10 at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Inter Station Analysis

An inter-station comparison of SO_2 concentrations in NMMC area in 2013-14 has been depicted in Table No. 10 and Figure No. 12. The annual mean concentration of SO_2 was within permissible limits at all the stations. The standard for daily mean concentration states that the concentration of a pollutant should be below 80µg/m³ for at least 98% of monitoring days. Hence 98th percentile decides whether the daily concentration meets the NAAQ standard.

It was found that the 98th percentile standard for all stations was within the permissible limits except at Turbhe where it was 108.2µg/m³. The annual mean concentration at all stations was below the permissible limits of 50µg/m³. Hence we conclude that average SO_2 was well within the permissible standards while on certain days the areas near Turbhe exceeded the daily standards indicating that during certain days the Turbhe was found to be highly polluted with SO_2.

Table No. 10: Concentration of SO_2 at various AAQMS in NMMC region for the year 2013-14

Station Name	Daily Max	Daily 98th percentile	Daily Mean	Daily Min	*Mean Standard*	*98th percentile Standard*
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Airoli	64.0	36.6	19.5	2.1	*50*	*80*
Koparkhairne	70.6	47.7	17.1	2.2	*50*	*80*
Turbhe	236.5	108.2	45.0	12.1	*50*	*80*
Vashi	74.0	58.0	31.5	6.0	*50*	*80*

Source: Environment Laboratory, NMMC

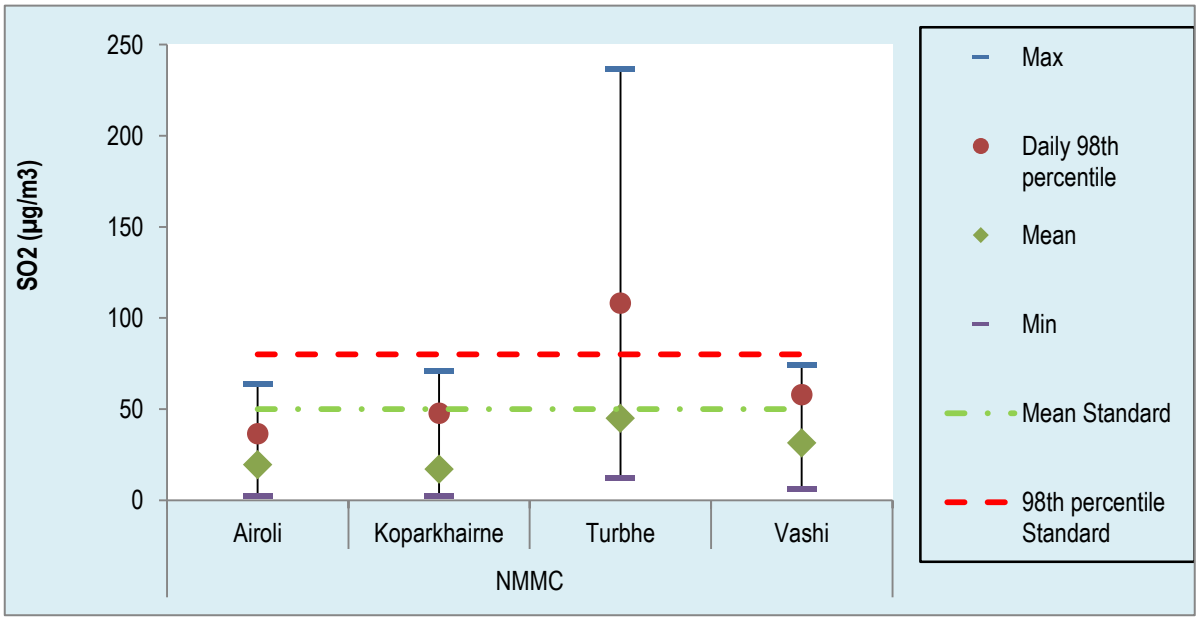


Figure No. 12: Concentration of SO_2 at various AAQMS in NMMC region for the year 2013-14

Source: Environment Laboratory, NMMC

Table No. 11: Concentration of NO_X at various AAQMS in NMMC region for the year 2013-14

Station Name	Daily Max	Daily 98th percentile	Daily Mean	Daily Min	*Mean Standard*	*98th percentile Standard*
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Airoli	216.9	90.4	47.6	10.8	*40*	*80*
Koparkhairne	108.4	87.7	36.1	4.3	*40*	*80*
Turbhe	170.3	94.8	30.4	7.2	*40*	*80*
Vashi	125.0	97.0	44.3	11.0	*40*	*80*

Source: Environment Laboratory, NMMC

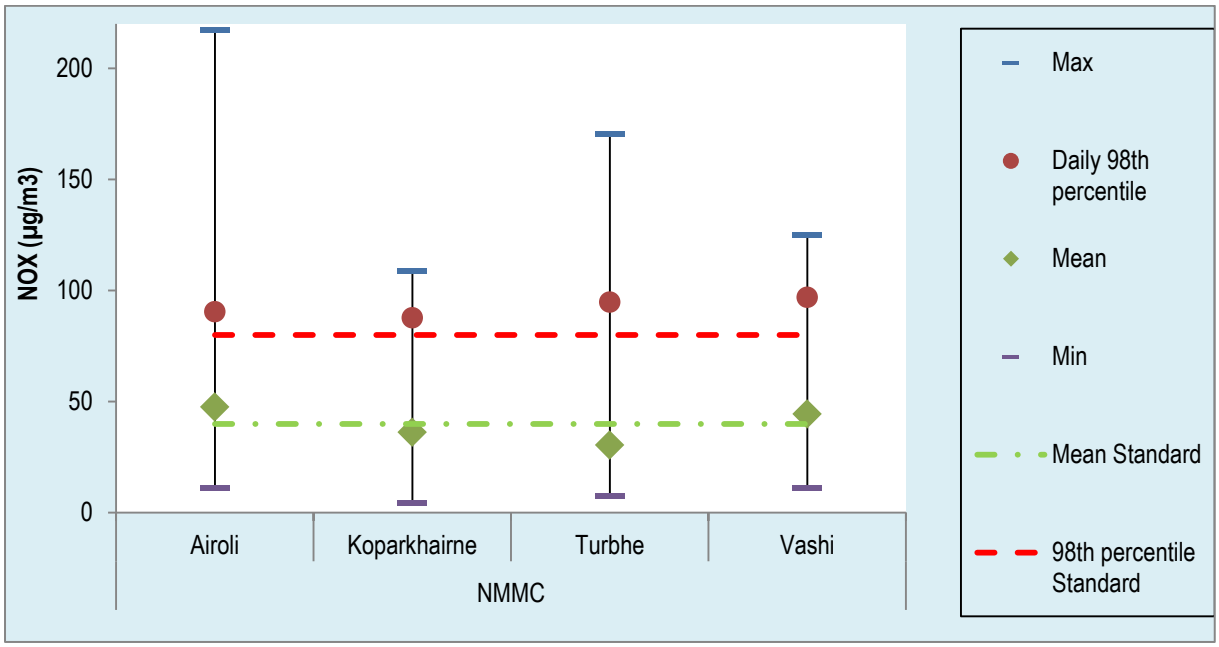


Figure No. 13: Concentration of NO_X at various AAQMS in NMMC region for the year 2013-14

Source: Environment Laboratory, NMMC

The trend in yearly concentration and daily 98th percentile reading of NO_X for the fiscal year 2013-14 is depicted in Table No. 11 and Figure No. 13. Mean daily NO_X concentration was found to be higher than the permissible limits at Vashi and Airoli while at Koparkhairane and Turbhe regions the NOx concentration was found be to within the permissible limits. No stations met the 98th percentile standard for NO_X, thus we can see that during the period 2013-14, the daily mean exceeded the limit of 80µg/m³ for more than 2% times for the number of days monitored.

Hence we conclude that annual average NO_X was well within the permissible limit except at Airoli and Vashi (48 and 44 µg/m³) where it exceeded the permissible standards, while on certain days at all stations, it was found to have exceeded the daily standard. Thus these certain days were observed to be afflicted with NO_X pollution. The rise in NO_X levels can be attributed to vehicular pollution in the near proximity and mainly the Mumbai – Pune High way passing through the city.

Table No. 12: Concentration of $PM_{2.5}$ at various AAQMS in NMMC region for the year 2013-14

Station Name	Daily Max	Daily 98th percentile	Daily Mean	Daily Min	*Mean Standard*	*98th percentile Standard*
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Airoli	171.0	96.0	38.3	6.5	*40*	*80*
Koparkhairne	183.3	140.4	64.0	14.3	*40*	*80*
Turbhe	163.2	148.1	54.2	12.7	*40*	*80*
Vashi	-	-	-	12.0	*40*	*80*

Source: Environment Laboratory, NMMC

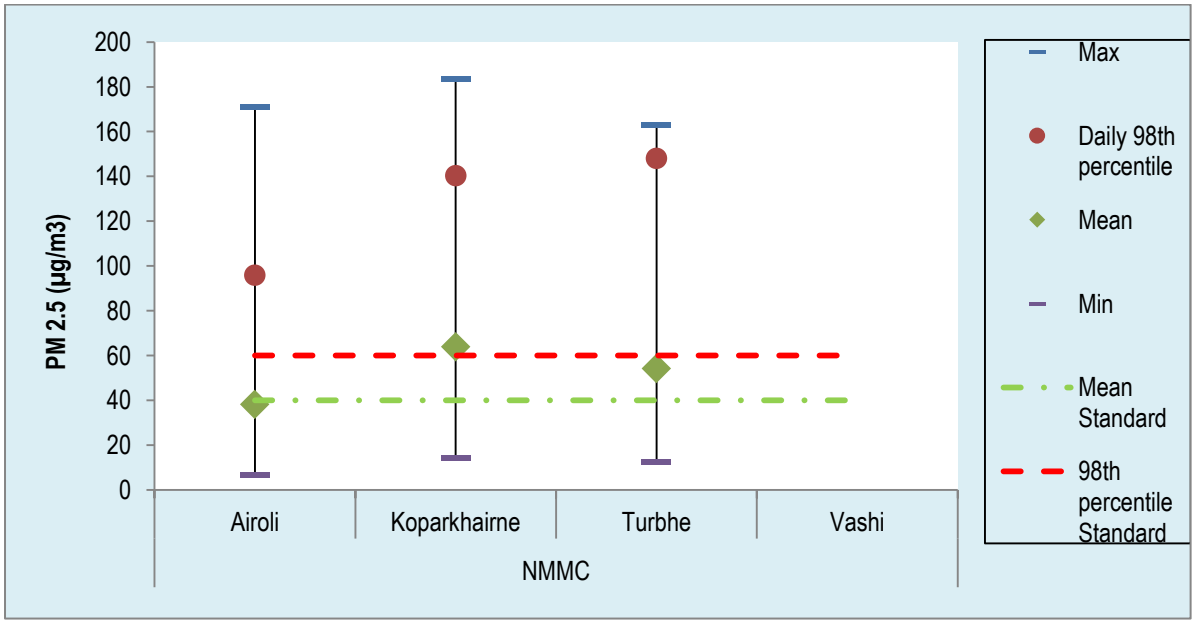


Figure No. 14: Concentration of $PM_{2.5}$ at various AAQMS in NMMC region for the year 2013-14

Source: Environment Laboratory, NMMC

The trend in yearly concentration and daily 98th percentile reading of $PM_{2.5}$ is presented in Table No. 12 and Figure No. 14. Mean daily $PM_{2.5}$ concentration was found to be slightly higher at all the stations than the permissible limits of 2% times of the readings.

The annual mean of $PM_{2.5}$ was below the permissible limits of (40µg/m³) at Airoli station, whereas at Koparkhairane (64µg/m³) and Turbhe (54µg/m³) stations it was above the permissible limits.

Hence we can conclude that pollution due fine particulate matter still poses a serious environmental issue at the installed monitoring stations in NMMC. Also the continuous efforts taken by NMMC have made it possible to constrain the $PM_{2.5}$ concentration in ambient air to a great extent.

Table No. 13: Concentration of PM_{10} at various AAQMS in NMMC region for the year 2013-14

Station Name	Daily Max	Daily 98th percentile	Daily Mean	Daily Min	*Mean Standard*	*98th percentile Standard*
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Airoli	193.8	122.8	44.6	0.0	*40*	*80*
Koparkhairne	369.5	262.8	134.4	24.3	*40*	*80*
Turbhe	443.8	380.2	151.2	24.8	*40*	*80*
Vashi	270.0	208.3	107.8	-	*40*	*80*

Source: Environment Laboratory, NMMC

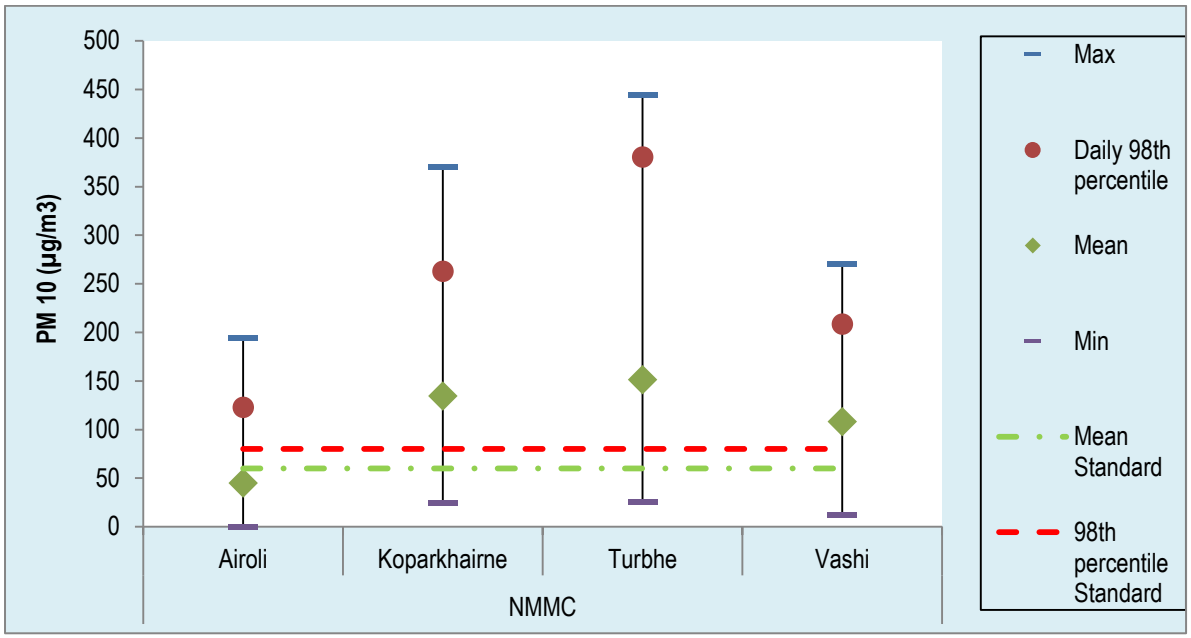


Figure No. 15: Concentration of PM_{10} at various AAQMS in NMMC region for the year 2013-14

Source: Environment Laboratory, NMMC

The trend in yearly concentration and daily 98th percentile reading of PM_{10} is presented in Figure No. 15. Mean daily PM_{10} concentration was found to be higher at all the stations than the permissible limits of 98 percentile standard (80µg/m³) for more than 2% readings.

The annual mean of PM_{10} was below the permissible limits of (60µg/m³) at Airoli station, whereas at Koparkhairane (134µg/m³), Turbhe (151µg/m³) and Vashi (108µg/m³) station it was above the permissible limits.

Hence we can conclude that pollution due to dust/fine particulate matter poses a vital environmental issue at the installed monitoring stations in NMMC. Higher value of PM_{10} is attributed to heavy traffic movement near the monitoring location at Koparkhairane and Vashi air monitoring stations. But the continuous efforts, like mechanized sweeping of roads, concretization of major junctions, developing smooth surface roads and various other initiatives by NMMC have made it possible to contain PM_{10} concentration in ambient air to a great extent.

Table No. 14: 8-hourly mean concentration of CO for 2013-14

Station Name	Duration of sampling	Max	98th percentile	8-hr Mean	Min	*98th percentile Standard*
	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3
Airoli	0-8 hr	3.15	2.33	1.05	0.15	2
	8-16 hr	3.75	2.59	1.09	0.23	2
	16-24 hr	0.70	0.61	0.34	0.10	2
Koparkhairne	0-8 hr	3.04	1.69	0.82	0.10	2
	8-16 hr	2.98	2.30	0.99	0.13	2
	16-24 hr	0.67	0.57	0.33	0.11	2
Turbhe	0-8 hr	0.70	0.61	0.34	0.10	2
	8-16 hr	3.04	1.57	0.83	0.10	2
	16-24 hr	0.67	0.52	0.31	0.11	2

Source: Environment Laboratory, NMMC

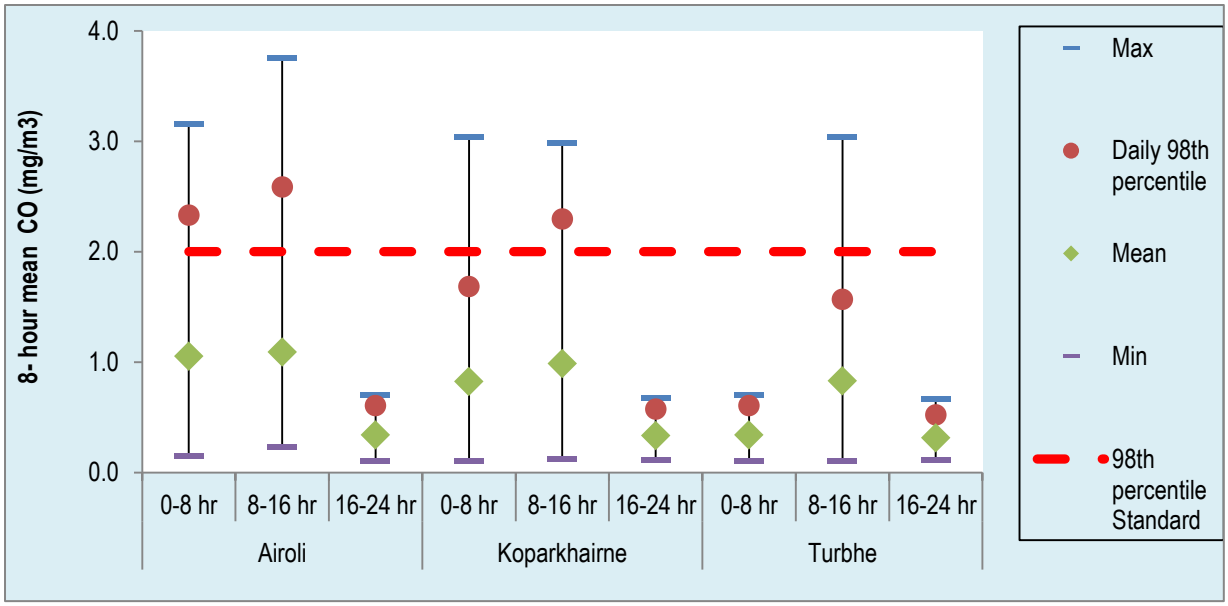


Figure No. 16: Mean 8-hourly mean concentration of CO for 2013-14

Source: Environment Laboratory, NMMC

As seen in Figure No. 16, the concentration of CO during 3 time durations monitored at three monitoring station in NMMC region, namely- Airoli, Koparkhairane and Turbhe. It was found that the concentration of CO slightly exceeded the 98th percentile standard for 8 hours at Airoli and Koparkhairane primarily during the time period of 8 and 16 hours.

The primary reason behind higher emission of Carbon monoxide is due to vehicular as well as domestic fuel emission.

Table No. 15: 8-hourly mean concentration of ground level Ozone for 2013-14

Station Name	Duration of sampling g	Max	98th percentile	Mean	Min	*98th percentile Standard*
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Koparkhairne	0-8 hr	86.76	68.17	29.51	3.48	*100*
	8-16 hr	135.52	88.63	40.03	0.88	*100*
	16-24 hr	151.48	118.69	56.52	6.89	*100*

Source: Environment Laboratory, NMMC

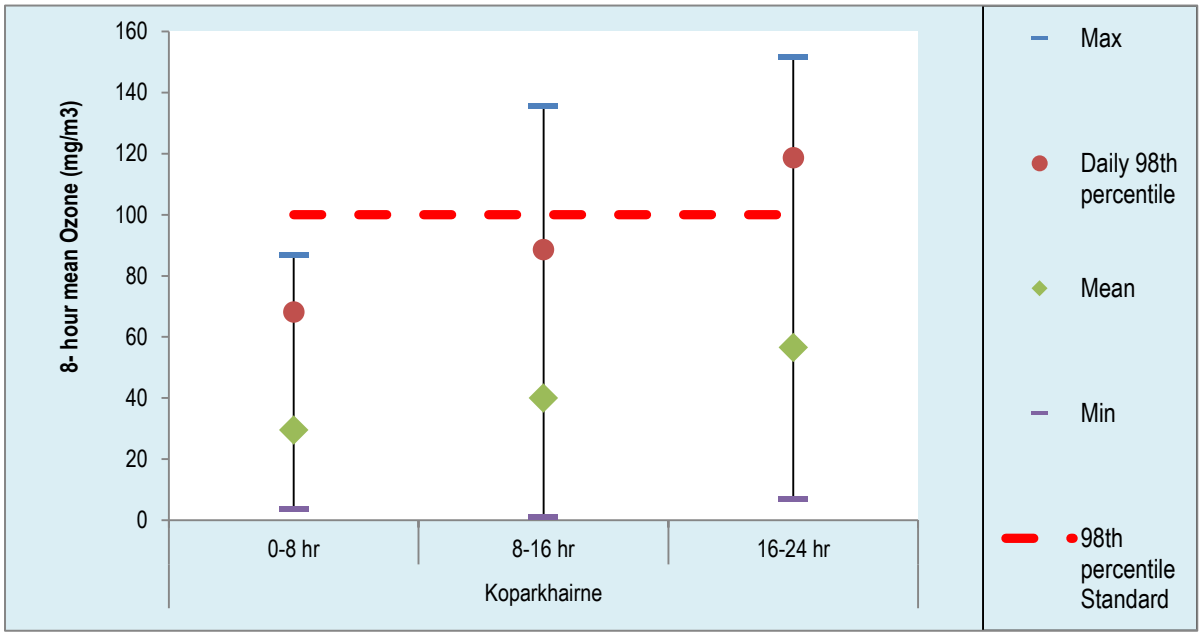


Figure No. 17: 8-hourly mean concentration of ground level Ozone for 2013-14

Source: Environment Laboratory, NMMC

The status of ground level Ozone for 2013-14 (Table No. 15 and Figure No. 17) at Koparkhairne station; presently it is the only station which monitors Ozone. As seen in the graph above, the levels of Ozone gradually increases from early morning to evening. The overall 98th percentile reading for the day (which is 107µg/m^3) is slightly higher than permissible limits. Also it is observed that the levels are higher only during 16 to 24 time duration. The reasons for such a high values of Ozone during evenings are due to gradual accumulation of ozone produced from complex chemical reaction involving primary pollutant and prevailing climatic condition in the region.

Table No. 16: 8-hourly mean concentration of ground level HC-Methane for 2013-14

Station Name	Duration of sampling	Max	8-hr Mean	Min
		µg/m³	µg/m³	µg/m³
Airoli	0-8 hr	8.28	2.49	0.33
	8-16 hr	7.75	2.36	0.00
	16-24 hr	8.87	2.46	0.06
Koparkhairne	0-8 hr	64.02	4.50	0.00
	8-16 hr	60.54	4.50	0.00
	16-24 hr	37.21	3.85	0.00
Turbhe	0-8 hr	73.56	17.97	0.22
	8-16 hr	68.93	14.53	0.00
	16-24 hr	69.27	15.07	0.00

Source: Environment Laboratory, NMMC

Table No. 16 and Figure No. 18 shows 8 hourly mean concentration of Hydro Carbon (HC)-Methane at Airoli, Koparkhairne and Turbhe at three different time interval. The Methane's average concentration at Airoli was found to range between 2.36 - 2.49 µg/m³ during the day, whereas at Koparkhairne average 8 hour concentration during the day ranged from 3.85 – 4.5 µg/m³. At Turbhe monitoring station the average concentration was found to be higher than Koparkhairne and Airoli. Average concentration during the time interval of 0:00 to 8:00 was 17.97 µg/m³, which is higher than the average concentrations recorded during 8-16 hrs and 16-24 hrs at Turbhe station.

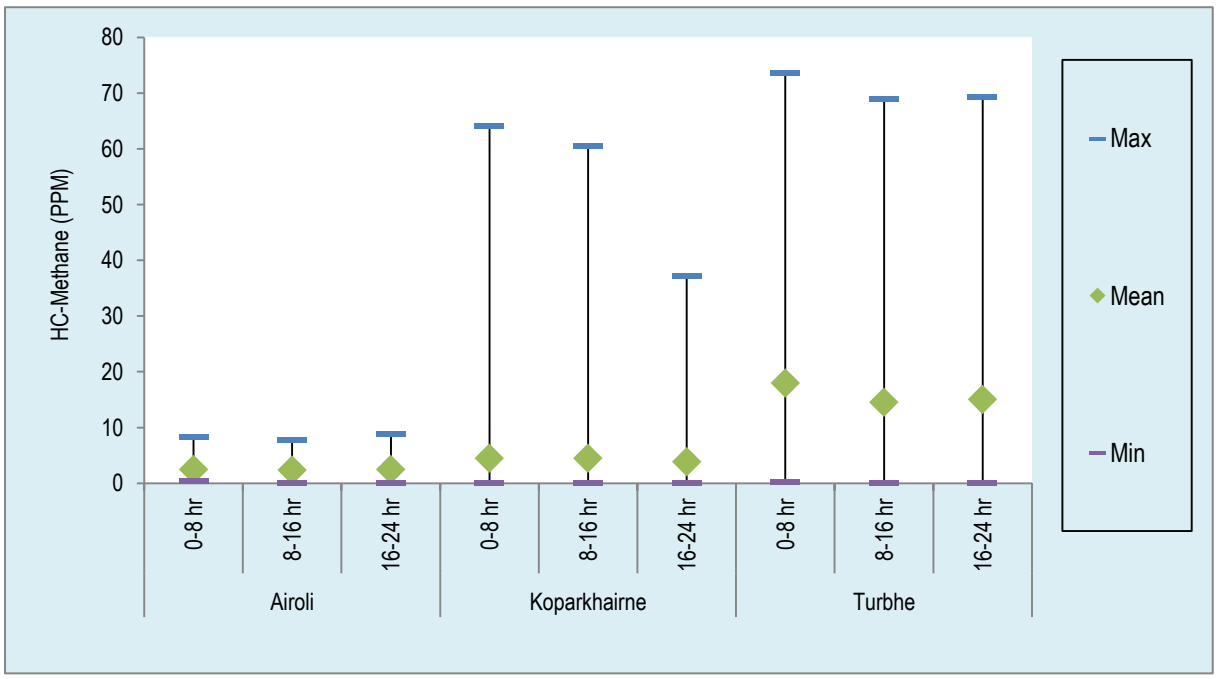


Figure No. 18: 8-hourly mean concentration of ground level HC-Methane for 2013-14

Source: Environment Laboratory, NMMC

Air Quality Index

The quality of air around us has direct implications on our health. The air quality, like the weather of a location, can change immensely within the span of an hour. Hence to convey the information on outdoor air quality, the easiest way possible, comprehensible to the general public, a tool such as AQI (Air Quality Index) has been devised.

Most of the AQI developed by various agencies have a range of 0 to 500. An AQI of 100 or below indicates attainment of National Ambient Air Quality Standards. A higher value of AQI indicates higher levels of pollution. When AQI values are above 100, air quality is considered to be unhealthy—at first for certain sensitive groups of people, then for everyone (including healthy people) as AQI values get higher. Depending upon 'doses of exposure' they are further divided into five classes of AQI, which present different health concerns. To make it easy to understand, the categories of AQI are assigned colour codes (Figure No. 19) colour Green to 'Good', Yellow to 'Moderate', Orange to 'Poor', Red to 'Very Poor' and Dark Red to 'Severe' (Figure No. 19).

A detailed calculation of AQI for Indian standards has been provided in the report published by MPCB for the Air Quality status of Maharashtra prepared by TERI[15]. The same calculations have been used to determine the AQI for the monitoring stations in NNMC area.

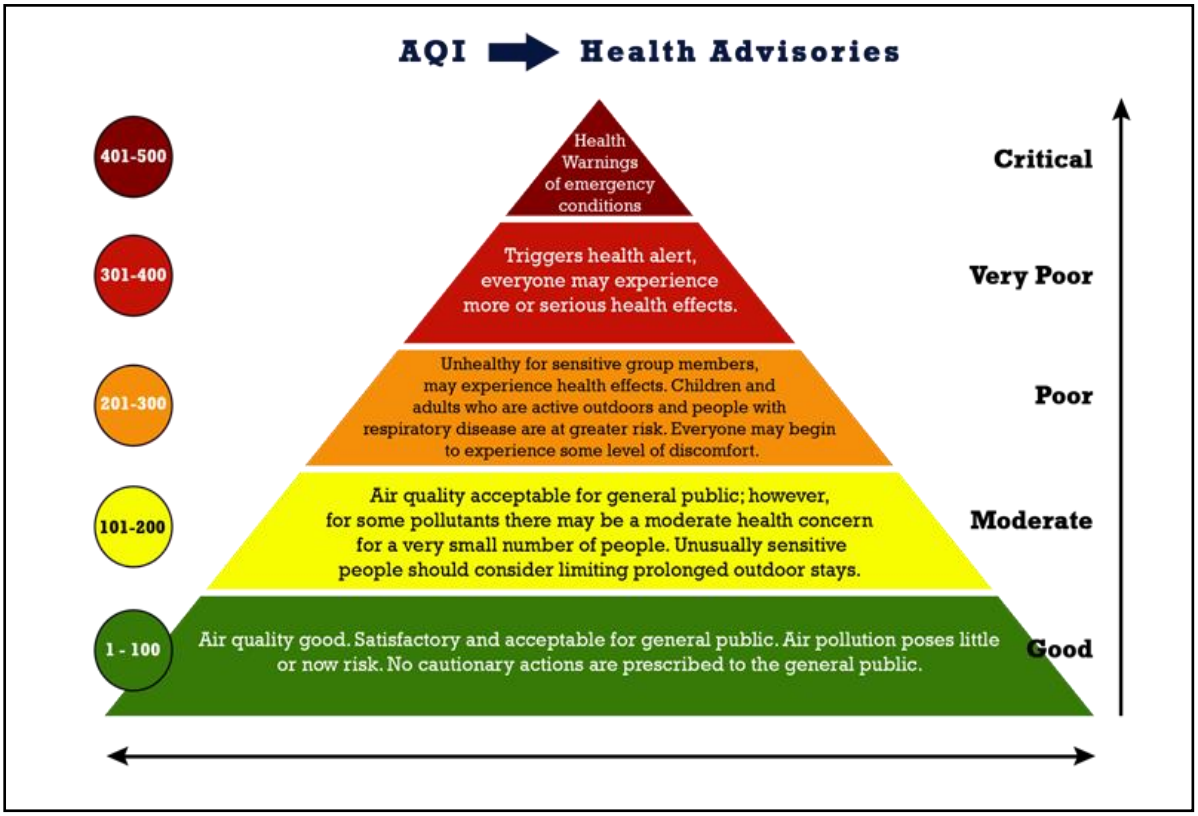


Figure No. 19: Health advisories for various range of AQI and respective colour codes

Data Source: EPA and System of Air Quality Weather Forecasting and Research, MoES, GoI

[15] http://mpcb.gov.in/ereports/pdf/Air%20Quality%20Report_MPCB_2013-14.pdf

AQI for NMMC Region

The quality of air in terms of PM (Figure No. 20) was *'Good'* (0-100 AQI) at Airoli station with a 100% occurrence of 'Green' category of AQI, whereas at Koperkhairane (*'moderate'*- 22% and *'poor'-1% monitoring days)*, Turbhe (*'moderate'*- 17% and *'poor'- 2% monitoring days)*, and Vashi (*'moderate'*-30% and *'poor'-20% monitoring days)* saw lower quality of air than Airoli during April 2013 to March 2014.

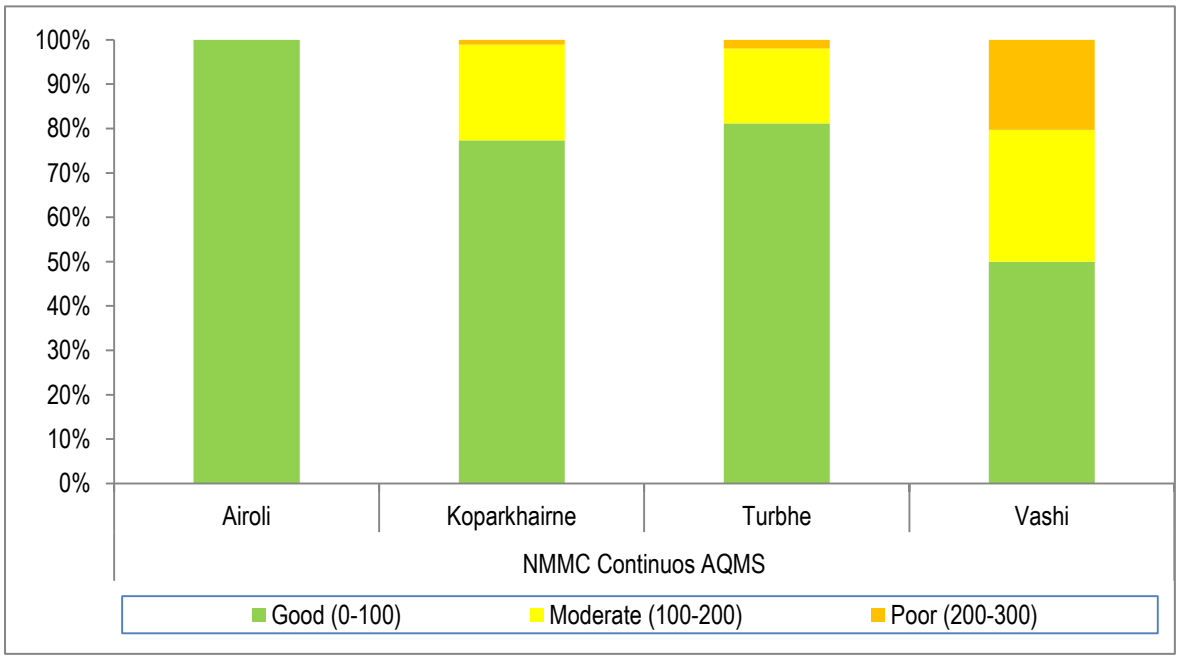


Figure No. 20: Occurrence of AQI classes for PM_{10} across NMMC area (2013-14)

Source: Environment Laboratory, NMMC

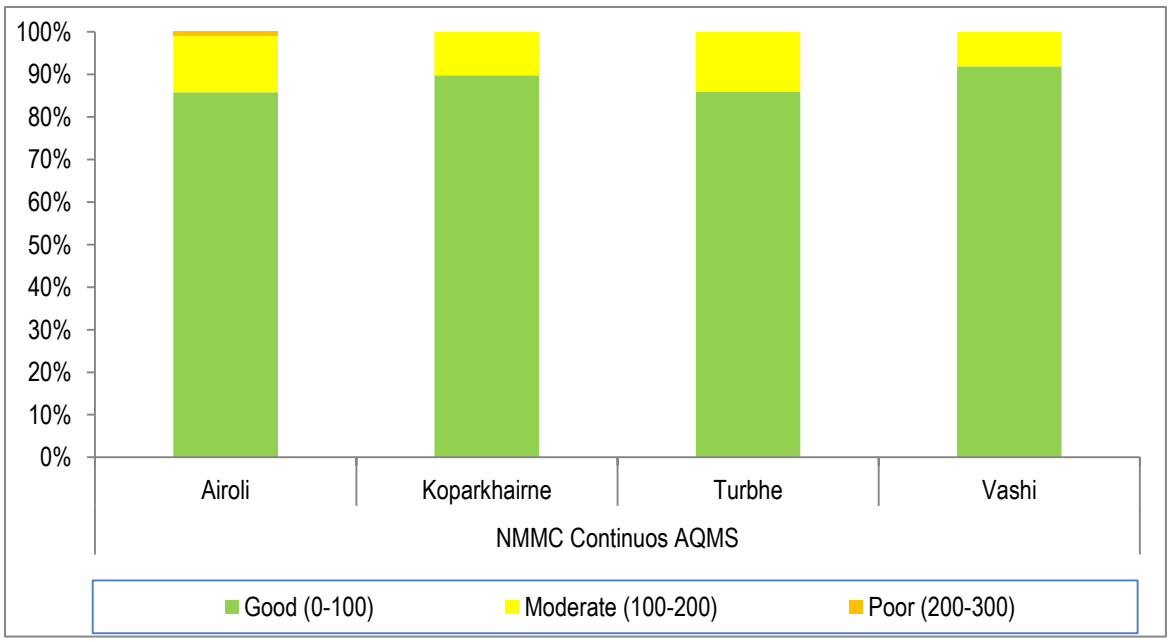


Figure No. 21: Occurrence of AQI classes for NO_X across NMMC area (2013-14)

Source: Environment Laboratory, NMMC

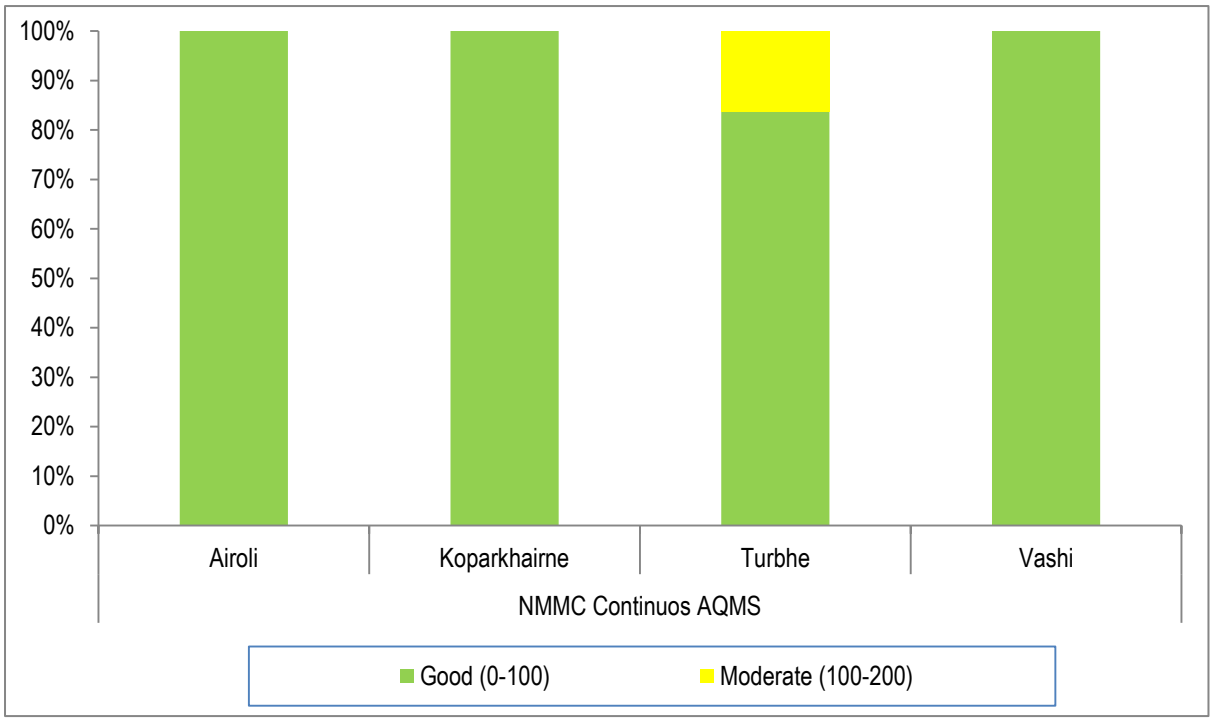


Figure No. 22: Occurrence of AQI classes for SO_2 across NMMC area (2013-14)

Source: Environment Laboratory, NMMC

The quality of air in terms of oxides-of-Nitrogen (NO_X) are given in the parentheses following the monitoring station: Airoli (*'moderate'*-13% and *'poor'-1% monitoring days)*, Koperkhairane (*'moderate'*-10% *monitoring days)*, Turbhe (*'moderate'*- 14% *monitoring days)*, and Vashi (*'moderate'*-8% *monitoring days)* during April 2013 to March 2014.

The quality of air in terms of Sulphur Dioxide (SO_2) was seen to be good (0-100 AQI) at all the stations except at Turbhe where it was to be *'moderate' (100-200 AQI)* category for 16% monitoring days during the period April 2013 to March 2014.

Pressures

Vehicular Growth

Detailed statistics on the number of vehicles which were registered year wise at Vashi RTO are shown in Table No. 17. The following information was sourced from Motor Vehicle Department of Maharashtra in their report *"Motor Transport Statistics of Maharashtra"*.

A graphical representation of number of motor vehicle is shown in Figure No. 23 and trend in total number of vehicles on roads is shown in Figure No. 24.

Table No. 17: Navi Mumbai Region wise and category wise No. of Motor Vehicles

SN	Category	Type of Vehicle	Navi Mumbai									
Newly Registered during the year			04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14
1	2-Wheelers	Motor Cycles	9643	11201	14262	12716	11345	5235	16361	15188	17395	16525
2		Scooters	411	2144	930	163	177	7547	271	81	-	0
3		Mopeds	0	5	0	0	0	0	0	0	-	0
4	4-Wheelers	Cars	5412	4455	8082	11165	9586	10665	13042	13184	11808	8298
5		Jeeps	1856	25	342	217	162	160	222	104	-	0
6		Station Wagons	0	0	196	0	0	0	0	0	-	0
7(A)	Taxi/Auto rickshaw	Taxi meter fitted	0	0	0	0	0	0	0	187	-	-
7(B)		Taxi Tourist Cabs	643	885	1010	1261	731	283	630	548	851	439
8		Auto-Rickshaws	391	892	516	457	227	606	444	493	628	1663
9	Buses	Stage carriages	17	0	0	31	33	49	116	11	4	1
10		Contract carriages	710	94	131	346	337	209	314	251	-	35
11		School Buses	0	0	0	14	30	23	35	136	180	99
12		Private Service Vehicles	97	46	6	32	39	21	43	32	171	5
13		Ambulances	31	6	4	41	24	35	39	28	10	16
14		Arti.& Muli. Vehicles.	335	10	43	0	0	0	2	0	30	-
15	Other Heavy Vehicles	Trucks & Lorries	1131	1094	1316	2297	939	934	1717	1067	901	725
16		Tankers	0	210	204	445	186	257	168	220	249	155
17		Delivery Van (4 wheelers)	724	864	1144	667	147	256	309	643	512	213
18		Delivery Van (3 wheelers)	354	966	2167	1501	978	1095	1237	1462	1565	1019
19		Tractors	0	20	11	0	0	0	0	0	-	0
20		Trailers	29	0	347	778	428	460	694	381	438	230
21		Others	0	0	19	12	11	10	20	57	7	15
		Total	**21784**	**22917**	**30730**	**32143**	**25380**	**27845**	**35664**	**34073**	**34749**	**29438**

Source: RTO, Navi Mumbai

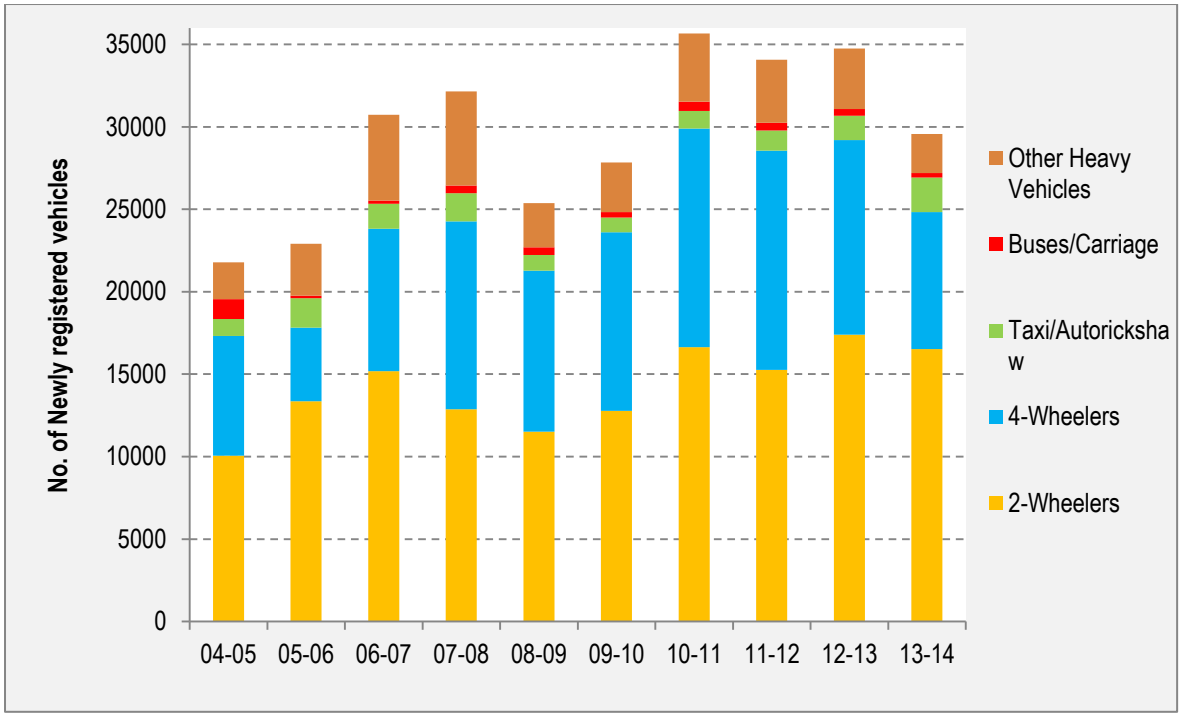


Figure No. 23: Trend showing newly registered vehicles in Navi Mumbai across 10 years

Source: RTO Publication 2013-14

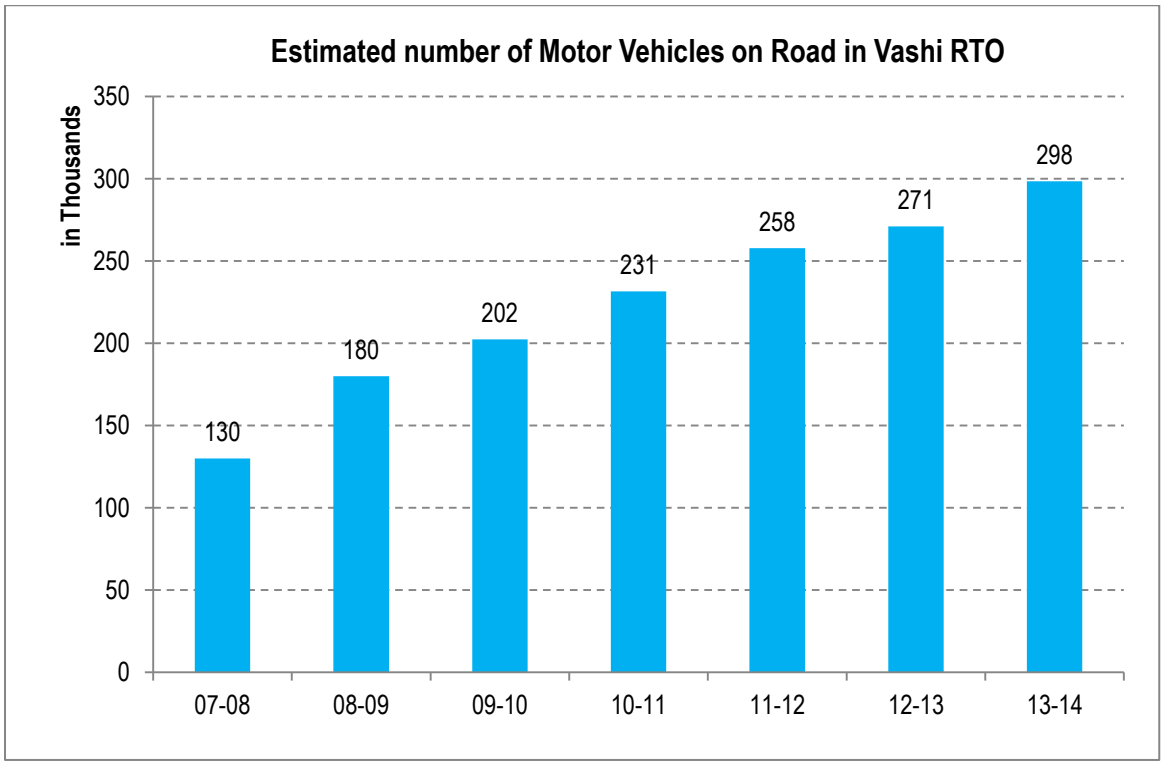


Figure No. 24: Estimated number of Motor Vehicles on Road in Vashi RTO

Source: RTO Publication 2013-14

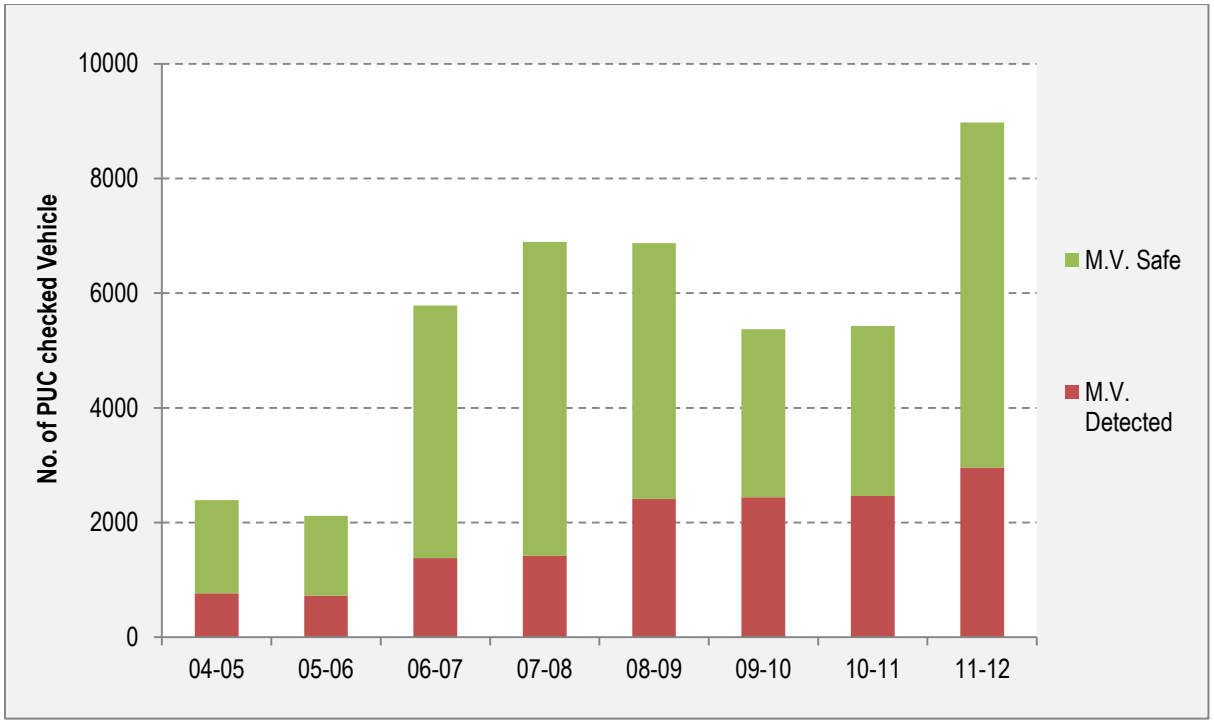


Figure No. 25: Performance of P.U.C. Checking in Navi Mumbai

Source: RTO Publication 2011-12

In Figure No. 23, the annual trend of vehicles registered in NMMC RTO region has been depicted. There has been a steady increase in the number of vehicle registrations, and an overall increase in vehicle population on road has increased to about 2.98 lakhs as seen in Figure No. 24. It was found in the year 2011-12 (2.5 Lakh vehicles on road) about 33% vehicles which undertook 'Pollution Under Control' (PUC) checking did not comply with the permissible emission norms. Studies have shown that emissions from vehicles are among the major contributors to the deterioration of air quality.

Fuel Consumption in NMMC

TERI had conducted the Carbon footprint estimation in Navi Mumbai in the year 2010, as per the study, the fuel consumption for NNMMC is given in Figure No. 26. For the sake of convenience some important data pertaining to the fuel consumption in NMMC region has been reproduced below from the same report

Transport Sector

Motor Spirits (MS) commonly known as petrol, HSD, CNG and Auto-LPG are the commonly used fuels in the transport sector. The public transport modes in Navi Mumbai including taxies, auto-rickshaws, and busses owned by Navi Mumbai Municipal Transport (NMMT) either consumes CNG or Diesel. Increasing vehicular growth exerts demand for fuel and it is clearly reflected in Figure No. 26. The sale of petroleum products has increased with a CAGR (Compound annual growth rate) of almost 8% in the last 5 years. The total sale of petroleum products in transport sector for the year 2011-12 accounted to almost 164.55 thousand metric tons.

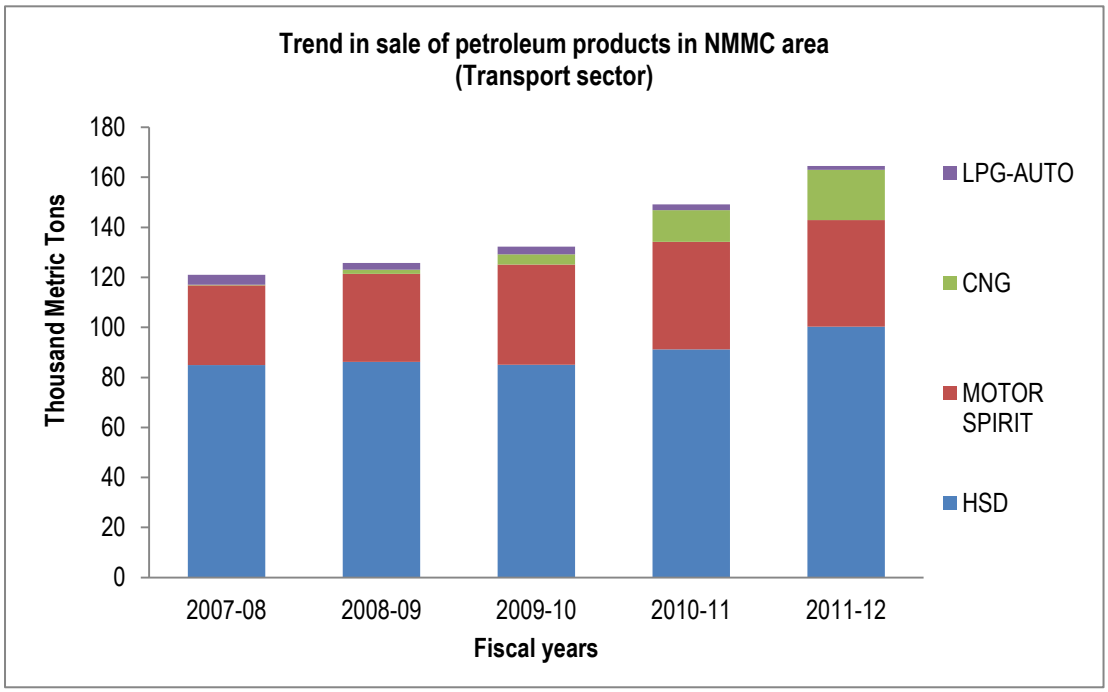


Figure No. 26: Trend in sale of petroleum products in Navi Mumbai (Transport sector) [16]

Source: HPCL, BPCL, IOCL and Mahanager Gas

It is distinct that the sale of Auto LPG has decreased and there is a remarkable rise in the sale of CNG in Navi Mumbai city. The sale for CNG has increased almost 11 times in the last 4 years; i.e. between 2008-09 and 2010-12 whereas the sale for both Motor Spirits (MS) and High Speed Diesel (HSD) has grown by 33% and 18% respectively in the last five years. The increase in sale of CNG can be attributed to the switching option to dual fuel types and it being mandatory for auto rickshaws, taxis and many busses owned by NMMT to use CNG.

[16] As per data obtained through correspondence with IOCL, BPCL, HPCL and Mahanagar Gas

Industrial sector

Owing to the presence of TTC industrial belt within NMMC limits, there is a huge demand for petroleum products like LDO, FO and HSD in industries. The total sale of petroleum products in 2011-12 was around 41.03 thousand metric tons and the sale in Navi Mumbai has grown at a CAGR of 10.16% between fiscal years 2007-08 and 2011-12. With only a slight dip in the year 2009-10, there has been an increasing trend in consumption of fuels in industrial sector.

It is remarkable to note from Figure No. 27 that there has been a decline in the sale of LDO and Kerosene by almost 63% and 93% respectively in last five years. These fuels have been replaced by LPG and PNG. The sale of LPG during the same time has more than doubled and the sale of CNG has been significant in the same period. The annual sale of HSD in industrial sector has also decreased by 6%in last five years. However the sale of furnace oil has registered a growth of more than 50%.

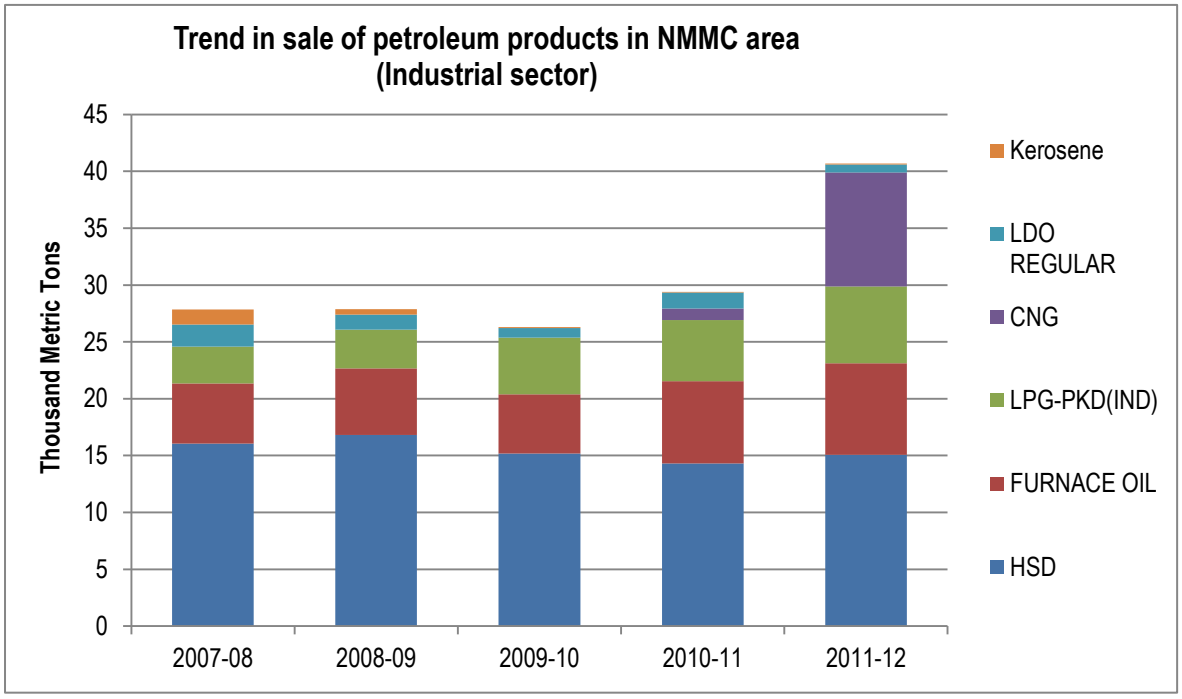


Figure No. 27: Trend in sale of petroleum products in Navi Mumbai (Industrial sector)[17]

Source: HPCL, BPCL, IOCL and Mahanagar Gas

Note: The sale of CNG includes both industrial and commercial & institutional sale of CNG as categorized by Mahanagar gas. HSD sale includes bulk sales made by fuel companies.

[17] As per data obtained through correspondence with IOCL, BPCL, HPCL and Mahanagar Gas

Residential sector

LPG, Kerosene and Piped Natural Gas (PNG) are the main fuels used in the residential sector. Together they aggregated for a sale of 39.70 thousand metric tons in the year 2011-12. PNG was introduced in Navi Mumbai in the year 2010 and hence its sales are reflected significantly only in the year 2011-12. However, being economical and cheap, its demand has increased dramatically in the residential sector and has already registered a growth of more than 4 times in two years.

In case of LPG sales, there has been a growth of almost 18%, from 27 thousand MT in 2007-08 to 32.03 thousand MT in the year 2011-12. Kerosene is supplied in Navi Mumbai through the Public Distribution System and it is used predominantly by urban poor. Vashi and Thane office under the Thane division are responsible for supplying kerosene to the Authorized Rationing Shops from Belapur to Digha. Almost 68.14 thousand MT of kerosene was distributed in Navi Mumbai in the year 2011-12. The total sale of fuel in residential sector has increased by 21% between 2007-08 and 2011 (Figure No. 28).

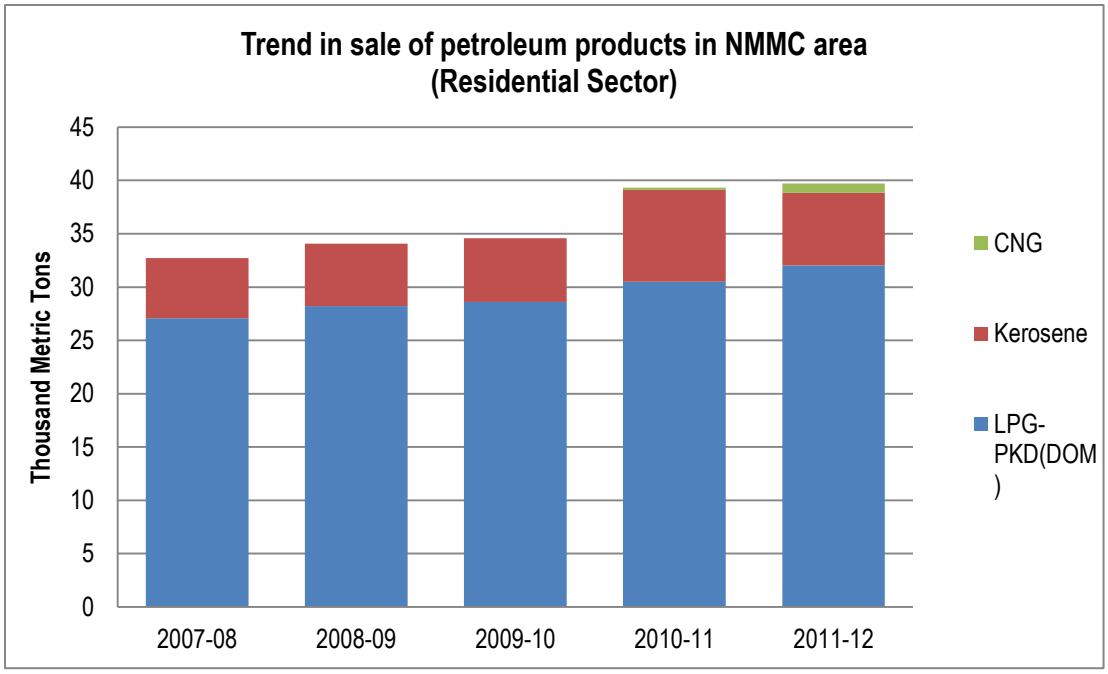


Figure No. 28: Trend in sale of petroleum products in Navi Mumbai (Residential sector)[18]

Source: HPCL, BPCL, IOCL and Mahanagar Gas

Note: LPG includes supply of LPG to agencies of respective oil companies within Navi Mumbai

Impact

As seen in Figure No. 29 number of airborne disease detected and deaths have reduced in the last year by 74% and 73% respectively. Along with preventive measures, NMMC is also planning to have awareness programs for the public regarding air pollution.

[18] As per data obtained through correspondence with IOCL, BPCL, HPCL and Mahanagar Gas

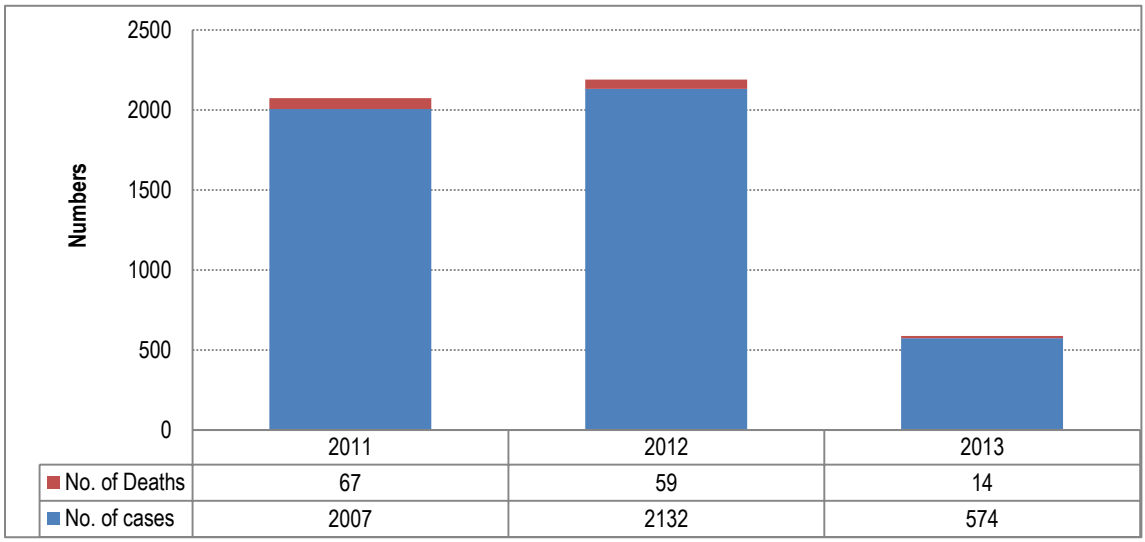


Figure No. 29: Total number of cases of airborne disease and deaths reported in the past three years

Source: Health Department, NMMC

Response

NMMC has taken various measures to tackle the issue of air pollution in the region and to restrain and contain levels of key pollutants below the permissible limits. These initiatives have resulted in constant improvement of the air quality of Navi Mumbai.

Some of the chief reasons behind these improvements in air quality as well as steps taken by the corporation have been highlighted below:

- Within the Navi Mumbai municipal limits completion of activities related to stone quarrying has resulted in decline of dust pollution
- Replacement of chemical industries by engineering and IT companies has also resulted in lesser air pollutants being emitted into the ambient atmosphere.
- Though the population of vehicles has increased but the traffic jamming and congestion has reduced to a large extent. Developing the smooth surfaced roads and concretization of major junctions has also resulted in smooth movement of traffic. Further timers have been installed at traffic signals to reduce the idling period and thus the emissions. NMMC has also completed renovation of underpass at Rabale, Ghansoli and Koparkhairne (Picture No. 4) and installed LED (Light Emitting Diode) lights at the Airoli-Diva skywalk (Picture No. 5).
- Greening/plantation along roadsides and on the dividers has also contributed in reduction in dust pollution.
- Sweeping machines are used to along Palm Beach road, Thane-Belapur and other major roads for vacuum suction of dust/fine particles, which has resulted in drop of air pollutants along these roads.

Picture No. 4: Artistic paintings along the underpass at Koparkhairne (left top) and Rabale

Picture No. 5: Illumination of LED lights installed at Airoli –Diva skywalk

Noise Pollution

NMMC monitors noise levels periodically across the city, which is listed in the Table No. 18 the readings were taken during day time.

As seen in Table No. 18 and Figure No. 30 one out of 7 places in residential zone, 2 out of 4 in commercial zones have exceeded day time permissible limit (55 dB). The average noise level ranged from 52.8-58.0 dB in residential zone, 54-56.5 dB in Commercial zone and 60.9-67.8 dB at traffic junctions.

Table No. 18: Noise pollution in Residential, Commercial and Traffic zone of Navi Mumbai

Zone	Sampling Location	Max	Avg	Min	*Day Time Standard*	*Night Time Standard*
		dB	*dB*	*dB*	*dB*	*dB*
Residential	Belapur SCADA Agroli Sec – 28	60.0	53.0	46.0	*55*	*45*
	Ghansoli Ward Off.	61.6	54.7	47.8	*55*	*45*
	Koparkhairne MCH Sec – 22	62.0	55.8	49.5	*55*	*45*
	Nerul GSR Sec – 22	59.0	52.8	46.5	*55*	*45*
	Vashi FRU Sec – 10	65.5	58.0	50.5	*55*	*45*
	Vashi Pump house sec - 6	62.5	54.9	47.3	*55*	*45*
	Airoli GSR Sec – 19	60.8	54.2	47.5	*55*	*45*
Commercial	Juinagar GSR Sec - 11	63.0	56.3	49.5	*65*	*55*
	Nerul ESR Sec - 21	62.3	55.3	48.3	*65*	*55*
	Sanpada GSR Sec - 4	61.5	54.0	46.5	*65*	*55*
	Turbhe MCH Sec -22	63.5	56.5	49.5	*65*	*55*
Traffic	Belapur fire brigade	69.5	62.8	56.0	-	-
	Digha Ward Off.	75.3	66.1	58.0	-	-
	Koparkhairne ward office	68.5	60.9	53.3	-	-
	Mahape Bridge	73.8	66.8	59.7	-	-
	Rabale Pump House	76.8	67.8	58.8	-	-
	Turbhe GSR Sec - 20	70.5	63.3	56.0	-	-
	Vashi ward office Juhugaon	70.5	62.3	54.0	-	-

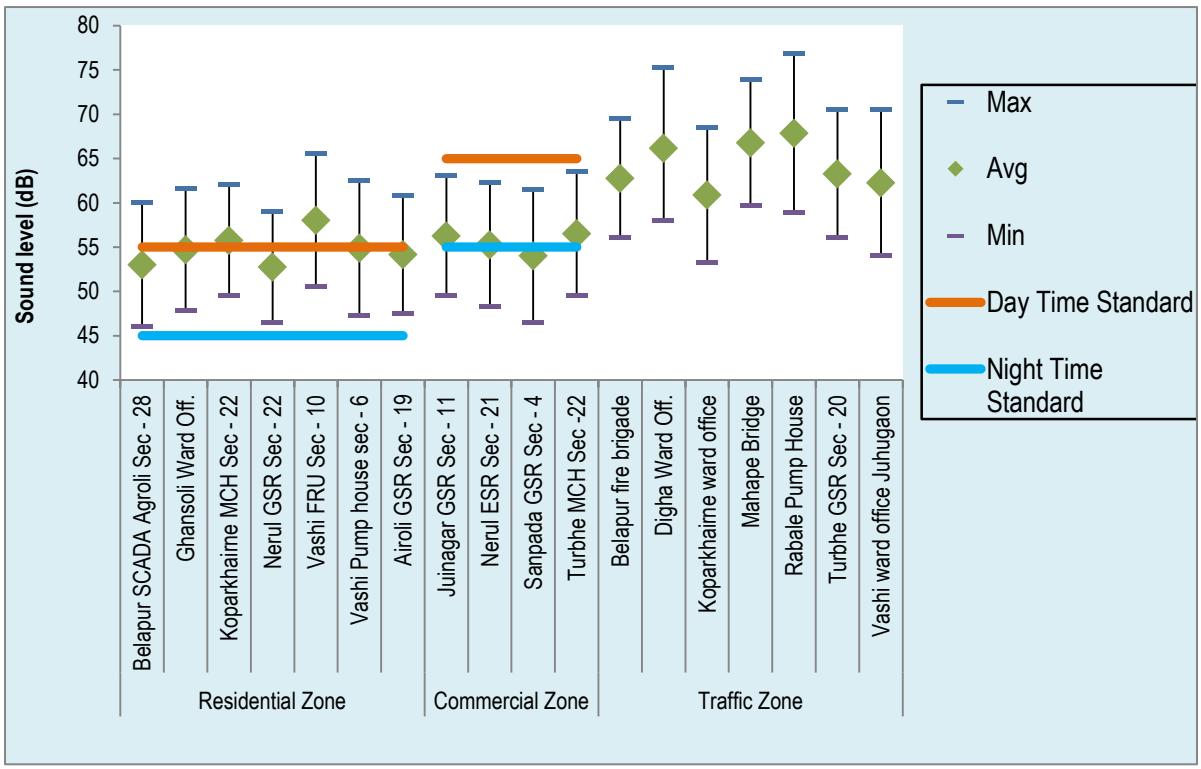


Figure No. 30: Level of noise pollution in Residential, Commercial and Traffic zone of Navi Mumbai

Source: Environmental Laboratory, NMMC

The Table No. 19 and Figure No. 31 represent the noise level recorded in silence zones of Navi Mumbai during 2013-14. The permissible limit for day time and night time is 50 and 40 dB respectively. The average noise levels were found to exceed permissible limits at all places. At Lakshadweep Hospital in Vashi the average recorded noise level was found to be highest (54.5 dB). Maximum daily recorded noise levels were highest at Lakshadweep Hospital in Vashi and Sushrusha Hospital in Nerul (61 dB).

Table No. 19: Noise pollution in Silence zones of Navi Mumbai

Date	Location	Max	Average	Min
		dB	dB	dB
19/3/2014	Awlong School, Vashi	57	51.0	45
03/01/14	D.A.V. School, Sector 20, C.B.D.	59	52.5	46
15/1/2014	Dyandeep School, Sector 2, Airoli	57	51.0	45
09/12/13	E.S.I.S. Hospital, Sector 5, Vashi	58	51.5	45
13/12/2013	Father Angel College, Sector 10A, Vashi	57	51.5	46
27/11/2013	Indira Gandhi College, Sector 16, Nerul	59	53.0	47
28/3/2014	Jhunjhunwala College, Sector 9A, Vashi	57	52.0	47
21/3/2014	Lakshadweep Hospital, Sector 9A, Vashi	61	54.5	48
26/12/2013	M.E.S. School, Sector 20, C.B.D.	58	51.0	44
28/2/2014	M.G.M. School, Sector 8, Nerul	59	52.5	46
25/2/2014	Manak Hospital, Sector 8, Nerul	57	52.0	47
24/3/2014	Mathadi Hospital, Sector 9, Vashi	59	52.5	46
27/3/2014	Modern College, Sector 16, Vashi	58	52.5	47
01/03/14	N.R.Bhagwat School, Nerul	57	52.5	48

Date	Location	Max	Average	Min
03/12/13	Navi Mumbai School, Sector 3, Vashi	57	50.5	44
26/3/2014	P.K.C. Hospital, Sector 14, Vashi	58	53.0	48
05/04/14	Shetkari School, Ghansoli	59	53.5	48
01/04/14	Shriram College, Sector 3, Airoli	58	51.0	44
29/3/2014	St. Lawrence School, Sector 9A, Vashi	59	53.0	47
18/3/2014	Sterling, Sector 7, Vashi	56	51.5	47
08/01/14	Sushrusha Hospital, Sector 6, Nerul	61	53.0	45
02/04/14	Terna College, Sector 20, Koparkhairne	58	52.5	47
26/2/2014	Terna School, Sector 10, Nerul	58	53.5	49
03/03/14	Vidya Bhavan School, Sector 18, Nerul	59	52.5	46
23/1/2014	Yashwantrao Chavan College, Sector 17, Koparkharane	60	53.5	45

Source: Environmental Laboratory, NMMC

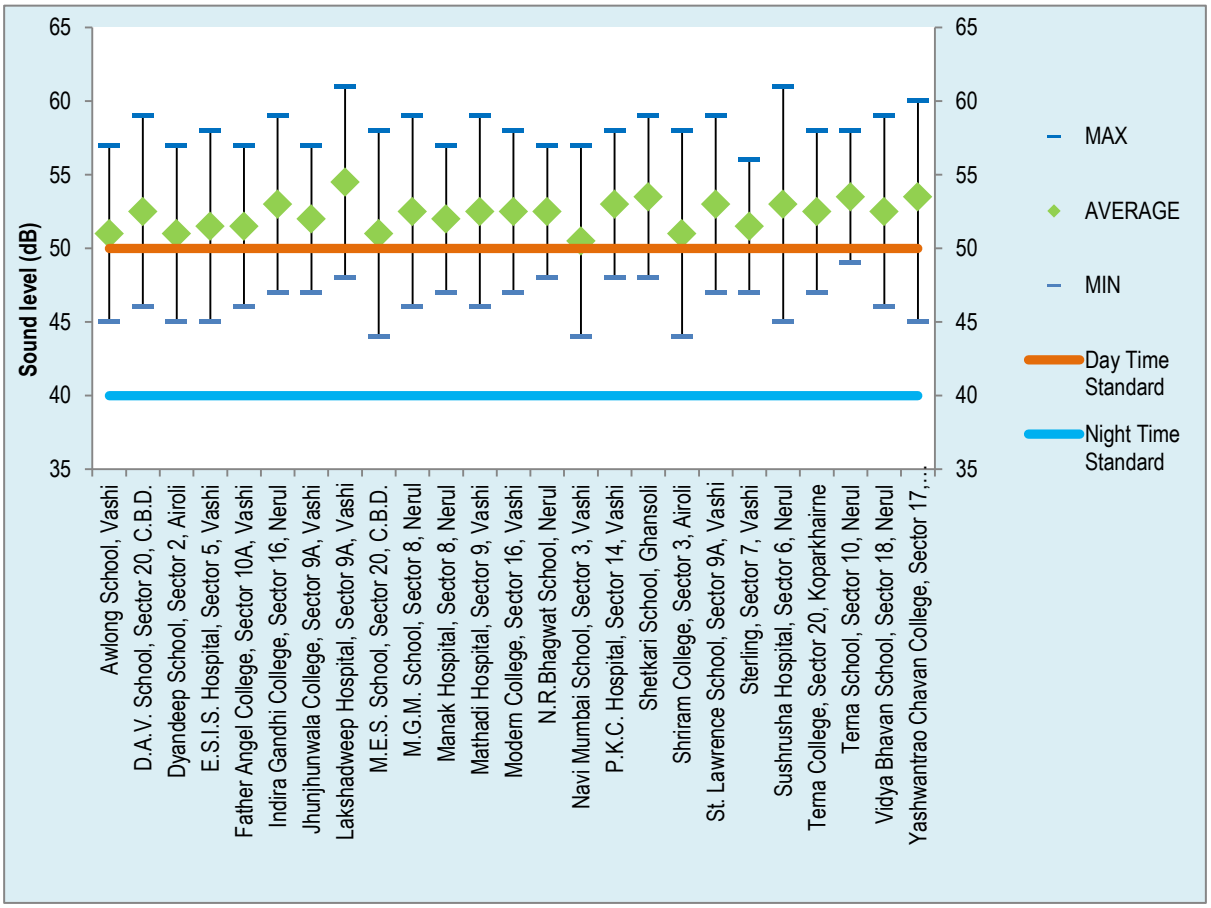


Figure No. 31: Level of noise pollution in Silence zone of Navi Mumbai

Source: Environmental Laboratory, NMMC

Water Resources

Although 70%–75% of the earth's surface is covered with water, less than 1% is fresh water available for human consumption. Humans depend on water resources for their day to day needs especially for use in agriculture, industry, households, and for recreational and environmental activities. A majority of human activities like drinking, cooking and sanitation require fresh water. Being the driver of life itself and so being central to most of its demands, it has, more often than not, been over-exploited to fuel economic growth and progress.

Status of Water Resources

The NMMC area has abundant water resources in terms of surface as well as ground water. The surface water resources including dam, lakes, holding ponds and creek front (22 km), while the ground water resource include wells and bore-wells. The population in NMMC is dependent on these resources not only for water supply and recreation, but also for the vital environmental and physical services they provide in terms of controlling the flood, regulating surface runoffs, regulating the urban heat island effect and so on. NMMC as a responsible corporation regularly monitors the water samples from various resources as well as at various check points across the water supply network. The following section presents the status of water resources (surface and ground) in terms of physical, quantitative and qualitative parameters and the pressures on the same.

Surface Water

Dam (Reservoir)

Morbe dam is a major resource for centralised water supply in NMMC area. The dam was constructed by MJP (Maharashtra Jeevan Pradhikaran), Government of Maharashtra for supplying water. The NMMC took possession of Morbe dam in November 2002, from MJP and over the next 9 years completed the balance work of the dam. The dam is the catchment area for the surface runoff from Matheran hill station. The main features of the Morbe dam have been tabulated in Table No. 20. The current physical surroundings of the dam are untouched and the dam has good tree cover along its periphery.

Table No. 20: Specification of Morbe dam

Specifications	Attributes
Name of the Dam	Morbe
Distance from city (NMMC Jurisdiction)	31 km
Type of dam	Gravity
Impounds	Dhavari river
Height	59.1 m (194 ft)
Length	3,420 m (11,220 ft)
Dam volume	18,075 km^3 (4,336 cu mi)
Total capacity	160.01 km^3 (38.39 cu mi)
Surface area	9,780 km^2 (3,780 sq mi)

Source: Central Water Commission[19]

[19] http://www.cwc.nic.in/main/downloads/National%20Register%20of%20Large%20Dams%202009.pdf

The raw water from the dam is pumped to the water treatment plant at Bhokarpada for treatment before supplying it to the city. NMMC has established an elaborate water quality checking and monitoring system at Morbe dam. Chlorine is added as a disinfectant at source as well as water treatment plant. The residual chlorine is maintained at the desired level (0.2mg/l) before supplying the same. NMMC monitors the water quality at the reservoir daily before supplying the water to the city. As seen in Table No. 21: Average water quality of the raw and treated water before supply the raw and treated water quality recorded for the water supplied by NMMC were at par with the BIS (Bureau of Indian Standards) specifications.

Table No. 21: Average water quality of the raw and treated water before supply

Sr. No	Parameters	Units	Raw Water (Bhokarpada)	Pure Water (W.T.P)	BIS Specifications[20] 10500:2012 Normal Values	
					Acceptable Limits	Permissible Limits
1	Physical Appearance		Clear	Clear		
2	Odour		No Smell	No Smell	Agreeable	Agreeable
3	Turbidity	N.T.U	0.26	0.22	1	5
4	pH Value		8.2	7.7	6.5 to 8.5	No relaxation
5	Chlorides (as Cl)	mg/l	12	14	250	1000
6	Nitrates (as NO_3)	mg/l	0.097	0.08	45	No relaxation
7	Total Hardness ($CaCO_3$)	mg/l	50	36	200	600
8	Alkalinity ($CaCO_3$)	mg/l	32	36	200	600
9	Total Dissolved Solids	mg/l	61.9	64.1	500	2000
10	Iron (as Fe)	mg/l	0.028	0.033	0.3	No relaxation
11	Fluoride (as F)	mg/l	0.001	0.002	1	1.5
12	Calcium (as Ca)	mg/l	8.01	7.21	75	200
13	Magnesium (as Mg)	mg/l	7.29	4.37	30	100
14	Sulphate (as SO_4)	mg/l	2.46	2.06	200	400
15	Residual Chlorine	mg/l	Nil	Nil	0.2	1

Source: District Public Health Laboratory, Kokan Bhavan, Belapur, Navi Mumbai

[20] http://bis.org.in/sf/fad/FAD25(2047)C.pdf

Lakes and Ponds

There are in all 24 lakes in NMMC area with cumulative area of around 2.23 Lakh sq.m (0.22 sq.km). The Belapur and Ghansoli nodes have the maximum number of lakes, 5 and 4 respectively and they account for the maximum share of lake area in the NMMC area, about 28 and 25% respectively. The Gothivali lake in Ghansoli node is the biggest lake in NMMC spread across an area of 32,635 sq.m.

Node wise details and coverage of the lake has been enlisted in Table No. 22. As seen in the table majority of the lakes in NMMC have either a concrete wall or a Gabion wall (stone wall) along its periphery and majority of the lakes lack a riparian zone, vegetated areas along the boundary of water bodies, and are surrounded by residential areas. Many of these lakes are been accessed for washing of clothes and religious activities.

Table No. 22: Node wise details of lakes and their coverage in NMMC area

Node	Name of Lake	Riparian zone	Surrounding area	Area of lake (Sq m)
Airoli	Airoli Naka	Concrete wall	Residential	3,988
	Diva	Gabion wall	Residential	2,042
Belapur	Agroli	Gabion wall	Trees and Garden	12,693
	Belapur	Concrete wall	Residential and a temple	17,905
	Darave	Gabion wall	Residential	5,724
	Karave	Concrete wall	Residential	23,506
	Killegaonthan	Gabion wall	Residential	2,650
Digha	Borol			1,500
	Khokad	Gabion wall	Residential and Highway	17,842
Ghansoli	Gothivali	Gabion wall	Residential and Informal hutments	32,635
	Gumali	Concrete wall	Residential	3,596
	Rabada	Gabion wall	Residential and Highway	7,823
	Talvali	Gabion wall	Residential	11,590
Koparkhairne	Khairne	Concrete wall	Residential	13,870
	Koparkhairne	Concrete wall	Residential	2,231
	Mahape	Concrete wall	MIDC area	1,338
	Savaligaon	-	Slums	6,060
Nerul	Nerul Sector 20	Gabion wall	Residential	9,894
	Shirvane	Gabion wall	Residential	13,686
Turbhe	Sanpada	Natural	Residential	2,500
	Turbhegaon	Gabion wall	Residential	8,482
Vashi	Juhugaon	Concrete wall	Dense residential area on all four sides	1,486
	Kopari	Gabion wall	Trees and Garden	10,000
	Vashigaon	Gabion wall	Residential	10,620
Total				**2,23,661**

Source: NMMC

NMMC monitors lake water quality for various parameters with a frequency of five times a year. Upon analysing the water quality monitored for the lake (Table No. 23 and Table No. 24) one may note that the annual average values for all the lakes in NMMC area are well within the standards.

Table No. 23: Annual average water quality of lakes in NMMC area (1 of 2)

Node	Name of Lake	pH	S.S (mg/l)	TDS (mg/l)	D.O (mg/l)	B.O.D (mg/l)	C.O.D (mg/l)
		5.5-9.0	<100	<2100	4.0-7.0	<100	<250
Airoli	Airoli Naka	7.4	42	522	3.3	6	43
	Diva	7.5	25	674	4.3	8	49
Belapur	Belapur	7.5	45	461	4.8	10	61
	Darave	7.5	20	763	4.3	9	58
	Karave	7.5	56	546	4.0	5	33
	Killegaonthan	7.7	11	533	7.5	6	36
	Agroli	7.4	41	746	4.6	5	35
Digha	Khokad	7.6	46	554	4.3	4	28
Ghansoli	Rabada	7.6	33	604	4.4	7	45
	Gumali	7.5	50	834	6	7	44
	Mahape	7.4	4	525	4	6	48
	Talvali	7.4	34	588	4.2	6	37
	Gothivali	7.5	27	364	4.4	4	34
Koparkhairne	Koparkhairne	7.3	16	480	6.2	5	28
	Khairne	7.5	40	534	3.4	7	42
Nerul	Shirvane	7.4	110	972	4.1	10	60
	Nerul Sector 20	7.5	55	778	4.4	6	36
Turbhe	Turbhegaon	7.6	21	825	5.1	9	60
	Sanpada	7.6	46	572	7.0	6	35
Vashi	Vashigaon	7.6	210	756	5.4	5	36
	Kopari	7.5	22	722	6.2	5	35
	Juhugaon	7.4	50	721	6.3	8	52

Source: Environmental Laboratory, NMMC

Table No. 24: Annual average water quality of lakes in NMMC area (2 of 2)

Node	Name of Lake	Nitrate (mg/l)	Nitrite (mg/l)	Phosphate (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Sulphate (mg/l)
		<45		<5	<1000	-	<1000
Airoli	Airoli Naka	1.467	0.302	0.358	76.72	370	53.81
	Diva	1.519	0.763	0.244	97.84	535	62.21
Belapur	Belapur	1.400	1.295	0.181	74.73	260	33.83
	Darave	1.992	0.920	0.088	55.87	478	90.95
	Karave	1.611	0.136	0.138	131.62	290	43.60
	Killegaonthan	1.526	0.025	0.230	39.43	246	27.17
	Agroli	1.788	0.057	0.188	52.95	507	73.34
Digha	Khokad	1.322	0.211	0.239	56.84	512	64.21
Ghansoli	Rabada	2.577	0.106	0.262	63.31	507	78.36
	Gumali	1.206	0.238	0.206	79.84	461	56.06
	Mahape	1.283	0.531	0.565	66.03	323.0	52.02
	Talvali	1.278	0.382	0.147	80.62	354	59.19
	Gothivali	0.866	0.268	0.251	50.38	337	41.32
Koparkhairne	Koparkhairne	0.669	0.031	0.163	78.01	375.125	22.22
	Khairne	0.935	0.063	0.227	121.32	349.1	15.95
Nerul	Shirvane	1.880	0.320	0.246	102.13	1177	106.97
	Nerul Sector 20	1.546	0.509	0.106	49.48	419	75.44
Turbhe	Turbhegaon	1.794	0.621	0.269	46.48	618	105.12
	Sanpada	1.288	0.391	0.084	58.44	384	58.11
Vashi	Vashigaon	1.485	0.092	0.103	79.24	1140	122.82
	Kopari	1.399	0.029	0.031	133.77	548	101.20
	Juhugaon	1.309	0.847	0.590	92.60	269.625	44.13

Source: Environmental Laboratory, NMMC

Creek water

NMMC monitors the creek water samples at 6 locations in NMMC area. The annual average values for the water quality tests indicate that the creek water has high BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) levels. The samples from Belapur and Sanpada creek violated the COD standards by more than 3 times. This has led to decrease in oxygen levels in the creek ecosystem and this is clearly reflected from the low DO (Dissolved Oxygen) levels in the water samples. This could lead to stress on the habitat and associated biotic factors.

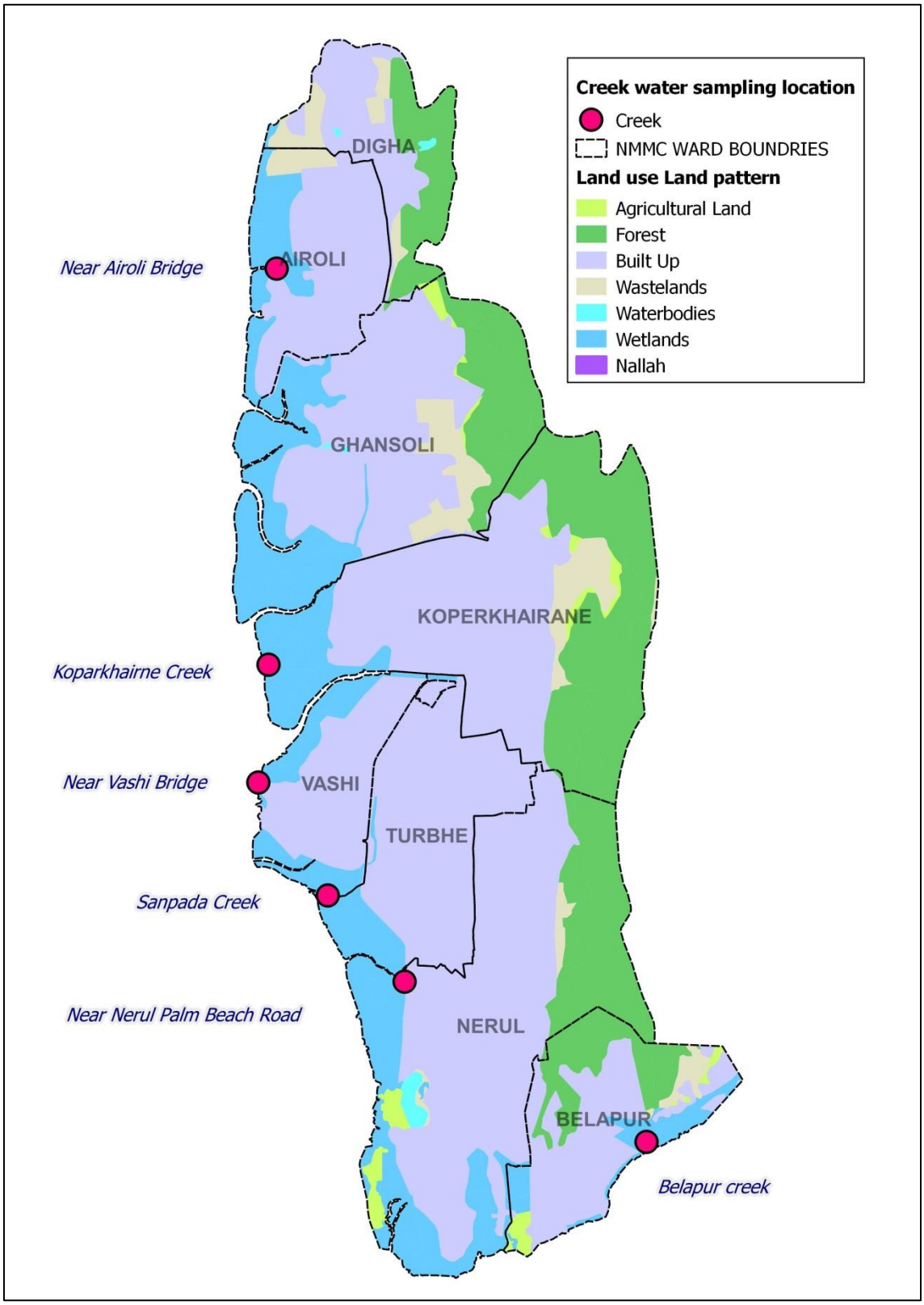
The creek water samples were recorded high Chloride pollution. All the samples exceed the standards (600 mg/l) by more than 20 times. It is the release of industrial pollutants that mainly leads to high chloride levels. Similarly, suspended solids were also high in the creek water samples and the violation across all the monitoring locations were more than 5 to 8 times the standards (100 mg/l).

Table No. 25: Annual average water quality of creek water samples in NMMC area

Name of Creek	Parameter								
	pH	S.S (mg/l)	D.O (mg/l)	B.O.D (mg/l)	C.O.D (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TKN (mg/l)	Chloride (mg/l)
	5.5-9.0	<100	4.0-7.0	<100	<250		<45	<5	<600
Belapur Creek	7.1	751	3.8	167.1	623.7	1.92	0.20	5.57	15546.47
Near Nerul Palm Beach Road	7.4	570	2.6	86.7	368.7	1.57	0.54	4.05	5261.84
Near Vashi Bridge (Sagar Vihar)	7.4	1092	4.5	140.4	537.7	2.62	0.25	4.97	15780.71
Sanpada Creek	7.1	872	3.7	180.9	683.4	2.76	0.15	6.76	13259.17
Koparkhairne Creek	7.4	874	5.2	114.6	418.5	3.07	0.60	5.94	13415.68
Near Airoli Bridge	7.2	831	4.6	124.8	494.3	2.53	0.38	4.94	12010.77

Source: Environmental Laboratory, NMMC

Map No. 3: Water Quality Monitoring Stations along creeks in NMMC area



Ground Water

There are about 132 wells in NMMC area. Given the fact that NMMC has a systematic decentralized water supply system, the dependence on ground water for day to day activities is almost negligible and well water is not used for drinking purpose. As a precautionary measure NMMC has already put up sign boards alerting the citizens to this effect.

However, NMMC undertakes periodic checks, cleaning and action to disinfect the wells to maintain their water quality. The analysis of samples from well water is regularly carried out for the parameters of pH, DO, BOD, residual chlorine, alkalinity, and fecal Coliform count (Table No. 26). In the year 2013-14 NMMC conducted water quality test for around 22 wells in NMMC area. All the parameters were detected to be within limits but the samples revealed presence of *E-coli* and fecal coliform in the well water samples necessitating frequent controlled chlorination.

Table No. 26: Well water quality recorded in NMMC area in 2013-14

Sr. No	Location	pH	Turbidity (NTU)	Residual Chlorine (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Chloride (mg/l)	Hardness (mg/l)	MPN Count/100 ml	*E.Coli*	F.Coli
1	Agroligaon, Sector 29	7.3	3.9	Nil	4.8	3	24	52.75	442	23	+ve	+ve
2	Shahabazgaon, Sector 19	7.3	1.7	Nil	4.0	3	16	59.34	281	23	+ve	+ve
3	Shiravane, Sector 1, Nerul	7.9	2.9	Nil	5.6	4	39	39.56	205	23	+ve	+ve
4	Sarsole, Sector 6, Nerul	7.2	10.8	Nil	4.0	11	86	65.94	180	23	+ve	+ve
5	Karavegaon, Near Lake, Nerul	7.2	3.5	Nil	2.4	7	67	92.31	175	23	+ve	+ve
6	Daravegaon, Sector 23, Nerul	7.2	1.7	Nil	5.8	4	35	46.16	175	23	+ve	+ve
7	Turbhegaon, Sector 21	7.3	0.9	Nil	4.0	6	31	685.74	646	23	+ve	+ve
8	Ganpatipada, Turbhe	7.3	3.5	Nil	5.2	6	43	336.28	570	23	+ve	+ve
9	Tin Taki, Sector 18,Koparkhairne	7.7	1.6	Nil	4.0	7	59	39.56	255	23	+ve	+ve
10	Infront of P.C.Patil's House, Sector 19, Koparkhairne	7.2	1.7	Nil	1.4	3	16	52.75	255	23	+ve	+ve

Sr. No	Location	pH	Turbidity (NTU)	Residual Chlorine (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Chloride (mg/l)	Hardness (mg/l)	MPN Count/100 ml	*E.Coli*	F.Coli
11	Near Keshav Uncle's House, Sector 19, Koparkhairne	7.3	2.2	Nil	2.6	2	16	46.16	264	23	+ve	+ve
12	Anant Patil, Chinchali, Ghansoli	7.2	1.9	Nil	3.6	5	27	98.91	502	23	+ve	+ve
13	Old Video Center. Talvalinaka, Ghansoli	7.3	4.3	Nil	3.4	2	12	125.28	459	23	+ve	+ve
14	Rabadagaon behind GSR/ESR, Rabada	7.3	3.2	Nil	4.4	4	24	72.53	255	23	+ve	+ve
15	Near Vitthal Mandir, Divagaon, Airoli	7.3	2.3	Nil	4.6	6	35	79.1	349	23	+ve	+ve
16	Vitbhatti, Airoligaon, Airoli	7.2	3.7	Nil	4.8	4	24	52.75	272	23	+ve	+ve
17	Near Hanuman Mandir, Chinchpada, Airoli	7.2	2.4	Nil	4.6	6	31	72.53	272	23	+ve	+ve
18	Ilathanpada, Digha	7.4	0.8	Nil	3.8	4	24	46.16	264	23	+ve	+ve
19	Subhashnagar, Digha	7.7	2.5	Nil	5.2	5	27	13.19	238	23	+ve	+ve
20	Sanjay Gandhi Nagar, Digha	7.6	3.7	Nil	0.4	6	43	65.94	274	23	+ve	+ve
21	Juhugaon, Sector 11, Vashi	7.7	3.0	Nil	3.0	6	39	92.31	167	23	+ve	+ve
22	Vashigaon, Sector 6, Vashi	7.5	2.9	Nil	0.4	11	67	79.12	425	23	+ve	+ve

Source: Environmental Laboratory, NMMC

Water Resource Management

Water Supply (Network)

As of 2013-14 the NMMC supplied around 435 MLD of water in NMMC area to more than 1,21,973 connections (Table No. 27), via its 870 km long distribution network facilitated by 114 service reservoirs and 132 booster pumps. The NMMC provides 24 hours water supply to almost 75percent while in the remaining 25% of the NMMC area water is supplied for about 4 to 8 hours.

The distribution losses account to around 19.02% of the total water supplied from Morbe dam, which translates to about loss of 82 million litres of water per day. Apart from the distribution losses in water supply NRW (Non-Revenue Water) accounts for almost 16 MLD, and around 337 MLD water is metered in NMMC area. Domestic sector accounts for a maximum share of consumption of water with almost 308 MLD (91%), of the water consumption in the city.

Table No. 27: Number and size of pipes for water supply connections in NMMC area

Type	Status	Connection Size								Total
		15	20	25	40	50	80	100	150	
Metered	Active	22935	1799	1892	1215	712	148	28	16	**28745**
	Disconnected Temporarily	18	2	5	1	1	0	0	0	**27**
	Sub Total (A)	**22953**	**1801**	**1897**	**1216**	**713**	**148**	**28**	**16**	**28772**
Metered Slab	Active	49086	0	0	17	0	0	0	0	**49103**
	Disconnected Temporarily	6	0	0	0	0	0	0	0	**6**
	Sub Total (B)	**49092**	**0**	**0**	**17**	**0**	**0**	**0**	**0**	**49109**
Gaothan	Active	13662	0	0	0	0	0	0	0	**13662**
	Disconnected Temporarily	54	0	0	0	0	0	0	0	**54**
	Sub Total (C)	**13716**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**13716**
Flat	Active	2861	0	0	0	0	0	0	0	**2861**
	Disconnected Temporarily	20	0	0	0	0	0	0	0	**20**
	Sub Total (D)	**2881**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2881**
Slum	Active	27216	0	0	0	0	0	0	0	**27216**
	Disconnected Temporarily	279	0	0	0	0	0	0	0	**279**
	Sub Total (E)	**27495**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**27495**
	Total (A)+(B)+(C)+(D)+(E)									**121973**

Source: Water Supply Department, NMMC

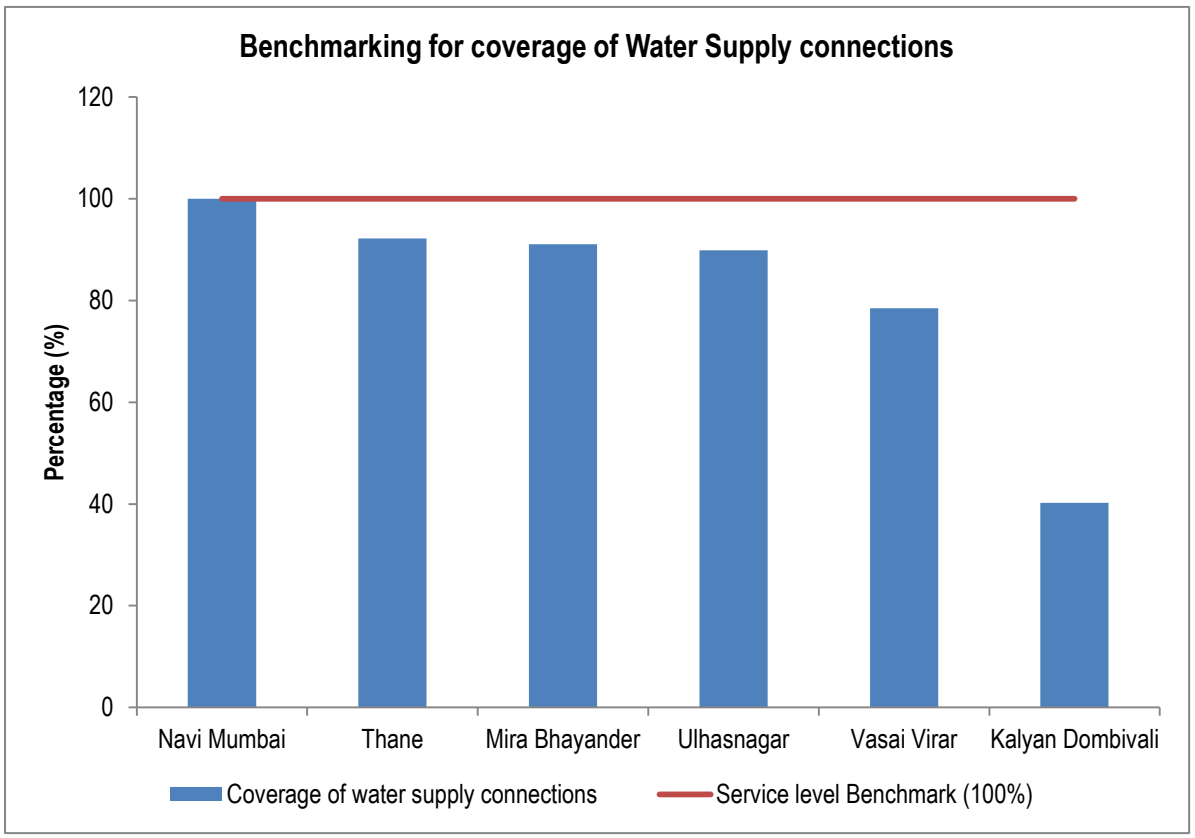


Figure No. 32: Benchmarking for coverage of Water Supply connections for major ULBs in MMR

Source: Performance Assessment System[21], AIILSG

It is important to note that the coverage of water supply in NMMC areas is 100% and meets the service level benchmarks set by Ministry of Urban Development, Government of India. Also as compared to other major ULB's in MMR NMMC is among the best performing ULB for water supply connections (Figure No. 32). The Municipal Corporations of Thane, Mira-Bhayander and Ulhasnagar have around 90% coverage while Vasai Virar and Kalyan Dombivali municipal corporations have around 70 and 40% coverage only.

[21] http://www.pas.org.in

Per capita water consumption

The per capita water supplied, expressed in LPCD (Litres Per Capita per Day), indicates the ability of the municipal water supply system in being able to source, treat water to potable standards and supply it into the distribution system. This indicator provides an insight of the adequacy of the water supply to meet the needs of the citizens in the city.

According to CPHEEO (Central Public Health and Environmental Engineering Organization), Ministry of Urban Development, Government of India[22], the maximum water supply is 135 LPCD including losses. As seen in Figure No. 33 the estimated per capita water supply in NMMC area is about 250 LPCD which is almost 1.85 times higher than the designated benchmark. It is interesting to note that NMMC supplies the highest LPCD water supply in NMMC area as against the major ULB's in MMR.

However the key limitation of this indicator is that it provides information on a city wide basis, and does not reveal intra city variations hence a ward wise data should be analysed to specifically identify the areas which may have more water supply so that even distribution of water supply could be attained across all nodes of NMMC area.

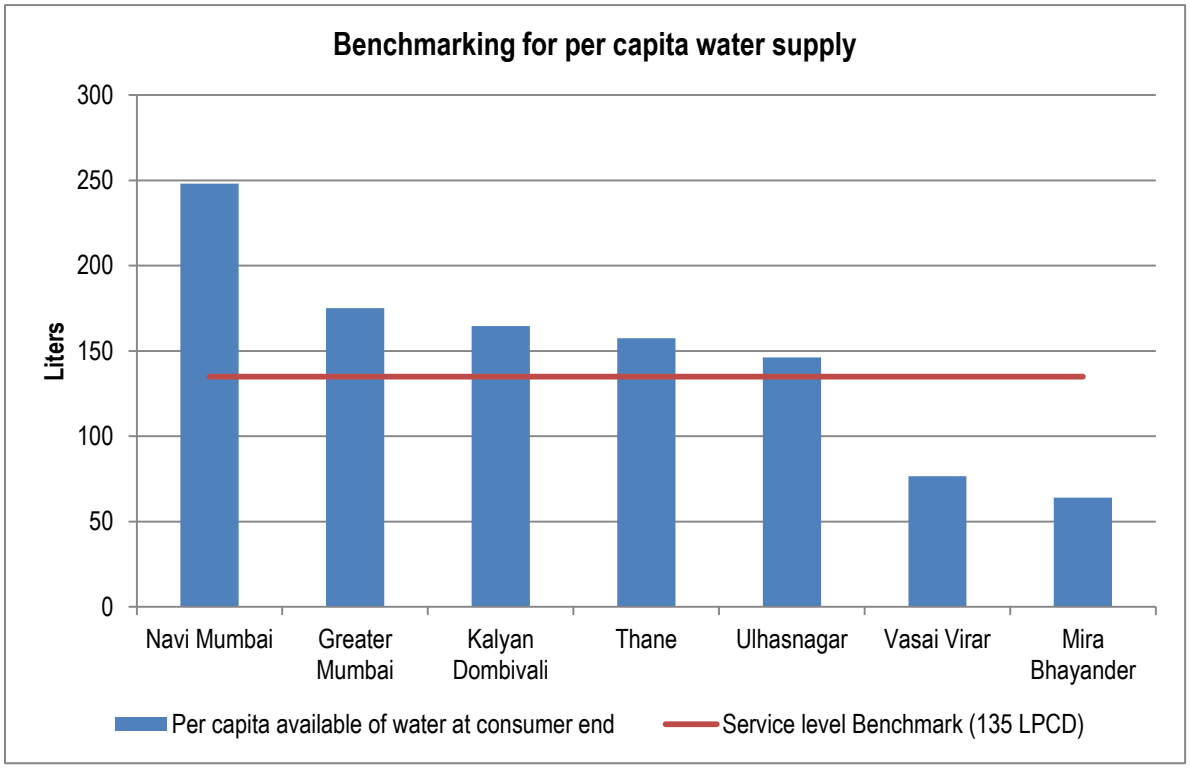


Figure No. 33: Benchmarking for coverage of Water Supply connections for major ULBs in MMR

Source: Performance Assessment System[23], AIILSG

[22] http://saiindia.gov.in/english/home/Public_Folder/Professional_Practices_Group/State_Local_Manual/PUDUCHERRY_MANUAL/Wad%20Manual/Water%20Supply.pdf

[23] http://www.pas.org.in

Drinking Water Quality at Tap End

Consumption of contaminated water may lead to severe diseases in individuals who consume the same. If the issue is left un-attended it may also lead to an epidemic. Although all necessary quality controls are taken by NMMC in order to supply potable water to citizens, as a precautionary measure, a log of the quality of water supplied by NMMC is maintained.

NMMC regularly collects drinking water samples at various critical points to analyse the water quality for its potability. In case of contamination, the source of contamination is traced and corrective measures are planned and implemented. During the year 2013-14, around 21,407 samples were analysed for potability and around 3.83% (806) samples were detected to be non-potable.

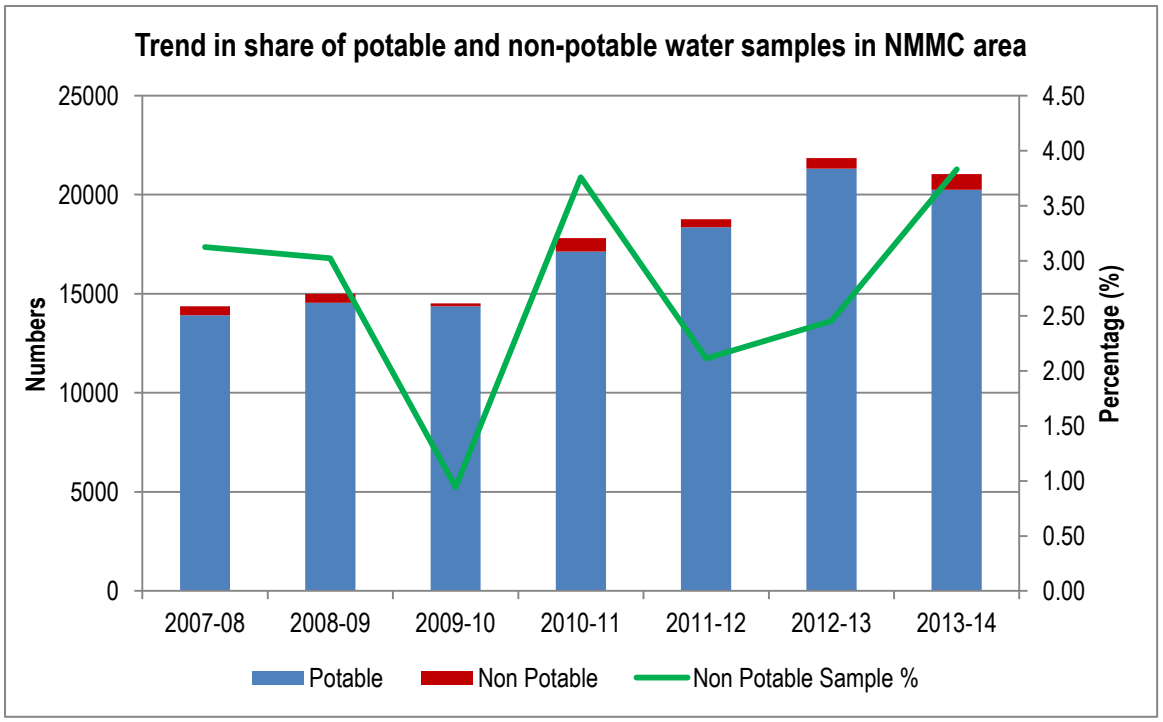


Figure No. 34: Trend in share of potable and non-potable water samples in NMMC area

Source: Environmental Laboratory, NMMC

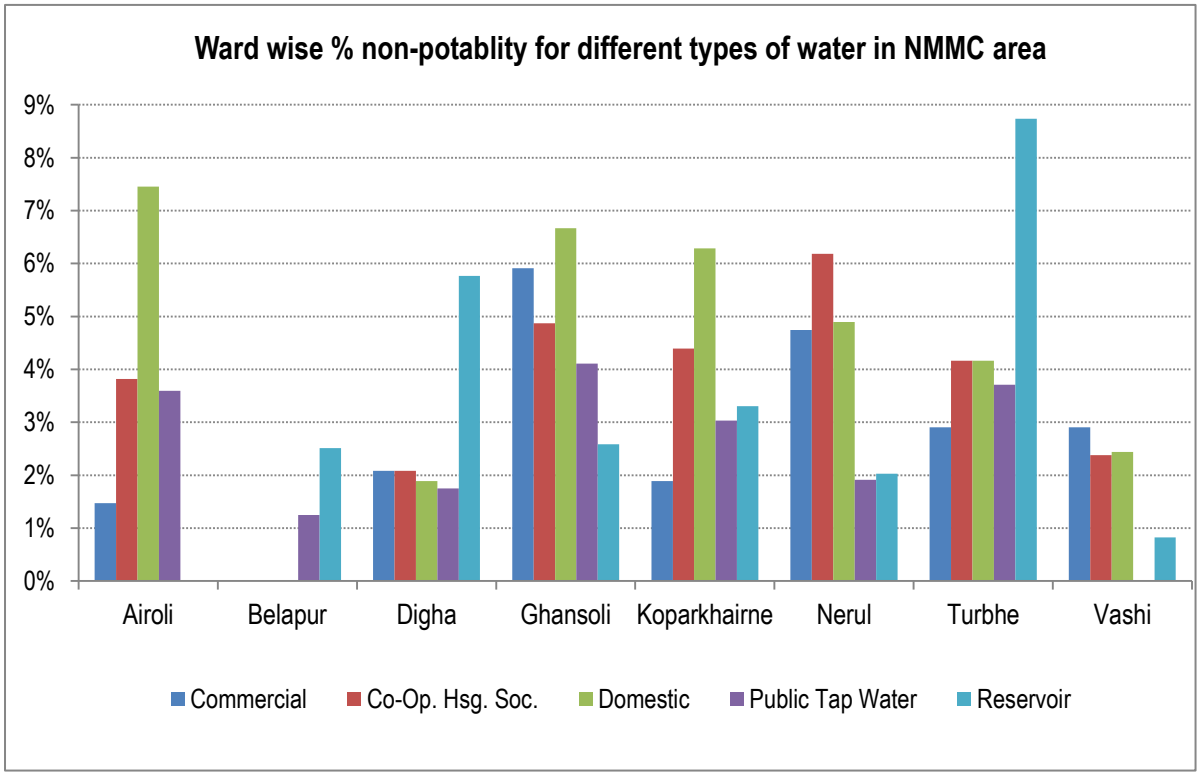


Figure No. 35: Ward wise % non-potablity for different types of water in NMMC area

Source: Environmental Laboratory, NMMC

Upon doing a ward wise analysis for percentage potability of water samples, Figure No. 35, one may note that the domestic water samples from Airoli, Ghansoli and Koparkhairne were non-potable for about 6-7%, while the domestic water at tap end in Belapur was always potable since all the samples analysed from Belapur ward were potable at all times.

The reservoir (ESR Elevated Storage Reservoir and GSR Ground Storage Reservoir) water quality at Turbhe and Digha are of concern as these wards registered the highest non-potability with about 9 and 6% respectively. Moreover since the reservoir water quality was detected to be non-potable the downstream supply points were also detected to be non-potable.

The distribution network of Nerul ward may need some investigation since the percentage non-potability at commercial consumers, housing societies, and domestic areas was more than the % non-potability at the reservoir.

Vashi and Belapur were detected with the least non-potable samples in the year 2013-14.

Sewerage Network and Public toilets

A well planned underground sewage network exists in the NMMC area, which has about 2,25,760 connections and the sewer lines cater to a population of about 9,19,477. This indicates that 100% of the organised housing is connected with sewer lines in the NMMC area. The network of sewerage lines in NMMC area are presented in Table No. 28 and Table No. 29. There are total 408 community and public toilets in the city having total 4895 seats. Out of these seats around equal distribution has been set for men and women and dedicated seats have been reserved for physically challenged people.

Table No. 28: Node wise length of sewers in NMMC area

Sr No.	Ward	Length of Sewers (km)
1	Belapur	72.57
2	Nerul	66.47
3	Vashi	75.83
4	Turbhe	77.36
5	Koperkharine	62.00
6	Ghansoli	42.00
7	Airoli & Digha	51.26
	Total	**447.51***

**Round off to two decimals*

Source: Public Health Engineering Department, NMMC

Table No. 29: Zone wise details of public toilets in NMMC area

Sr.No.	Ward Name	Total Toilets	
		Total Toilets	Total Seats
1	Belapur	57	690
2	Nerul	47	521
3	Vashi	34	435
4	Turbhe	47	563
5	Koperkharine	46	562
6	Ghansoli	72	893
7	Airoli	56	602
8	Digha	49	629
	Total	**408**	**4895**

Source: Public Health Engineering Department, NMMC

Sewage Treatment Facilities

The raw sewage generated in developed nodes of NMMC is 180 MLD. There are 7 sewage treatment plants in NMMC area and one aerated lagoon in Nerul. All the STP's are based on the Cyclic Activated Sludge Treatment (C-TECH), an advanced Sequencing Batch Reactor (SBR) process. It provides highest treatment efficiency possible in a single step biological process. The system operates in a batch reactor mode and thus eliminates all the inefficiencies of the continuous processes and ensures 100% treatment. The complete process takes place in a single reactor, within which all biological treatment steps take place sequentially.

A brief detail of the STP's in Navi Mumbai under NMMC is provided in Table No. 30. Being a planned city, the STP's of Navi Mumbai have been designed to cater to a larger set of population. However at present the STP's have a load less than the designed capacity and taken together for all the STP's the present load adds up to 180 MLD.

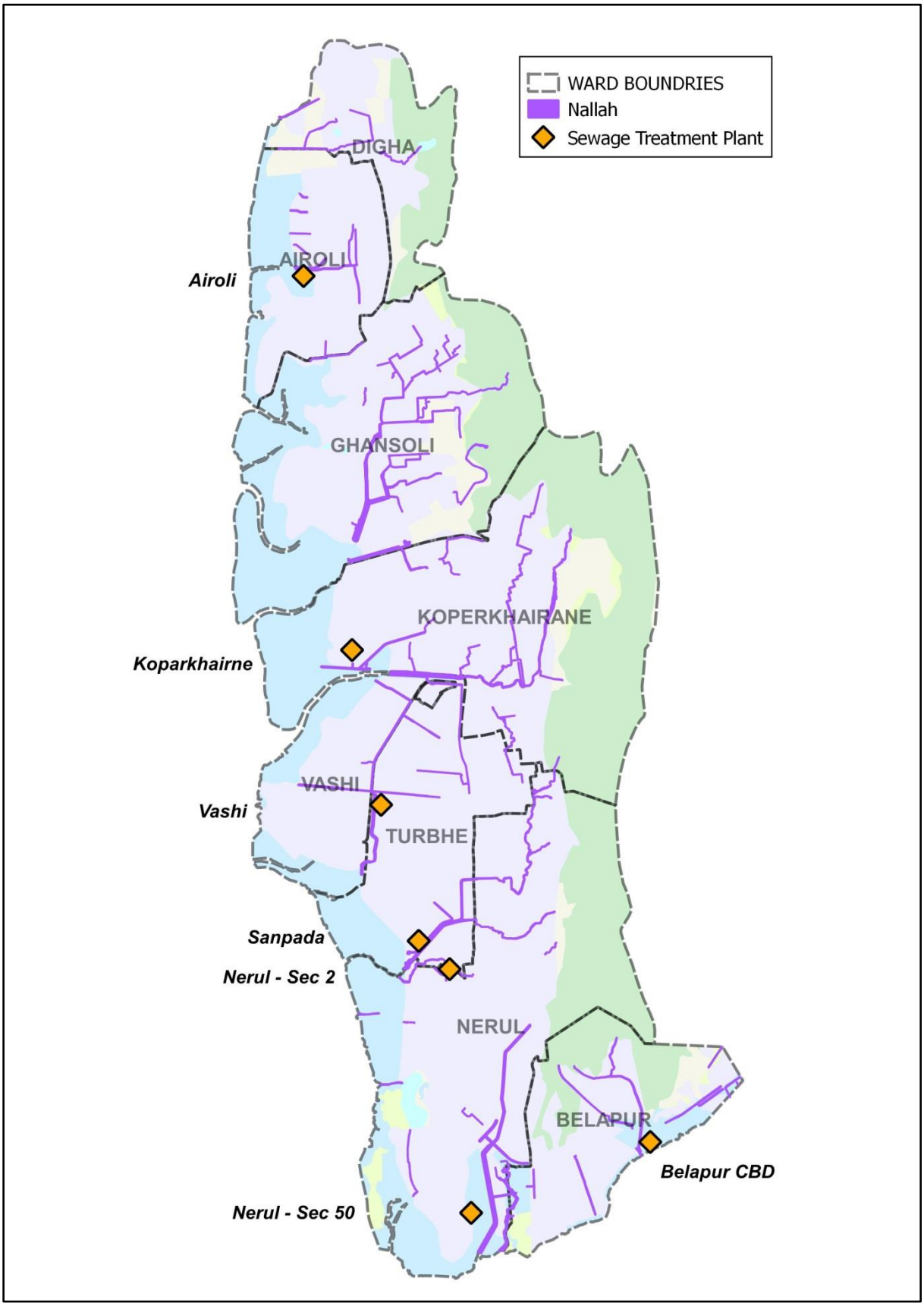
NMMC has purchased special suction units to clean the sewage from public toilets. There are around 10 suction units having capacities of 2000 liters (7 Nos) and 6000 liters (3 Nos). They are responsible to dispose of the sewage to the treatment plants. The balance sewage generated from the *Gaothans* & slums is being let out without treatment.

Table No. 30: List of functional Sewage Treatment Plants in NMMC area 2013-14

Sr. No.	Node & Sector	Design Capacity, (MLD)	Treatment Scheme
1	CBD Belapur - 12	19	Cyclic Activated Sludge Process (SBR Tech)
2	Nerul - 50	100	
3	Sanpada - 21	37.5	
4	Vashi - 18	100	
5	Koparkhairne - 14	87.5	
6	Airoli - 18	80	
7	Nerul - 2	17	Aerated Lagoon

Source: Public Health Engineering Department, NMMC

Map No. 4: Location of STP's in NMMC area



Performance of Sewage Treatment plant

NMMC regularly monitors the water quality from the STP's and keeps a vigilant watch before the water is released into the creek. It also helps to assess the efficiency of treatment plants. One may observe from the annual average performance of the sewerage treatment plants presented in Table No. 31, that the efficiency of the STP's has been at par since the water quality of the effluents has not violated the standards[24] for pH (5.5 – 9), BOD (100 mg/l) and SS (100 mg/l), while it has also enhanced the minimum desirable DO levels (4mg/l).

Table No. 31: Average performance and efficiency of STP's in NMMC area

Treatment Plant	PH		DO (mg/l)		BOD (mg/l)		COD (mg/l)		SS (mg/l)	
	In	Ef	In	Ef	In	Ef	In	Ef	In	Ef
Belapur-CBD	7.1	7	0.9	5.4	100	4.2	210	20	110	5
Nerul	7.2	7.1	0.7	5.6	150	4	280	40	140	7
Sanpada	7	6.9	0.8	5.5	165	3.8	280	46	180	8
Vashi	6.9	7	0.75	4.8	180	4.4	330	35	170	6
Khoparkhairne	6.8	6.95	0.8	4.7	170	4.1	300	42	190	7
Airoli	6.95	7.2	0.7	4.5	190	4.5	280	44	160	8

Note: In: Influent; Ef: Effluent

Source: PHE Department, NMMC

Picture No. 6: Sewage Treatment facility at Sanpada

[24] http://www.cpcb.nic.in/Industry-Specific-Standards/Effluent/446-1.pdf

Storm water Management

Being a planned city, the NMMC area has a well-planned and structured storm water management system. The storm water drainage network in NMMC city is about 550 km in length (Table No. 34). The road-to-drain ratio in NMMC area is about 84% and covers almost the entire city except for the MIDC area where the ratio is about 50%. The main features of the storm water drains are the substantially designed *Nallahs* and the unique holding ponds of the city which prevent flooding of water in the city. No flooding or water logging has been recorded in NMMC area thus validating the robustness of the storm water management design in the city. NMMC regularly monitors the water quality in the *Nallahs* as well as the holding ponds. The water quality recorded in the year 2013-14 has been presented in the following section.

Nallahs

There are around 10 major *Nallahs* with a combined length of 74 Km which help discharge the storm water and surface run off during the monsoon season in the creek. These *Nallahs* originate in MIDC area and carry industrial effluent from industries in MIDC. Many of the *Nallahs* carry untreated sewage from slums in MIDC and in the dry season (non-monsoon months) they carry mixed wastewater. The list of open *Nallahs* in NMMC area is presented in Table No. 32.

Table No. 32: Details of open Nallahs in NMMC area

Sr. No	Nallah	Node	From	To	Length (meters)
1	Nalla No-1	Belapur	Sector-1	Sector-12	2418
			Artist Village Branch		726
			Sector-1a Nalla		430
	Nalla N0-2		CBD Railway St- Sector-15		1105
2	Nalla N0-3	Nerul	Sector-9	Palm Beach Marg	4273
			Sector-15a		2661
3	Nalla N0-4	Sanpada	MIDC	Sector-4	7233
			Railway Branch		1418
			Sector-4 Branch		1403
			Herdilia Branch		1550
			MIDC Branch		1875
4	Nalla N0-5	Vashi	Sector-12	Vashi R/W Station	7310
5	Nalla N0-6	Koparkhairane	Khairane Nalla		7990
			Branch-1		3709
			Branch-2		739
			Branch-3		1678
			Branch-4		1470
6	Nalla No-7		Mahpe Nala		2036
7	Nalla No-8	Ghansoli	NOCIL Nalla		4690
			Branch-1		1360
			Branch-2		2937
			Branch-3		1615
			Branch-4		1620
8	Nalla No-9	Airoli	Bharat Bijlee Nalla		1891
			MSEB Nalla		1911
			Branch-1		732
			Branch-2		670
9	Nalla No-10	Digha	Ilthanpada Nalla		3500
			Thane Boundry-Digha		3332
				Total	**74282**

Source: NMMC

NMMC monitors water quality of the 13 *Nallahs* with a frequency of four times in a year. Upon having the annual average (Table No. 33) for the same one may note that the COD levels and chloride levels are quite high in the water samples, which majorly is caused by release of industrial effluents. This impacts the oxygen levels in the water. Moreover since this water is released in the creek it may cause stress in the creek ecosystem.

Table No. 33: Annual average water quality of water samples collected from Nallahs

Nallah	Parameters								
	pH	D.O (mg/l)	B.O.D (mg/l)	C.O.D (mg/l)	S.S. (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Sulphide (mg/l)	Chloride (mg/l)
	5.5-9.0	>5	<350	<250	<600	<45	-	-	<1000
Belapur Sector 12	7.1	**2.4**	41	158	378	1.382	1.438	5.90	607.60
Belapur Sector 15	6.9	**3.8**	38	151	291	0.754	1.078	7.79	**3229.44**
Vashi Sector 28 Nallah	7.5	**2.9**	97	**398**	278	1.759	0.381	11.71	740.44
Turbhe Mafco Nallah	7.2	**4.9**	53	219	306	1.241	0.846	5.31	**1535.37**
Pavane MIDC Nallah	7.2	Nil	103	**410**	181	1.417	0.111	10.43	**1972.75**
Turbhe Sector 19	7.0	**0.7**	59	230	182	1.064	0.573	5.70	451.80
Turbhe Sector 24	7.3	**3.5**	45	176	198	1.130	0.779	4.10	**1857.36**
Juinagar Herdillia Nallah	7.1	**2.0**	62	**266**	280	1.020	0.146	10.30	375.24
Koparkhairne Sector 11	7.4	7.4	144	**570**	226	1.613	0.334	7.74	**4622.25**
Mahape Bridge Nallah	7.5	**1.9**	32	140	146	1.223	0.579	4.67	**2652.26**
Airoli Bharat Bijali Nallah	7.4	Nil	46	148	136	1.030	0.499	3.90	**2907.37**
NOCIL Nallah	7.2	**0.4**	61	232	155	1.675	0.366	7.04	**3055.20**
Nerul Palm Beach Road	7.3	5.7	97	**381**	370	1.084	1.574	10.11	**2711.63**

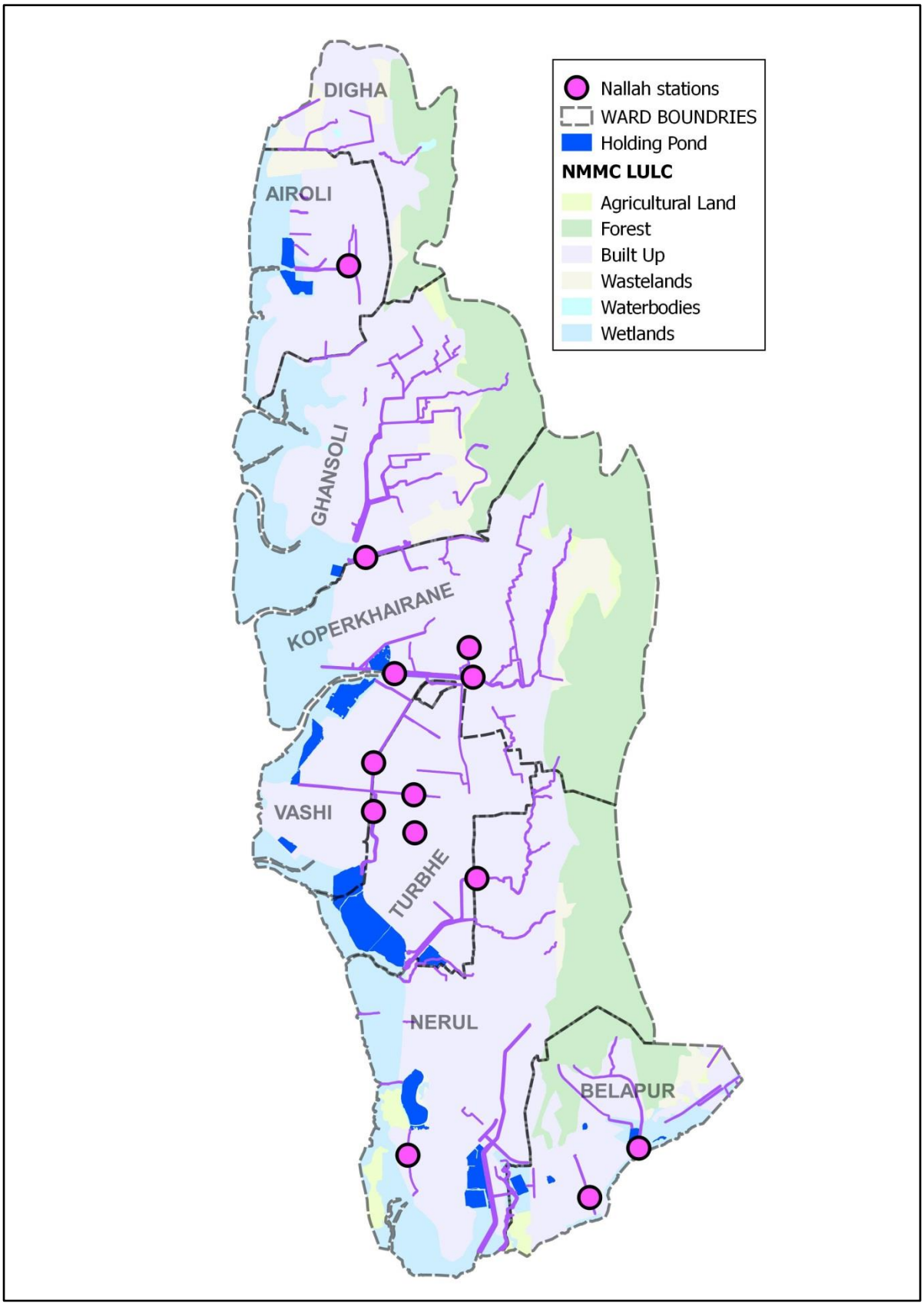
Source: Environmental Laboratory, NMMC

Table No. 34: Ward wise length of storm water drains in NMMC area

Sr.No	Ward Name	Ward Number	Storm Water Drain Length (Km)
1	Belapur	A	82.00
2	Nerul	B	111.00
3	Vashi	C	90.15
4	Turbhe	D	82.00
5	Kopharkhirane	E	79.00
6	Ghansoli	F	40.00
7	Airoli	G	65.85
8	Digha	H	0
9	MIDC		0
Total			**550**

Source: NMMC

Map No. 5: Water Quality Monitoring stations along Nallahs in NMMC area



Holding Ponds

Navi Mumbai is a reclaimed city and certain areas lie about one meter below the sea-level. Owing to the fact that the area has high precipitation levels, there is always a threat of water logging, especially during heavy rains and high tides. While developing the city, CIDCO adopted Dutch technology to reclaim land. This method involves construction of bunds (dykes) rising above Highest High Waterline along coast water line to block entry of tidewater in the area proposed to be reclaimed (Figure No. 36). These entities, more commonly known as the 'Dutch dykes', have been especially designed and installed with unidirectional flap gates along the bund wall. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff.

These ponds are sometimes used for recreational purposes and for seasonal fish breeding but these are not perennial. It is often found that people deliberately encroach the holding ponds and break open the flap gates allowing the inlet of sea water for fish breeding which is all done illegally. This activity gives rise to undesired entry of sea-water into the holding ponds.

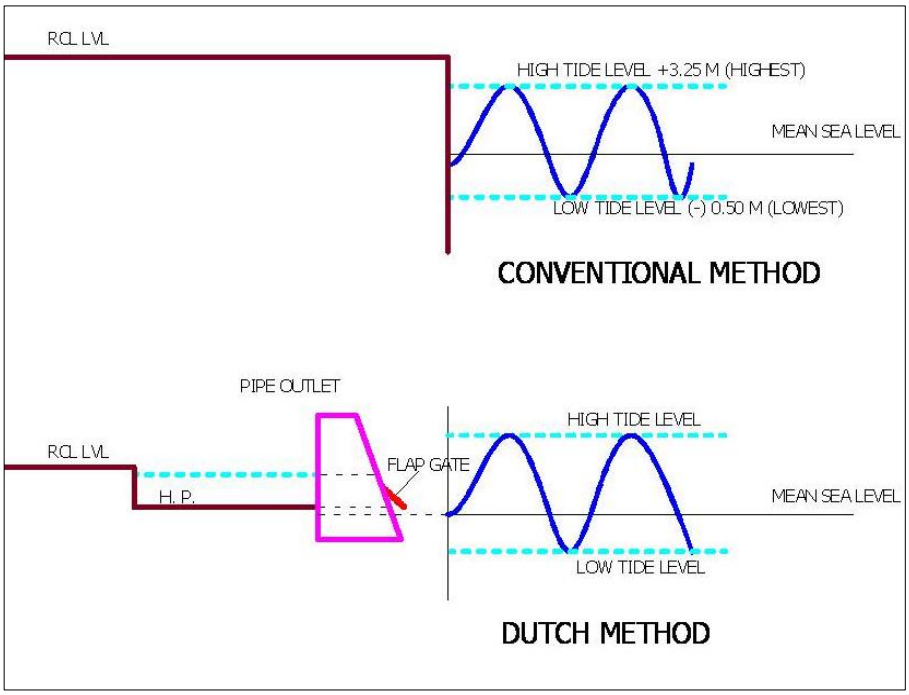


Figure No. 36: Schematic of the Dutch dyke used for land reclamation in Navi Mumbai

There are 11 Holding ponds in NMMC area across the nodes of Belapur, Vashi, Koparkhairne, Sanpada and Airoli (Table No. 35). NMMC regularly monitors water quality for all the holding ponds with a frequency of five times in a year. Similar to the water quality from the Nallahs the water quality of holding ponds violated the standards for suspended solids, COD, BOD and chloride consistently (Table No. 36). This could be attributed to the effluents released from the industries.

Table No. 35: Details of holding ponds in NMMC area

Sr. No.	Node	Location	Area in hectare
1	Belapur (CBD)	Sector 12	5.5
2	Belapur (CBD)	Sector 15A	13.85
3	Vashi	Sector 8A	2.3
4	Vashi	Vashi Gaon	1.93
5	Vashi	Sector 10A	15
6	Vashi	Sector 12	24
7	Koparkhairne	Sector 14	9
8	Airoli	Sector 18	16
9	Airoli	Sector 19	14
10	Vashi	Behind Rly. Station	77
11	Sanpada	Sector 30A	22
	Total		**200.58**

Source: NMMC

Table No. 36: Annual average quality of water samples collected from holding ponds

Holding Pond	Parameters									
	PH	S.S (mg/l)	D.O (mg/l)	B.O.D (mg/l)	C.O.D (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)
	5.5-9.0	<100	4.0-7.0	<100	<250	<1000	<45		<5	<1000
Belapur Sector 12	7.0	**491**	**3.4**	70	**310**	**7206.56**	1.964	1.345	0.215	142.41
Vashi Sector 8	7.3	**514**	**3.1**	**120**	**497**	**6912.98**	3.065	1.465	0.255	124.73
Vashi Sector 10	7.5	**896**	6.8	**144**	**613**	**10414.08**	2.181	2.206	0.318	149.06
Vashi Sector 11 & 12	7.3	**548**	**3.0**	**120**	**524**	**8262.96**	2.082	0.056	1.042	121.41
Vashi Sector 30	7.1	**625**	Nil	**122**	**485**	**7865.61**	2.513	0.690	0.966	132.10
Koparkhairne Sector 14	7.1	**406**	**3.1**	**121**	**538**	**5933.42**	1.812	0.157	1.088	82.39
Airoli Sector 18	7.1	**735**	**3.8**	60	**443**	**7598.62**	1.074	2.216	0.463	156.10
Airoli Sector 19	7.2	**754**	4.6	**184**	**761**	**12171.40**	1.196	1.579	0.312	159.85
Sanpada	7.3	**1036**	4.1	**145**	**664**	**8945.77**	2.808	1.473	0.171	130.06
Nerul – (Water Body)	7.5	**449**	6.4	**105**	**425**	**4181.74**	2.197	1.337	0.191	99.72

Source: Environmental Laboratory, NMMC

Pressure and Impacts

There are various growing pressures that exist on water as a resource, which need to be addressed. The pressures are increase in demand for water, water pollution owing to increasing industrial and residential waste and water losses due to theft and leakage. It is the duty of the municipal body of a city to ensure good quality water supply for its citizens. A brief coverage on the pressures on water resource in the city, are presented in this section.

Increase in demand for water supply

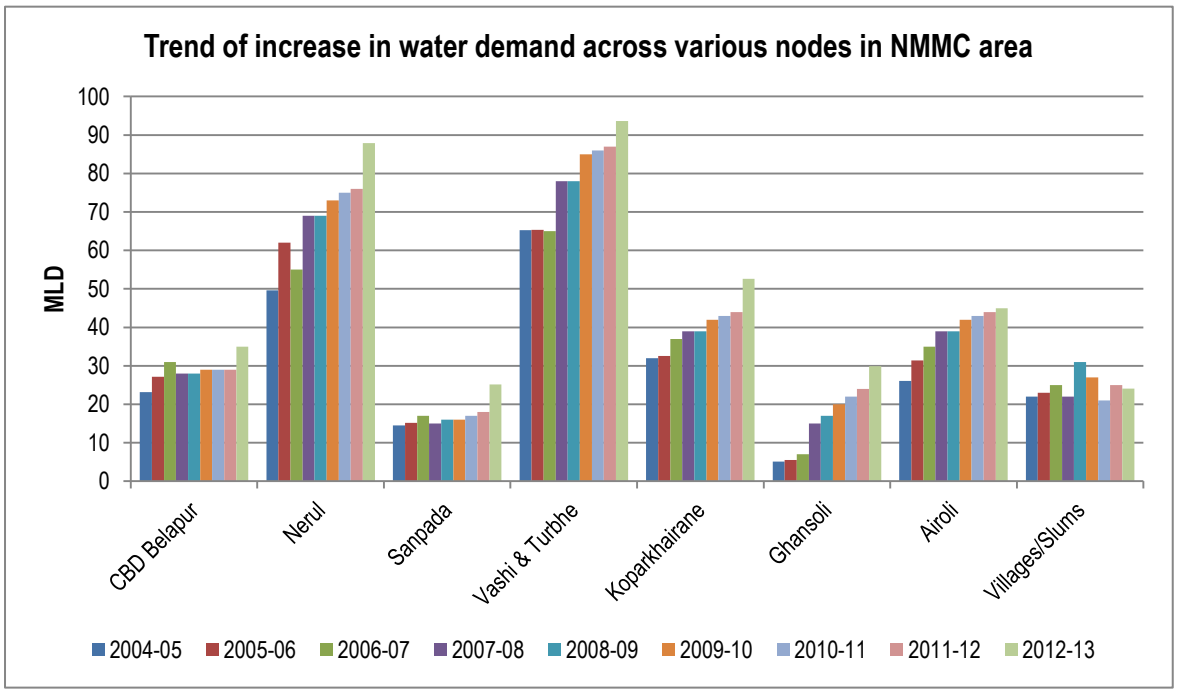


Figure No. 37: Trend of node wise increase in water requirements in NMMC area

Source: Water Supply Department, NMMC

Owing to increasing population and activities in the NMMC area there has been a steep increase in the demand for water. The demand for water has increased by almost 50%, from about 262 MLD to about 393 MLD in the past six years. Water requirement of NMMC jurisdiction is estimated to escalate and reach to about 500 MLD (Million Litres per Day) by the year 2042 (NMMC). As seen in Figure No. 37 the demand has increased across all the nodes of NMMC area.

Distribution losses and Leakages

The losses incurred due to distribution losses and leakages induce immense pressure on the water supply system. They not only cause losses in terms of absolute water requirements but also losses in terms of energy requirements at the pumping stations, booster pumps treatment consumables and so on. The daily average distribution losses have increased by two times in the last seven years. In the year 2006-07 the daily distribution losses accounted to about 36 MLD about 13% of the total water distributed in the city, while in the year 2013-14 the distribution losses and non-revenue water accounted to about 19% (82 MLD) of the daily water supplied to NMMC area (435 MLD) (Figure No. 38).

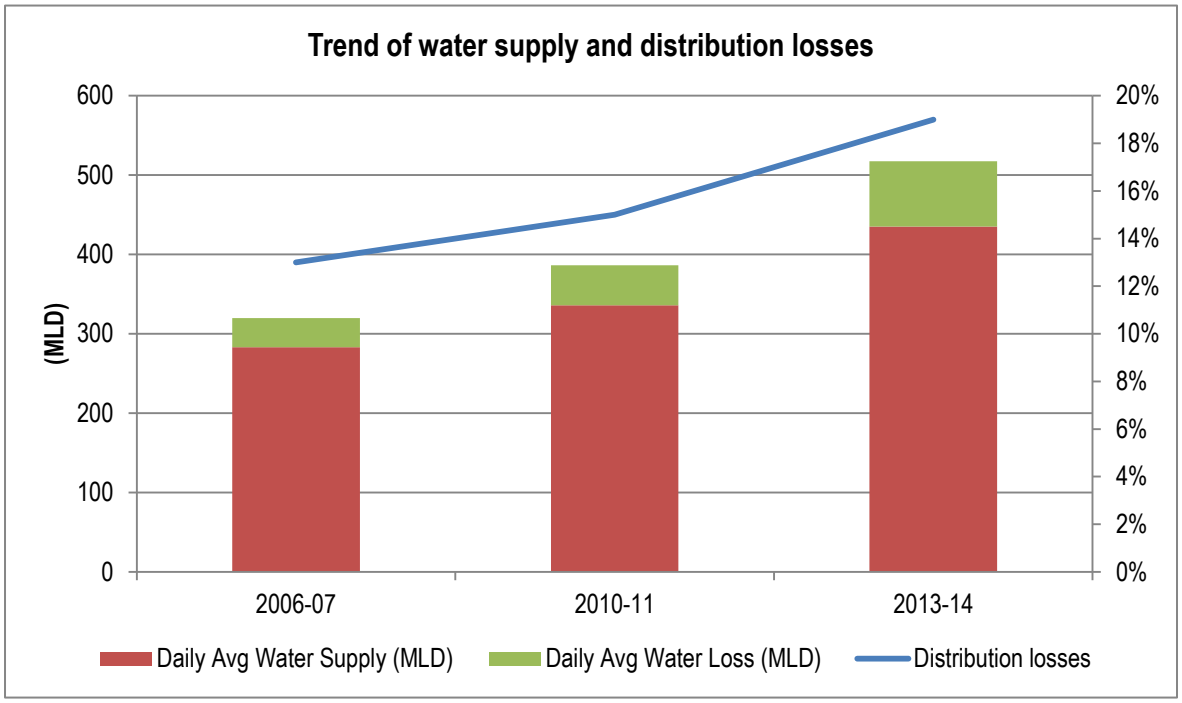


Figure No. 38: Annual Average water losses recorded in NMMC area in respective fiscal year

Source: Water Supply Department, NMMC

Response

- In the year 2013-14, around 290 major leaks were reported in the NMMC area and all were attended to and repaired by NMMC within 24 hours
- Around 976 complaints were received for water supply and all were addressed by the corporation within 24 hours
- NMMC conducts regular water audit for the water supply schemes.

Release of Sewage and industrial effluents

One of the major causes of concern for water pollution is release of domestic and industrial waste water into the water bodies. NMMC area being a coastal city, any release of polluted water into the creek water can lead to severe water pollution and may lead to stress on the aquatic eco-system. Since NMMC area is a developing city, the population increase is on the rise and as the water demand has increased manifold across the city, the release of waste water is also bound to increase. In the past six years, the average daily generation of domestic waste water has increased by almost 40 MLD. A trend for the increase in sewage generated in NMMC areas in presented in Figure No. 39.

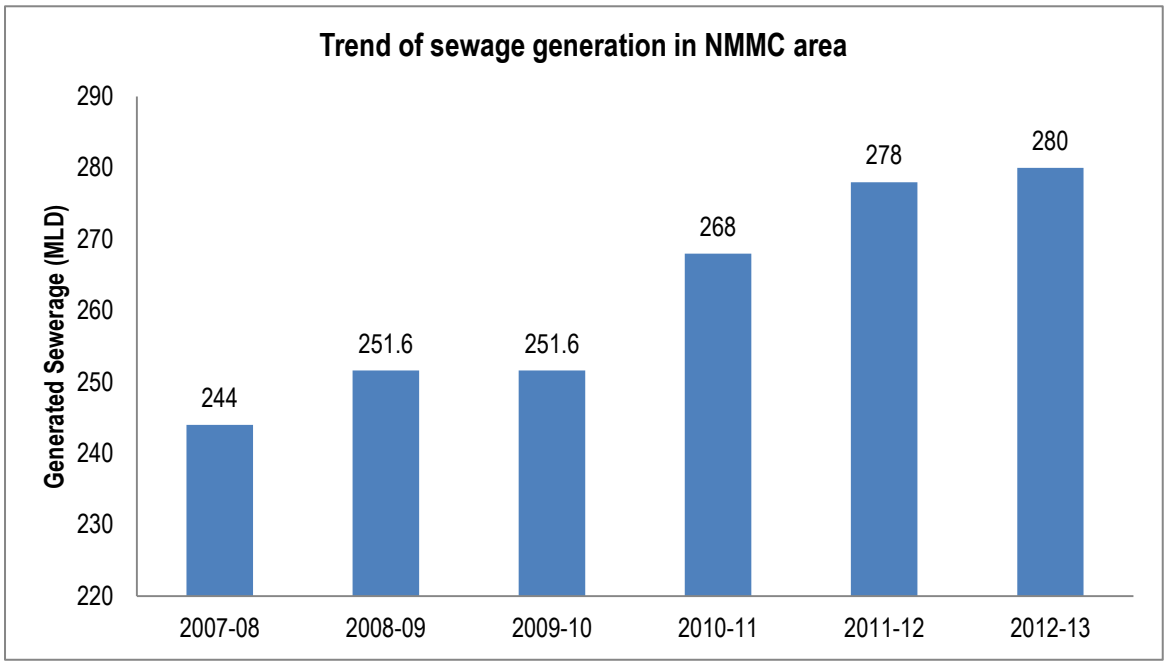


Figure No. 39: Trend of sewage generation in NMMC area

Source: Public Health Engineering Department, NMMC

Similarly release of waste water form industrial belts also induces water pollution and severely increases the COD (Chemical Oxygen Demand) levels of the water. In the year 2013-14 there were about 1297 polluting industries in the red (702) and orange (577) category in the TTC (Trans Thane Creek) industrial belt. Of the total polluting industries there are about 100 large scale red category industries.

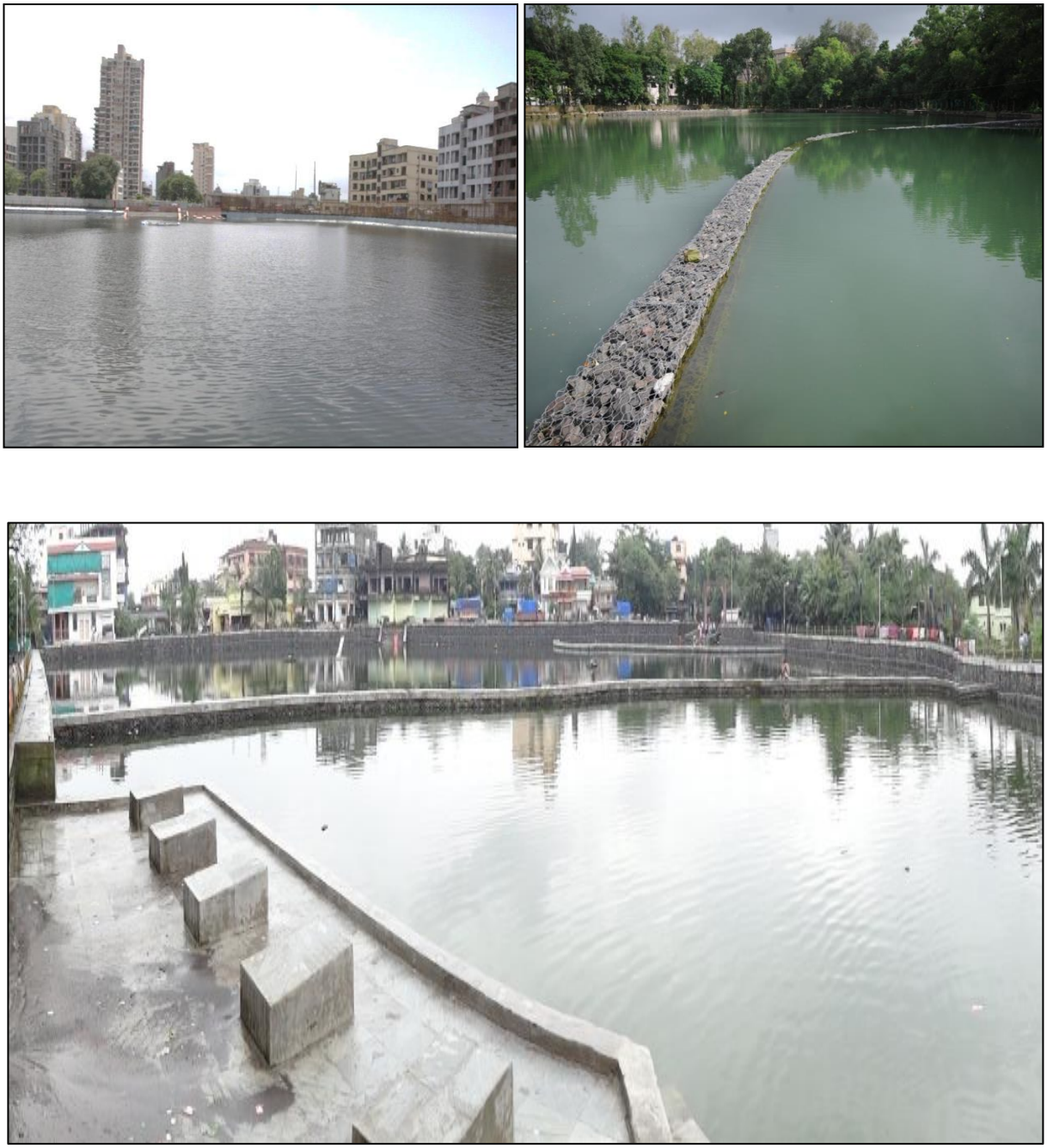
Illegal dumping of debris and other waste in water bodies

Irresponsible dumping of debris, solid waste, washing of clothes, bathing, and so on also leads to water pollution. In earlier times, religious offerings during festivals were directly released into small ponds and holding ponds. However realising the negative impacts of such types of pollution, NMMC has taken some initiatives which are elaborated in the section below.

Response

NMMC launched the lake vision project in 2009-10 and has taken the following initiatives as a response to tackle the pressure on the lakes of Navi Mumbai

- Periodic dewatering and desilting of lakes after appropriate investigation to revive the water quality and increase the water holding capacity
- Constructed Gabion retaining wall along periphery & partition wall for Idol Immersion tank
- Beautification of lake surroundings by ultra-modern infrastructure i.e. tensile structures, installing signages, erecting Jodhpur red stone entry gates, installing benches and so on.
- Decorative lights, flowerpots, cobal stone path way, stamp concrete for Ghat.
- Controlled entry of pollutants in the lake by providing RCC Nirmalyakund, Washing area & Idol immersion partition to the lake.
- Improved & Maintained water quality of lake by providing controlled aeration system and central fountain in the lakes.
- Washing areas have been designed such that the run off from the washing (soap lather and waste water) does not enter the water body and is released into the storm water drains.



Picture No. 7: Nerul lake Post completion of Lake Vision Project (Top Left), Gabion wall at Agroli lake (Top Right) and Uniquely designed cloth washing area along lake periphery at Digha

Silting of holding ponds

Since the holding ponds are transitory entities between the creek and the land, there is always movement of creek water in and out of the holding pond owing to the tidal currents. As Navi Mumbai is rich in mangrove coverage, the tidal currents have caused effective transportation of mangrove propagules in the holding ponds which have further increased the mangrove growth in the holding ponds.

Since these entities have been left untouched there has been deposition of silt in these ponds. This hinders the basic design of these unique entities which regulate the storm water flow during high tides and prevent the city from flooding and water logging. If the silt of these ponds is not removed it could lead to water logging in the city during monsoon season and may result in flooding and waterlogging in the city if it is coupled with high tide. The capacity of holding ponds in NMMC area has reduced due to silt deposition of about 0.5 to 1.5 m. The growth of mangroves has left mere 20% of the effective space for water holding.

Response

NMMC has filed a petition on 18th December 2005 to carry out repair work of holding ponds. In 2006 a hearing was given by high court and permission was given to only those regular works which have been carried every year before monsoon as routein. These include-

1. Flap gate repairing
2. Installation of new flap gates.
3. Pipe outlet repairing and small repair works.
4. Repairing of bunds and repairing of service roads used to take machinery if necessary.

In 2010, Hon'ble High court has given a decision that NMMC should apply for the requisite permissions of de-siltation to MCZMA before applying to High court. It is expected that after their approval High court may deliver its verdict.

Accordingly NMMC has applied to MCZMA of Govt. of Maharashtra on 30th August 2012 and it was passed on 4th March 2013 to develop action plan. After that on 5th August 2013 NMMC has submitted an application with detailed action plan proposing treated silt to be used for quarry slope refill. The quarry slopes are steep and addition of artificial soil needs to be carried out using specialized technologies otherwise it could lead to more soil erosion during monsoons. The hearing in this case is awaited from the Hon'ble High court.

NMMC further proposes to develop a nursery for mangroves and the propogules, using this silt. Given that the soil is very saline it shall not be suitable for cultivation of any other tree species since they would not be able to adapt to saline conditions. As there are very few nurseries, the saplings could be distributed across the city and also in other areas of MMR. It will not only save the cost for treating the large quantity of soil but also it could be a unique feature for the Corporation. The citizen groups may be informed about these nurseries so that the mangrove patches destroyed along the coast may be restored.

Picture No. 8: Growth of mangroves at holding pond in Vashi

Land Resource

Land Resources refer to a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity[25].

Since Navi Mumbai is a planned city, CIDCO (City and Industrial Development Corporation) has already put a lot of planning and thought into its development. Appropriate plans were formulated for industrial belt, residential zones and open spaces while designing the city. This section highlights the present status of land resource in NMMC area and also discusses the threats faced by them.

Status

As per the map generated by MRSAC (Maharashtra Remote Sensing Application Centre) the land use pattern of the city consists of Built up area, agricultural land, forests, wastelands, water bodies, roads, and so on (Map No. 6). NMMC jurisdiction is spread across 108.63 sq. km (Table No. 37). Majority of the area (56.16%) is built up area which accounts to about 61.01 sq. km. This comprises residential, commercial, industrial, administrative constructions and infrastructure such as crematoriums, water supply, sewage disposal, roads, and railways. Wetlands are an important feature of the city with 13.46 sq. km area under lakes, rivers wetlands, creeks, mudflats and manmade water bodies. At present, agricultural activity is limited to only about 1.4 sq. km.

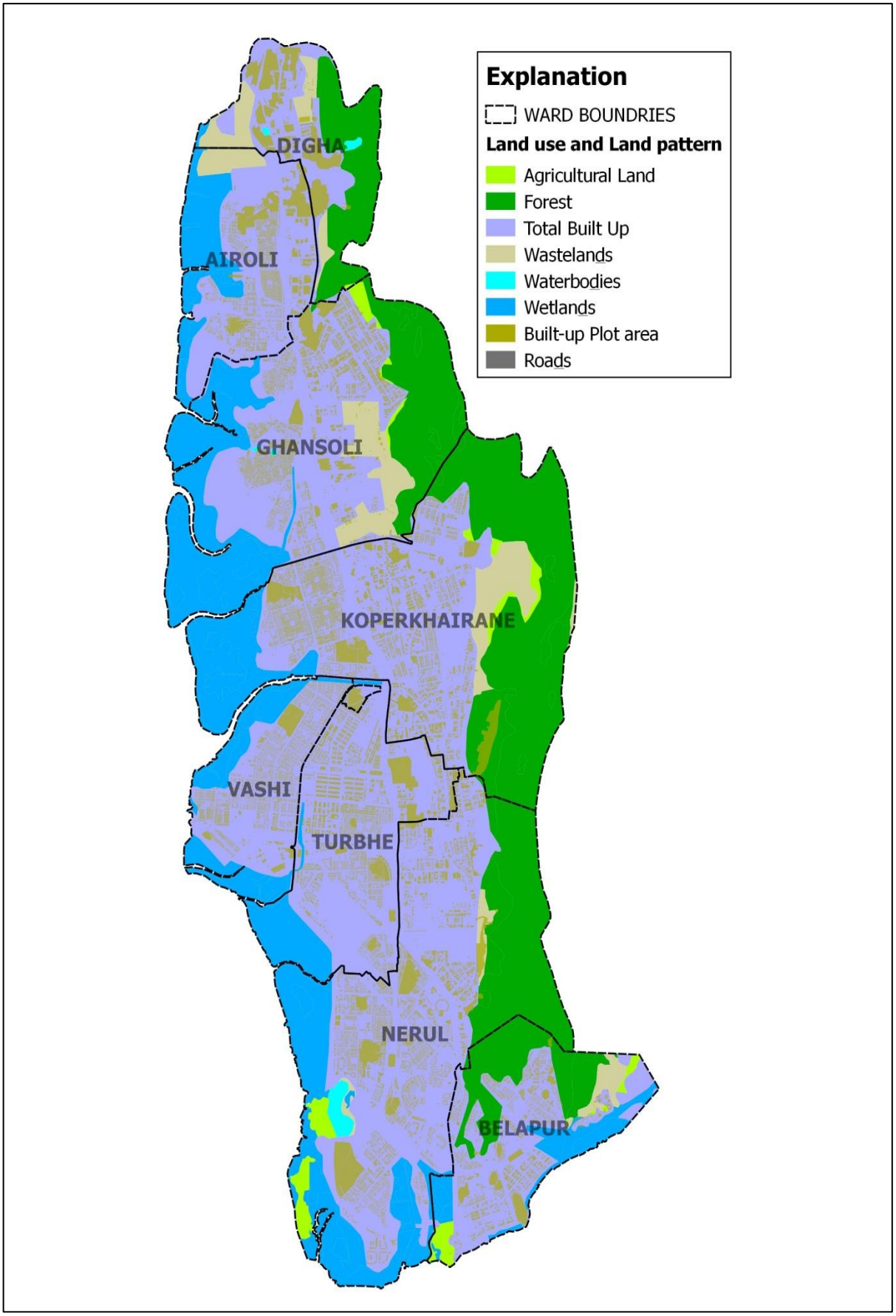
Table No. 37: Break up of Land Use Land Cover pattern in NMMC

Sr. No	Land Use Land Cover	%Share of land cover	Area in km²
1	Built Up	56.16	61.01
2	Forest	24.44	26.55
3	Wetlands	12.39	13.46
4	Wastelands	05.39	05.85
5	Agricultural Land	01.29	01.40
6	Water Bodies	00.33	00.36
	Grand Total	**100**	**108.63**

Source: MRSAC

[25] FAO/UNEP. 1997. *Negotiating a Sustainable Future for Land.* Structural and Institutional Guidelines for Land Resources Management in the 21st Century. FAO/UNEP, Rome.

Map No. 6: Land Use Land Cover pattern of Navi Mumbai



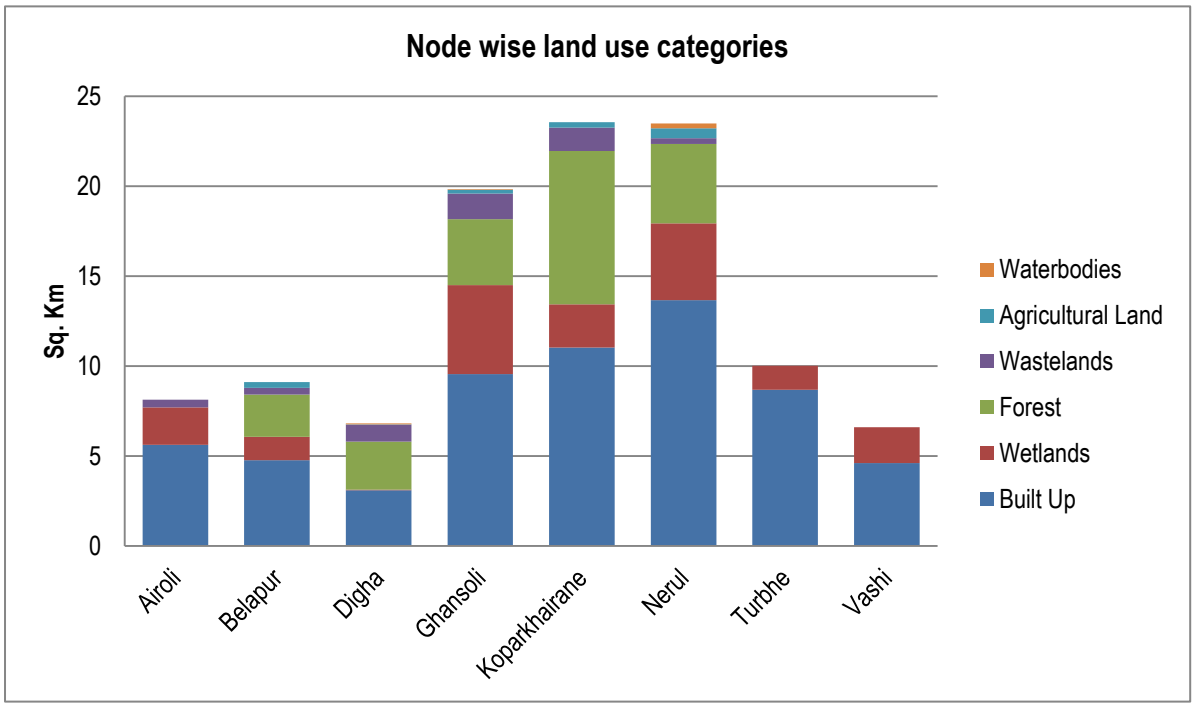


Figure No. 40: Ward wise land use categories in NMMC

Source: MRSAC

It can be clearly observed from Figure No. 40 that almost 3/4th of the total area in Turbhe and Vashi is built up area which indicates that the population density in these areas is higher compared to other areas.

Forest areas can be observed at Belapur, Digha, Ghansoli, Koparkhaine and Nerul which indicates need for protection of these areas to conserve the green spaces of the city. Wetlands can be observed in all the wards except Digha. Marginal farm lands can be observed in Belapur, Ghansoli, Koparkhairane and Nerul which indicates that agricultural practices are still carried out in the city but at a very small scale.

Built up Area

Built up area is an important land use for any city. More than 50% of the area in Navi Mumbai is under built up area for Residential, Commercial, and Industrial purposes in each node. Residential area comprises of majority of the built up area of the city to accommodate the ever increasing population. The current status and the threats exerted by growth in the residential, commercial and industrial area have been discussed in the Drivers section of the report. The built up area in the city is also under various infrastructural development projects such as roads, railways, WTP & STP (Water and Sewage Treatment Plants), SWM (Solid Waste Management) & so on. The status of these infrastructural projects is further elaborated in their respective sections.

Wetlands

As defined by Ramsar convention, wetlands are areas that are seasonally or perennially covered by water[26]. Wetlands usually consist of water structures like lakes, rivers, mangroves, coral reefs and so on. Artificial man-made wetlands consist of paddy fields, dams, saltpans and so on. Navi Mumbai is rich in several wetland areas such as lakes, ponds, holding pond, mangrove wetlands & so on.

Water Bodies

Navi Mumbai consists of several water bodies such as 24 lakes, dams, creeks, ponds, wells & so on. The water bodies are used for various domestic and industrial purposes in the city. These water bodies have been further explained in the Water resources section of the report.

Mangroves

Mangroves are a taxonomically diverse group of salt tolerant, mainly arboreal, flowering plants that grow primarily in tropical and subtropical regions[27]. They are distributed in the inter-tidal region between the sea and land[28]. Mangrove wetlands are ecologically important since they serve as a home for a variety of diverse plants and animals. Increase in mangroves has also been observed from 15.50 sq. km to roughly 49.78 sq. km since the last 2 decades[29] but only few areas are under the jurisdiction of Municipal Corporation. The mangrove species recorded in the area included *Avicennia marina* and a mangrove weed, *Acanthus ilicifolius*. *Sonnertia alba* can also be commonly seen in the region. Research studies of NMMC area documents species of true mangroves representing approximately 3 genera and 3 families 10 species of mangrove associates belonging to 8 genera and 6 families and 1 species of non-mangrove halophytes[30]. As mangroves play a valuable role as natural barrier against cyclones, floods and tsunamis, they tend to act as a lifeline for citizens of Navi Mumbai. They also play a vital role by providing breeding and feeding habitat for various birds and fishes of the city.

Picture No. 9: Fruits of *Avicennia marina* (Left) and Leaves of *Acanthus ilicifolius* (Right)

Source www.niobioinformatics.in

[26] Ramsar Convention
27 http://cmsdata.iucn.org/downloads/managing_mangroves_for_resilience_to_climate_change.pdf
28 http://www.marineclimatechange.com/marineclimatechange/bluecarbon_2_files/Girietal2011.pdf
29http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue40/news/toi_mangroves_cidco.pdf
30 Pawar (2011). Floral Diversity Of Mangrove Ecosystem From Coastal Environment Of Uran (Raigad), Navi Mumbai, Maharashtra. Electronic Journal of Environmental Sciences Vol. 4, 113-117 (2011) ISSN: 0973-9505

Picture No. 10: Mangroves in Navi Mumbai

Carbon sequestration by mangroves in NMMC

Mangrove forests are one of the most promising means of carbon sequestration, having the highest net carbon productivity among all ecosystems. Mangrove species are able to reduce the amount of excess carbon in the air by sequestering carbon dioxide and thereby reducing the contribution of greenhouse gases to global warming[31]. Studies have found that mangroves have the potential to store more carbon in their biomass compared to tropical and temperate forests[32]. It is found that mangroves sequester approximately 1.5 metric tons/hectare/year of carbon[33]. Considering the total mangrove area of Navi Mumbai (4978 hectare), the sequestration due to mangroves can be estimated to be approximately 7467 metric tonnes per year.

As the Carbon footprint of Navi Mumbai is estimated to be about 2.8million metric tonnes/year as per study conducted by TERI, it could be predicted that almost 0.26% carbon emissions are sequestered by the mangroves of Navi Mumbai per year.

[31] http://www.mangrovesforfiji.com/mangroves/carbon-sequestration
[32] http://www.wetlands.org/News/tabid/66/ID/3503/Not-all-mangroves-are-identical-new-study-reveals-hotspots-for-mangrove-biomass.aspx
[33] Singh et al (2012). Carbon Sequestration In Mangroves Ecosystems, Journal of Environmental Research And Development, Vol. 7 No. 1A.

Open Spaces

Natural Areas

Natural forests are an important component of the green areas in Navi Mumbai and about 16.35 % of total NMMC area (26.55 sq. km) is forest area[34]. The city encompasses various habitats ranging from low hills with tropical semi-evergreen, tropical moist deciduous, tropical dry deciduous, to marshlands, estuary and mangroves. Around 1,471 hectares (14.71 sq. km) of mangroves on government land in Navi Mumbai have been notified as "reserved forests"[35]. Such areas with a high green-coverage have ecological and environmental importance & can also improve the urban climate, abate the urban heat-island effect and reduce environmental damage[36].

Navi Mumbai city has a good area under tree cover. A study by NASA (National Aeronautics and Space Administration) indicates that it takes 17.5 trees per person to produce sufficient oxygen for survival but it takes 20 trees per person to consume the CO_2 each person generates[37]. Thus trees play a vital role in regulating the city environment and maintaining a proper balance. NMMC has carried out tree plantations in every block consecutively as per the requirement which can be observed in Table No. 40. Out of the total trees present in the city 1.14 Lakhs (1,14,931) have been planted on road dividers. As per the tree census conducted in 2006, the total tree count of the city is around 4.79 Lakhs (4,79,120).

As these green areas work not only as lungs for the city but also provide various environmental services, conservation of these areas is of key importance in order to ensure sustainable development of the city.

Man-made Areas

Growing urbanisation which has resulted in loss of natural areas of the city has exacerbated the process of air, water and land pollution. Gardens act as small regulators to clean the environment of the city. They not only help in reducing the pollution of the city but also contribute to the environment by providing oxygen, enriching the climate, conserving water, preserving soil, and acting as micro habitats for a variety of city dwelling fauna such as birds and butterflies. Also they create a peaceful, aesthetically pleasing environment[38]. Gardens further play a significant role in enhancing the physical, emotional and spiritual well-being necessary to build healthy and socially sustainable communities[39]. Realizing the importance of these green components for the city, NMMC has taken various initiatives in the form of afforestation programs and proposing new gardens for effective conservation of the environment.

A total of 199 gardens are present in the city. These gardens have had a large contribution towards the increasing green cover of the city (Table No. 38). Maximum number of gardens can be observed in the Belapur node with a total of 46 gardens. Some gardens in the city are developed based on a special theme in order to provide aesthetic value to area and also to increase the beauty of the city.

[34] http://www.nmmconline.com/land-usage
[35] http://indianexpress.com/article/mumbai/1471-hectares-of-mangroves-notified-as-reserve-forests/
[36] Balogh and Takács (2011). *The significance of urban open spaces and green areas in urban property developments* First International Conference "Horticulture and Landscape Architecture in Transylvania" Agriculture and Environment Supplement (2011) 110-121.
[37] http://settlement.arc.nasa.gov/Contest/Results/96/winner/seis.html
[38] http://www.savatree.com/whytrees.html
[39] http://designinghealthycommunities.org/role-community-gardens-sustaining-healthy-communities/

Table No. 38: Ward wise total gardens in NMMC

Sr. No	Node	Total Gardens	Total Area (Sq. m)
1	Belapur	46	166987
2	Nerul	41	143398
3	Sanpada	11	60721
4	Vashi	44	179252
5	Koparkhairane	20	60617
6	Ghansoli	8	20984
7	Airoli	29	100903
	Total	**199**	**732862**

Source: Garden Department, NMMC

Picture No. 11: Joggers Park developed at Airoli

Picture No. 12: Day time aerial view of Wonders Park at Nerul

Biodiversity of NMMC

Biological diversity refers to the full range of variety and variability within and among living organisms and the ecological complexes in which they occur. It encompasses ecosystem or community diversity, species diversity, and genetic diversity[40]. Biodiversity of an area is an indicator of the rich environment of the area & Navi Mumbai is one such area with a variety of habitats. Being a tropical ecosystem, it is bestowed with a high biodiversity[41]. Navi Mumbai is currently home to approximately more than 168 species of birds, 80 species of reptiles and amphibians, 140 species of butterflies, 125 species of marine fish, 800 species of flora & so on. Despite such a high biodiversity, no legal protection for the area in the form of a 'protected area' has been granted except for mangroves. Karnala bird sanctuary is the nearest protected area located at a distance of 30 km. The important highlights of biodiversity of the Navi Mumbai area are as follows:

Birds

Navi Mumbai is a famous spot for observing birds due to the presence of the coastal and mangrove wetland ecosystem. Different species like winter birds, water birds, local and passage migrants & so on are spotted at several places in Navi Mumbai. More than 168 species of birds are present in the area out of which many are migratory in nature. Part of Thane Creek and Uran Creek are the key biodiversity hotspots to observe migratory birds.

[40] http://ceres.ca.gov/ceres/calweb/biodiversity.html

[41] The forest type is as per the classification provided in "Vegetation types of India following Champion and Seth 1968" (http://www.sikkimforest.gov.in/docs/Forestry/Vegetation%20Types.pdf) Please note that mangrove forest are no considered in this type of classification however have been included in this report for its significance to the region.

Nerul's Talave, Airoli & Ghansoli mudflats are also home to some exotic birds. A total of 77 species of birds belonging to 35 families and 14 orders were recorded from Uran mudflats. The recorded avifauna comprised of resident (48%), local migrant (23%) and migrant (29%) bird species[42] but Pawar (2011) observed a total of 56 species of birds representing 11 orders, 29 families and 46 genera from the mangroves of Uran mudflats[43]. Migratory and threatened birds such as Lesser Flamingoes visit Navi Mumbai in large numbers. Flocks of flamingoes can be observed from Belapur to Airoli in high numbers along the mangrove patches from November to May. Scientists have also observed a substantial rise in their population and attribute the reason for this to availability of sufficient food and conducive habitat[44].

Picture No. 13: Lesser flamingoes at Navi Mumbai

Other Taxa

Other lesser known taxa of Navi Mumbai have been studied to an extent. The data on species diversity of fin fishes from Uran coast revealed the presence of 31 species of which 3 species of Chondricthyes (Cartilaginous fish) representing 2 genera and 2 families and 28 species of Osteicthyes (Bony fish) representing 28 genera and 23 families were recorded[45]. Pawar (2012) have also studied the decapod and molluscan diversity of the Uran Coast where 26 species of decapods were found and 55 species of molluscs representing 13 orders, 30 families and 39 genera were also recorded[46][47].

[42] Malwadkar (2011). A Contribution to Avifauna Of Uran (Raigad), Maharashtra, India. J.Aqua.Biol. Vol 26(1), 2011: 21-25

[43] Pawar (2011). Species diversity of birds in mangroves of Uran (Raigad), Navi Mumbai, Maharashtra, West coast of India. Journal of Experimental Sciences 2011, 2(10): 73-77

[44] http://dnasyndication.com/dna/dna_english_news_and_features/Flocks-of-flamingos-amuse-Navi-Mumbaikars/DNMUM303944

[45] Pawar (2011). Monitoring of fin-fish resources from Uran coast (Raigad), Navi Mumbai, Maharashtra, West coast of India. International Multidisciplinary Research Journal 2011, 1(10):08-11 ISSN: 2231-6302.

[46] Pawar (2012). Diversity of Decapod fauna from Mangrove Ecosystem of Uran (Raigad), Navi Mumbai, Maharashtra, West Coast of India. Indian J.Sci.Res.3(1): 87- 90.

[47] Pawar (2012). Molluscan Diversity in Mangrove Ecosystem of Uran (Raigad), Navi Mumbai, Maharashtra, West coast of India. Bull. Environ. Pharmacol. Life Sci.; Volume 1 [6] May 2012: 55 – 59, ISSN 2277 – 1808.

Pressure & Impact

Mining and Quarrying

Mining and stone quarrying is an important pressure exerted on land resources. It is the main reason for degradation of many natural areas of India. Extensive mining causes air, water and land pollution impacting the biodiversity around it and ultimately affecting human beings. Navi Mumbai also faces pressures from mining and quarrying activities. A total of 80 leases have been provided in 7 different regions of the city which account to a total area of 966151 sq. m (Table No. 39). The operators are permitted to carry out mining activities in the area till the year 2016. Air pollution with high RSPM level can be observed in the area near the mining sites as explained in Air section. This is one of the important factors accelerating air pollution in the city. Exposure to such polluted air may result in acute respiratory diseases which may cause chronic bronchitis and decreased lung function. Population in city living near mining areas is more vulnerable to the effects of high RSPM.

Table No. 39: Mining in Navi Mumbai

Sr. No	Region	No. of Lease/Operator	Area in (Sq.m)
1	Bonsari	15	179792
2	Kukshet	11	115450
3	Pavne	12	136365
4	Sirvane	10	103125
5	Turbe	28	344344
6	Turbe,Bonsari	2	64800
7	Turbe\ Pavne	2	22275
	Grand Total	**80**	**966151**

Source: http://www.thane.nic.in/pdf/sand_mining/khanipatta list.pdf

Dumping of Debris

Dumbing of debris is currently a serious issue faced by the city. Illegal dumping of debris is being carried out on a large scale in various wards. Not just construction debris from the city but also debris from nearby regions is randomly dumped in the city at various locations. The dumping is carried out in mangrove areas and holding ponds creating a pressure on these areas. Mangrove area proves to be an important habitat for the migratory birds such as flamingoes and other wader birds which visit the city during the winter season. Dumping of debris in these areas will impact the activities of these birds, possibly causing them to migrate to other areas.

Destruction of Mangroves

Mangroves are also being impacted on a large scale by the growing pressures. Overexploitation and unsustainable demand has resulted in considerable degradation of mangrove areas. Deforestation is major threat to mangrove forests and the land is being

reclaimed for construction purposes. Sometimes mangroves also face the threats from oil spills due to accidents[48]. Illegal deforestation and burning of mangroves is also observed in some areas. A steady decrease in the mangroves of Thane Creek has been observed to an extent which may affect the local environment of the area if conservation and restoration measures are not taken in time[49]. Thus as Navi Mumbai is identified to be a vulnerable city which may face impacts of sea level rise due to climate change, conservation of mangroves is the need of an hour to avoid future losses.

Poaching of Flamingos

Poaching of Flamingos has also reported in some parts of Navi Mumbai for consumption purposes[50]. Important habitats such as Uran are also seen to be facing various threats from the present SEZ and erosion which has resulted in migration of various species in large numbers[51].

Other Projected Impacts

Urban Heat Island Effect

An Urban Heat Island (UHI) is a metropolitan area that is significantly warmer than its surrounding rural areas due to human activities[52]. The main reason for this effect is the concretization of buildings and houses which indirectly act as insulators of heat. This insulation makes the areas around buildings warmer. The Urban Heat Island effect has been observed for cities like Mumbai, Chennai, Kolkata and Pune with effects in the form of heat stress and rising precipitation which has impacted the urban life of the city[53][54]. Temperature rise due to climate change in the city can also add to the threats on biodiversity. Studies in various cities have recorded migration of wildlife to areas with cooler temperatures[55][56], although Navi Mumbai is currently not facing any such effect of the rising urban heat. But in future such effects may be observed considering the growing trend of urbanization and rise in built up area in the form of concrete structures in the city.

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[48] NEERI: Environmental Impact Assessment (EIA) Study on Pollution Due to Oil Spill and Other Hazardous Substances, Interim Progress Report.

[49] Nikam et. al (2008). Conservation of Wetlands and Mangroves in Thane creek and Ulhas river estuary, India. Proceedings of Taal2007:The 12th World Lake conference: 1635- 1642.

[50] http://timesofindia.indiatimes.com/home/environment/flora-fauna/Flamingos-hunted-for-meat-in-Navi-Mumbais-mudflats/articleshow/30692721.cms

[51] Thakur (2010). Impact Of Special Economic Zone (Sez) On Birds In Uran, Maharashtra, Report Submitted To Mumbai University.

[52] http://education.nationalgeographic.com/education/encyclopedia/urban-heat-island/?ar_a=1

[53] http://books.google.co.in/books?id=aTLlnoV8dSUC&pg=RA3-PA1997&lpg=RA3-PA1997&dq=urban+heat+island+in+Mumbai+TERI&source=bl&ots=GyUWIYc6NA&sig=vxz27Z7PYu80cUwehell61ZlByg&hl=en&sa=X&ei=hb2vU8PWHNiTuASvtoKIAw&ved=0CDgQ6AEwAw#v=onepage&q=urban%20heat%20island%20in%20Mumbai%20TERI&f=false

[54] http://www.theguardian.com/global-development/poverty-matters/2013/jan/09/delhi-mumbai-urban-heat-islands-india

[55] http://www.york.ac.uk/news-and-events/news/2011/research/wildlife-responds/

[56] http://www.sciencedaily.com/releases/2014/04/140422113443.htm

Compounded Impacts

Increase in building permissions and rise in the number of properties would increase the pressure on resources to a great extent. All buildings may not be resource efficient and may depend directly on them to fulfill their needs. Thus a rising number of properties will directly impact the land resources leading to over exploitation of the same. This will impact the sustainable development of the city leading to scarcity of resources in future. Also rise in properties in a particular area would lead to congestion in that area which would also indirectly impact the resources of that particular area.

Response

Green Buildings

In order to contribute to the sustainable development of the city, NMMC is promoting the concept of Green Buildings under their ongoing project titled "Navi Mumbai: An Eco City" in collaboration with The Energy and Resources Institute (TERI) Adoption of the green building concept would lead to conservation and efficient use of limited resources like land, water, energy and so on. Given the need of the hour and to set an example for the building & construction industry NMMC has constructed its own headquarters at Belapur (Picture No. 14) on the principles of green building wherein they have implemented several features such as:

- Rainwater harvesting system consisting of 13 pits with a capacity to store up to 80,000 liters of water.
- Reflective tiles fitted on the terrace to reduce the load on electric consumption by air-conditioners.
- STP of 0.15 MLD capacity to treat sewage generated in the building.
- Recycled water is used for toilet flushing & gardening purpose.
- Biomethanation Plant for scientific disposal of canteen waste.
- Grass pavers are fitted on the ground to allow percolation of water.
- Use of Double Glazed Unit glass to reduce heat transfer & increase energy efficiency
- Pneumatic plumbing system to reduce load on water flow.
- Recycled wood has been used for furniture in the building

Picture No. 14: New NMMC Headquarters- A green building

Vigilance against illegal dumping of debris

Realizing the seriousness of the issue NMMC has established a special flying squad for monitoring the activity of illegal dumping of debris in the city. For the year 2013-14, almost 323 vehicles carrying illegal debris were caught by the department carrying approximately 4845 tonnes of debris.

Addition of Open Spaces

As open spaces in the city helps in reducing the impacts of Urban Heat Island, NMMC and CIDCO plan to increase the area by adding various open spaces in future[57]. NMMC is also taking various steps to avoid misuse of the open spaces through organizing anti-encroachments drives and sending legal notices to concerned agencies[58].

[57]http://timesofindia.indiatimes.com/city/navi-mumbai/NMMC-may-use-some-plots-for-open spaces/articleshow/36503199.cms
[58]http://www.mumbaimirror.com/mumbai/others/NMMC-serves-notices-to-private-agencies-for-misusing-open-spaces/articleshow/16021126.cms

Raising Awareness about Bio wealth of City

- In order to increase awareness and sensitize citizens about the local biodiversity of the city, NMMC in collaboration with TERI has installed biodiversity panels at Nisarga Udyan, Koparkhairane highlighting the importance of flora and fauna to the city. The garden was transformed from a garbage dumping site and now the garden proves to be a habitat for many bird species (Picture No. 15).

Picture No. 15: Biodiversity lecterns at Nisarga Udyan, Koparkhairane

- The forest department and the City and Industrial Development Corporation (CIDCO) are undertaking a joint survey of mangroves in the area with the plan of creating a mangrove wetland centre for Navi Mumbai[59]. Several initiatives have been taken by the citizens of Navi Mumbai which include afforestation drives and generation of awareness among the stakeholders regarding significance of mangroves[60].

[59] http://indianexpress.com/article/cities/mumbai/forest-dept-cidco-plan-mangrove-wetland-centre-in-navi-mumbai/
[60] http://timesofindia.indiatimes.com/city/mumbai/Navi-Mumbai-residents-plant-saplings-to-save-ravaged-mangroves-on-World-Forestry-Day/articleshow/32539601.cms

- NMMC has carried out tree plantations in every block as can be seen in Table No. 40. As the last Tree Census was conducted in 2006, NMMC felt the need to conduct a fresh census in order to maintain details and progress of the present & planted tree in the city. Thus tenders have been invited by NMMC in order to undertake Tree Census.

Table No. 40: Tree plantation data for 6 years in NMMC

Sr. No	Node	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
1	CBD Belapur	10235	5950	4500	3000	0	3100
2	Nerul	3940	9250	4743	0	0	800
3	Juinagar	1582	1050	0	0	0	0
4	Sanpada	3248	650	0	0	0	0
5	Vashi	5100	7250	0	1500	0	0
6	Koparkhairane/ Ghansoli	1704	4300	10800	1500	67500	65000
7	Airoli	3428	9500	2962	1000	0	0
	TOTAL	**29237**	**37950**	**23005**	**7000**	**67500**	**68900**
	*65000 Proposed Tree Plantation on Adwali Bhutawli forest Area						

Source: Garden Department, NMMC

This year NMMC has proposed to plant around 68900 trees to increase the green cover of the city.

Restoration of Stone Quarries and Protection of Hills

Gravel and stone quarry operations result in extensive manipulation of the landscape and ecosystems. Quarrying results in accelerated erosion because the topsoil environment required for establishment of vegetation is eliminated. Once quarry resources are exhausted or operations ceases, the landscape is extensively degraded and renders to be of no use.. Such degraded lands lead to safety, ecology, and aesthetics-related concerns. The intrinsic impact of quarrying is the exposure of the bare soil and underlying strata which vary in stability and do not support vegetation, contrasting sharply with the adjacent undisturbed landscape features. There are over 200 quarries in NMMC area (Nerul-106, Turbhe-92, Koparkhairane-8, and Digha-3). In view of land degradation due to stone quarrying in NMMC, restoration of these areas is a challenge for NMMC. The actions proposed by NMMC for restoration of such sites are as follows:

- Assessing feasibility of using abandoned quarries for rainwater harvesting;
- Planting trees for restoration of land under abandoned quarries
- Quarries in operation to implement better handling operational facilities with pollution control facilities.

- Abandoned quarries can be restored by sanitary land filling with innocuous inorganic wastes, especially construction debris by adopting suitable slopes from stability angle and with due compaction. [61]

Proposed Activities

- NMMC proposes to set up bird watching towers near the mangrove area for the citizens of Navi Mumbai in order to increase awareness among citizens regarding significance of migratory birds (Picture No. 16). This initiative will also allow citizens to connect with nature.

Picture No. 16: Proposed watch tower at mangroves area for Bird watching

[61] NMMC Environmental Status Report-2012-13.

- NMMC has proposed several gardens in order to increase the aesthetic beauty and green cover of the city. The list of the proposed gardens is given below in Table No. 41.

Table No. 41: Gardens proposed for Navi Mumbai

Sr. No	Name of the garden	Node
1	Scientific Park	Airoli
2	Zen (Buddha Garden)	Airoli
3	Sane Guruji Park	Digha
4	Botanical Garden	Belapur
5	Navras	Koparkhairane
6	Amusement Park	Vashi

Source: Garden Department, NMMC

Solid Waste Management

MOEF has defined Municipal Solid waste as commercial and residential wastes generated in a municipal or notified area in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes[62].

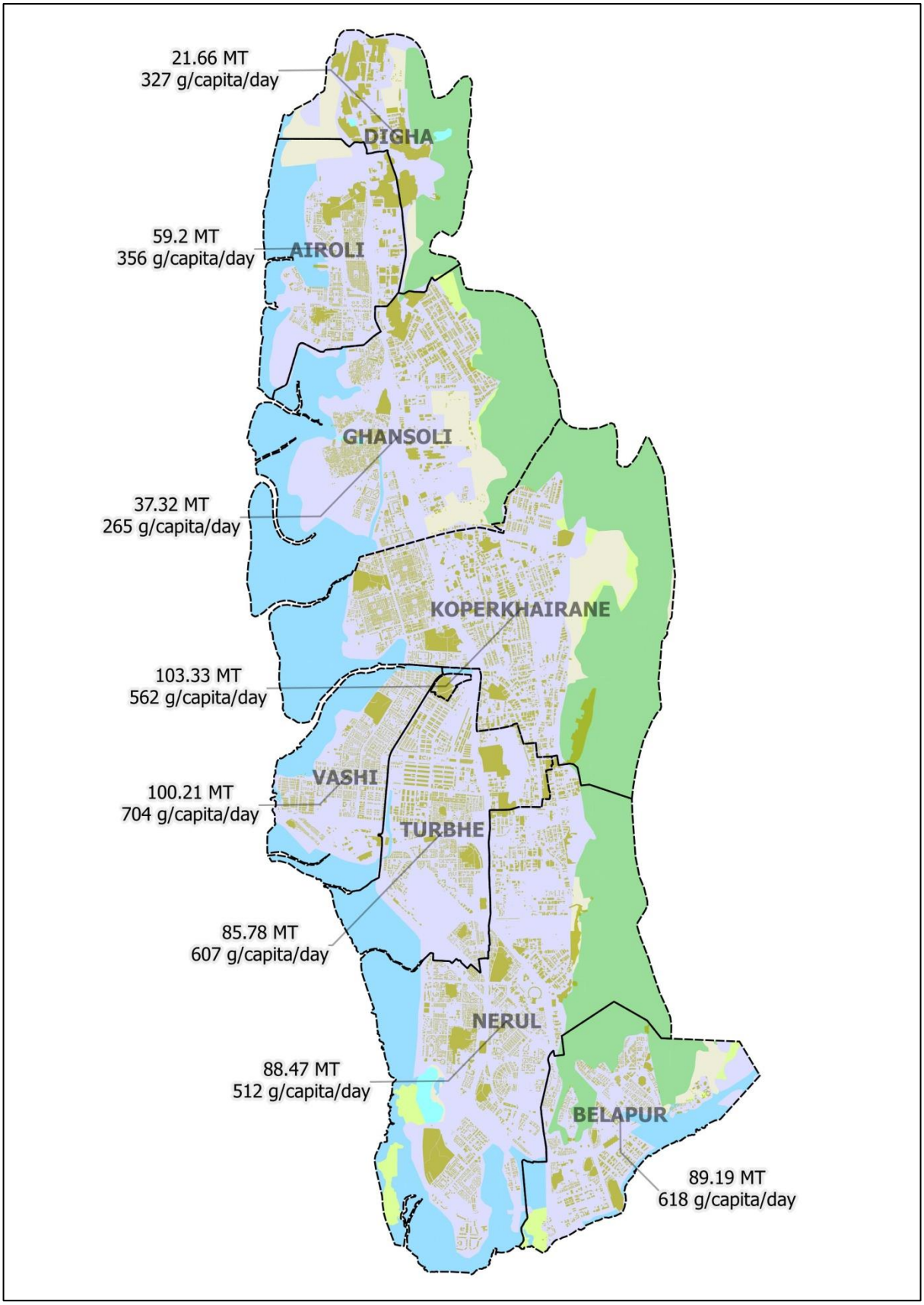
Solid waste collection is carried out in 81 zones through private contractors. As per the guidelines of Honourable Supreme Court on March 1999 and Municipal Solid Waste (Management & Handling) Rules September 2000, the solid waste management system has been reorganized. NMMC introduced mechanised sweepers for the main roads in 2012-13. NMMC took over Thane Belapur Industrial Area of MIDC in November 2004 and is providing SWM services in MIDC areas. This has increased 4 zones making total zones 85.

Source and Composition

The total amount of solid waste generated and collected by the NMMC is 650 Metric Tonnes (MT) per day. The main source of solid waste is from the residential areas comprising of household and commercial waste with a share up to 74% followed by Agricultural Produce Market Committee (APMC) and Maharashtra Industrial Development Corporation (MIDC) (Figure No. 41 and Table No. 42). Considering the average waste generated by each node per capita per day, maximum waste (607 g per capita) is generated from the Vashi node while least waste in generated in Ghansoli node (256 g/capita).

[62] http://www.moef.nic.in/legis/hsm/mswmhr.html

Map No. 7: Waste generated per thousand persons per day in each ward of NMMC



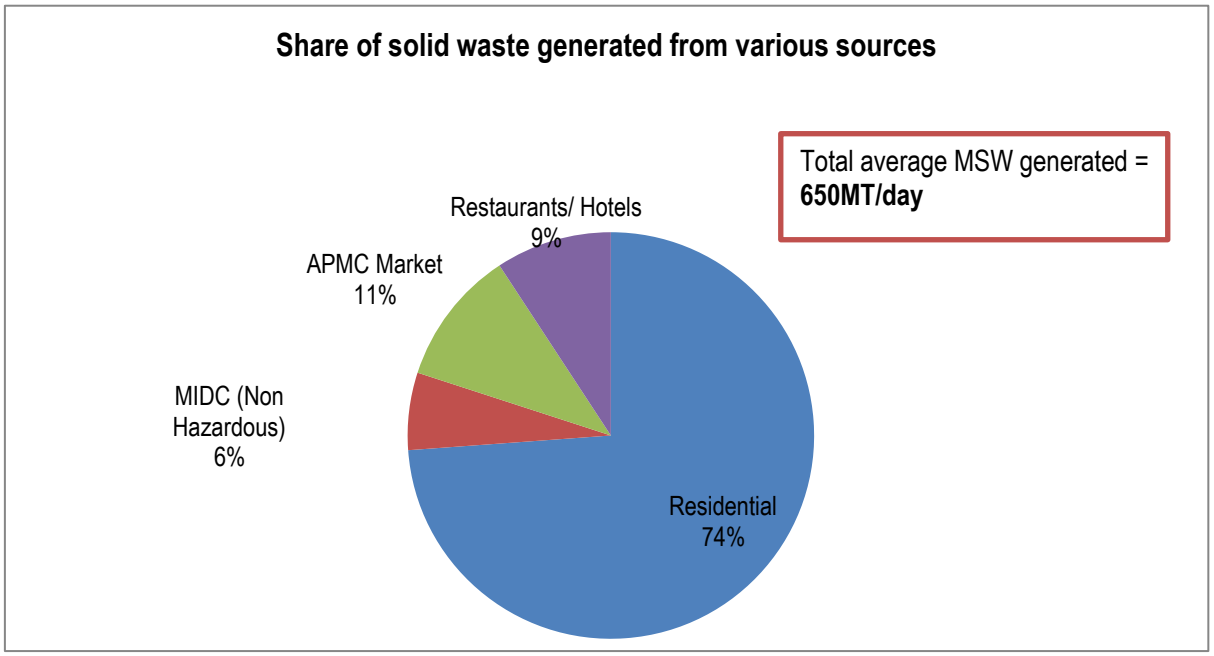


Figure No. 41: Total percent waste generated from various sources in NMMC

Source: Environment Laboratory, NMMC

Table No. 42: Quantity of daily average MSW generated from NMMC in 2013 -14

Sr.No	Ward	Quantity of waste (Kg/day)	Average Per capita waste generated per day(g/capita/day)	Quantity of waste (MT/day)
1	Belapur	89185	618	89.185
2	Nerul	88470	512	88.47
3	Vashi	100210	704	100.21
4	Turbhe	85775	607	85.775
5	Koparkhairane	103330	562	103.33
6	Ghansoli	37315	265	37.315
7	Airoli	59200	356	59.2
8	Digha	21655	327	21.655
	Total	**585140**	**3951**	**585.14**
9	APMC	45125		45.125
10	MIDC (Non-hazardous)	19735		19.735
	Total	**650000**		**650**

Source: Environment Laboratory, NMMC

The waste mainly consists of biodegradable waste from the residential areas followed by plastic, paper and so on (Figure No. 42).

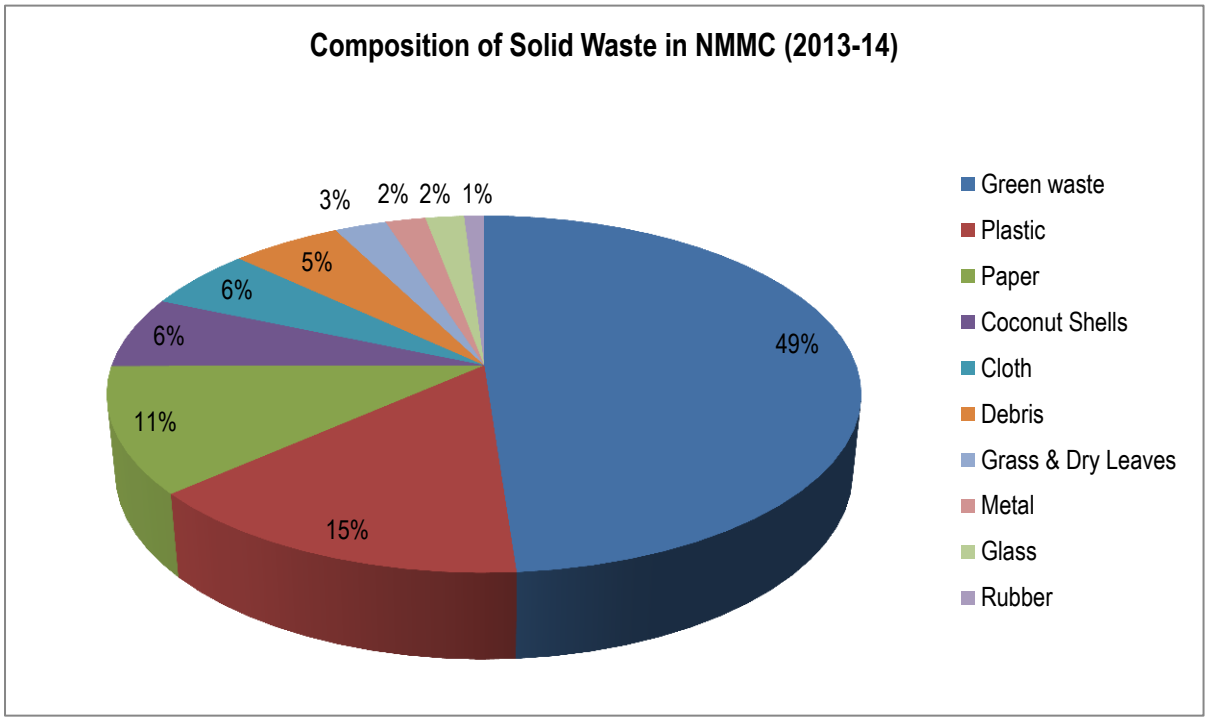


Figure No. 42: Composition of solid waste in NMMC
Source: Environment Laboratory, NMMC

Biomedical Waste

The city also generates considerable amount of biomedical waste due to presence of hospitals and various other health facilities in the city. The average biomedical waste generated this year was around 5387.28 Kg (Table No. 43). Biomedical waste is collected from various hospitals and dispensaries by private contractors and disposed of at the Hazardous Waste Disposal facility at Taloja.

Table No. 43: Composition of Biomedical Waste (Kg) in NMMC Area

Categories (% evalution)	Disposal Method	Vashi Hospital Vashi	Mata bal Hospital Nerul	Mata bal Hospital Turbhe	Mata bal Hospital Kopar Khairne	Mata bal Hospital Airoli	Total
Needle, Lancet, Scalpel Veinflor, Discarded Glass wares- Tube, Pipettes, Syringes, Slides, Coverslips,	Autoclaving & Shredding	2431.233	0	286.776	272.3805	74.844	3065.23

Categories (% evalution)	Disposal Method	Vashi Hospital Vashi	Mata bal Hospital Nerul	Mata bal Hospital Turbhe	Mata bal Hospital Kopar Khairne	Mata bal Hospital Airoli	Total
Disposal Waste- IV Sets, Disposal syringes, Injection Vials, Amp. Glass, Bio Catheters, Plastic Bottles							
Microbial Waste ,Highly Infectious Waste, Isolate, Discarded Medicines, Solid Waste, Liquid Waste	Incineration	1923.915	0	177.9645	171.423	48.7515	2322.05
Total		**4355.15**	**0**	**464.74**	**443.8**	**123.6**	**5387.28**

Source: Health Department, NMMC

Sweeping

The waste collected from the road is mainly using the method of sweeping. The total length of road swept accounts to 1317.19 km. On an average one sweeper sweeps 700 running meters of road length. NMMC has now introduced 8 mechanical sweepers for efficient sweeping of roads. About 196.16 km road is swept by the sweeping machines per day. The sweeping machines are fitted with suction technology, water sprinklers and brushes which are used to collect dirt, sand, pebbles and scattered leaves from the road. The total number of sweepers employed for this purpose is 2461, mainly on a contract basis. Sweeping is conducted daily for a maximum period of 8 hours in the morning. The sweepers are provided with around 2100 waste collection bins/ containers and 8 mechanical sweeping machines for the purpose of effective sweeping & collection of waste.

Collection

About 108.63 (sq. km) of area is covered for the collection of solid waste. The total number of households covered for collection is around 277622 out of which 221776 are covered through door to door collection (bell ringing) while the rest of the waste for 55846 households collected through common facilities like public trash bins. Domestic solid waste from houses

is mechanically collected and loaded in refuse transportation vehicles by transportation contractors. Community bins are provided at market places. There are total 2100 bins present in the city with varying capacities mainly of closed type.

Processing & Scientific Disposal

NMMC is collecting domestic solid waste (wet & dry) from NMMC area and transporting it to the sanitary landfill at Turbhe. The separation is done at sanitary landfill site. The landfill site is spread over 65 acres and 650 MT waste is received daily for processing. The expected life expectancy of the landfill site is for around 69 years. The waste is processed daily using the Wind Rows composting & Refused Derived Fuel technology. Recyclable waste is separated and recycled. Wet waste is used for production of Refuse Derived Fuel (RDF) and compost. The rejects are disposed off into the sanitary landfill. Out of the total intake of waste, a majority of the part is moisture (Figure No. 43).

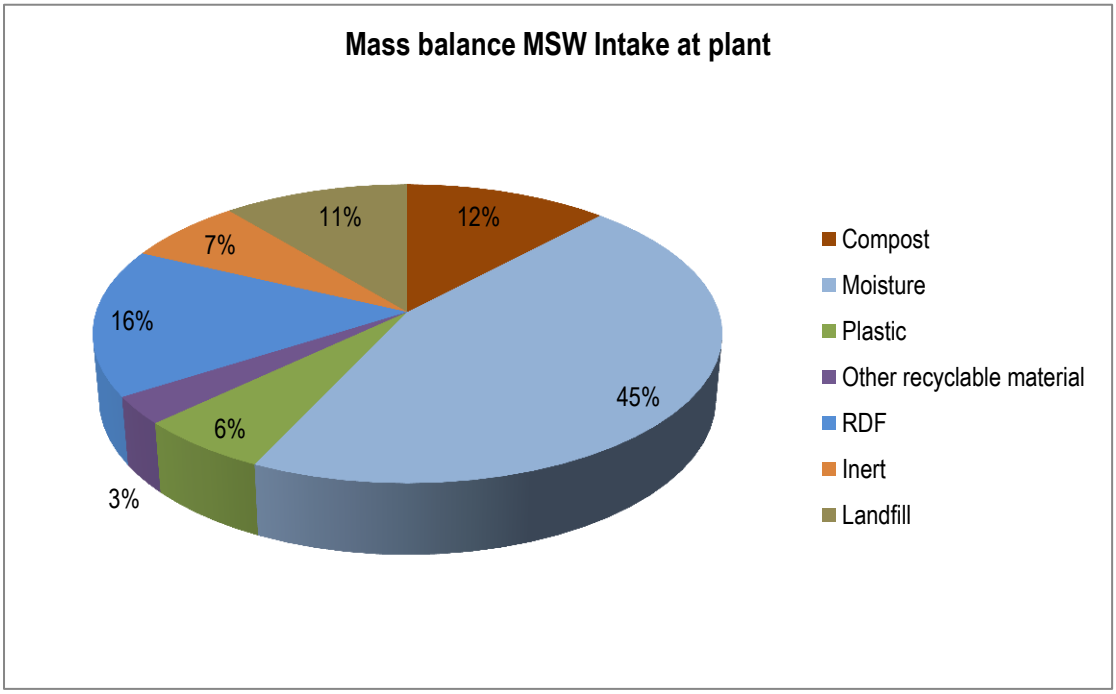


Figure No. 43: Mass balance MSW Intake of 650 tons at plant

Source: Environment Laboratory, NMMC

While disposing solid waste, de-odorant is sprayed to minimize fly and odour nuisance. The operation & management of landfill is through Public Private Partnership basis (PPP). The sanitary landfill is protected from stray dogs and trespassers by constructing compound wall all around. A green belt is constructed and planted with various plants around the periphery of the site. Completed phases of sanitary landfill are covered with grass and methane is flared and burnt to reduce the "Green House" effect. Air Quality Monitoring Station is provided to monitor air pollution from this integrated solid waste disposal facility at Turbhe.

Picture No. 17: Scientific closure of Cell I, I and III at Turbhe landfill site

Leachate Analysis: Turbhe Site

The landfill site is responsible for generation of a lot of leachate due to the solid waste. The Leachate treatment plant was commissioned in 2011-12 and is one of the environmental achievements. The leachate water is regularly sampled and the quality of water is tested each year (Table No. 44).

Table No. 44: Leachate analysis report at Turbhe site in NMMC

		PARAMETERS						
		pH	D.O	B.O.D	C.O.D	Chloride	Sulphate	Hardness
		5.5-9.0						
Average	Influent	7.5	Nil	2475	7307	2617.65	122.94	1255
	Effluent	7.3	5.6	138	462	1002.23	45.19	505

Note: All Values are in mg/l except pH

Source: Environment Laboratory, NMMC

Initiatives

Scientific Closure of Old Wild Dumping Ground at Koparkhairne

Scientific closure of an old wild dumping ground at Koparkhairne, having an area of 17 hector containing 20 lakhs M.T garbage was completed by NMMC. A network of wells to collect trapped landfill gas was laid and a flaring unit was installed at site to burn the LFG. Leachate collection tank was also constructed to collect the leachate which is being treated before disposal. A Green vegetation cover was prepared with pathway, sit-out etc. Treated sewage water from nearby Sewerage Treatment Plant is being used for watering the lawn through Sprinkling System. NMMC has set a leading example in closing existing open dumping ground and converting to into lush green garden (Picture No. 18). In the year 2013-14, grass layer for 22000 sq. mt area was laid to increase the green cover of the garden. As part of the development of Phase II, a jogging track has also been set up which is highly appreciated by the citizens residing in the nearby localities.

Picture No. 18: Koparkhairane dumpsite in 2006 (Left) and 2008(Right)

The closure of Koperkhairne dumping ground and the sanitary landfill at Turbhe are ideal projects as per Municipal Solid Waste (Management & Handling) Rules September 2000 and appreciated by visitors from World Bank, foreign missions, municipal commissioners from various state and other visitors.

Proposed Initiatives

- NMMC is planning to set up a Debris Recycling Plant realising the need for conservation of environment. The recycled debris is further planned to be used for restoration of quarry sites.
- Scientific closure of Phase 4 at Turbhe landfill site.
- Setting up of an E-waste recycling plant has been proposed by NMMC.

Health

The status of health of residents is one of the most crucial indicators of the environmental status of a city. But in addition to good environmental conditions, a city also needs to have good healthcare facilities. Navi Mumbai has diverse health care services and facilities including clinics, hospitals, super speciality hospitals, private and government dispensaries and so on. NMMC hospitals are equipped with necessary aid for emergency cases. It has recently introduced the service of super specialty wards at hospitals with the help of private operator. There are plenty of private hospitals and government hospitals in the city which are equipped with the latest technologies and specialist doctors. Given below in Table No. 45 is the list of current health care facilities of Navi Mumbai in comparison with the previous two years. The density of hospital beds is an indicator of the availability of inpatient services at any location in case of emergency or any epidemic outbreak. The global standard for the same is 3.5 beds per 1000 population[63]. As seen in Figure No. 44 Navi Mumbai (3.3)[64] has better density of hospital beds as compared to national (0.7) as well as the global average (2.7) per 1000 population.

Table No. 45: Health care facilities in NMMC

	2011-2012	2012-2013	2013-2014
No. of Private Hospitals	180	184	184
Registered With NMMC	173	180	181
Dispensaries	163	158	184
Ayurvedic Clinics	336	351	377
Homeopathy Clinics	190	144	152
Bachelor of Dental Surgery	83	54	80
Pediatricians	75	75	75
Gynecologists	83	83	83
NMMC Hospitals	5	5	5
NMMC Dispensaries	20	20	21
NMMC Mobile Dispensaries	2	2	2
Private Dispensaries	772	797	865
Private Nursing Homes	64	76	81

Source: Health Department, NMMC

[63] WHO Guidelines
[64] This involves private as well as government hospital beds

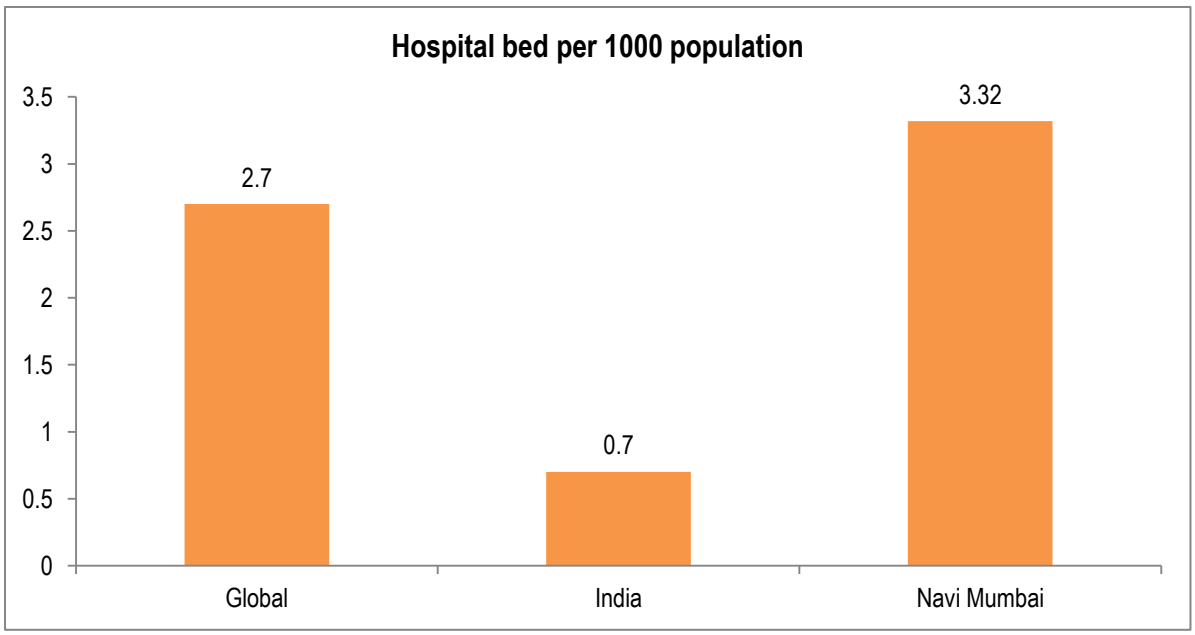


Figure No. 44: Benchmarking of hospital bed density per 1000 persons for Navi Mumbai

Source: World Health Statistics, 2013 and Health Department, NMMC

Environment and Health

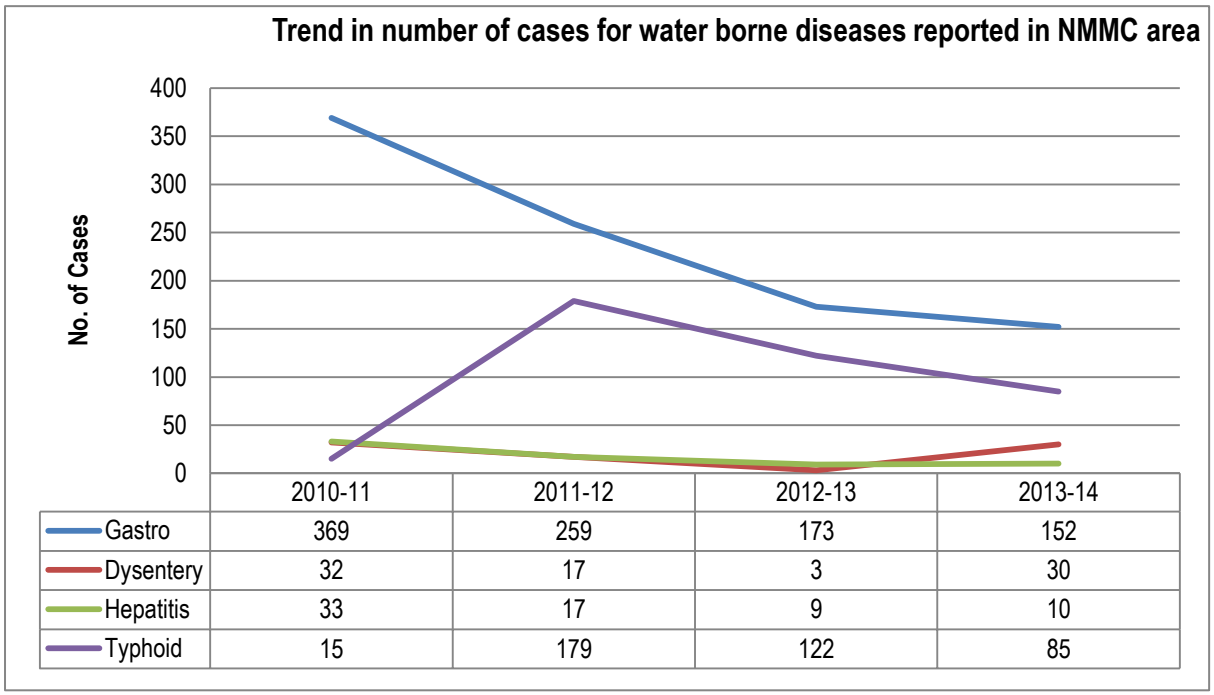
The interaction between the environment and human health are highly complex and difficult to assess. The best-known health impacts are related to ambient air pollution, poor water quality and insufficient sanitation. WHO has estimated that 24% of the global burden of disease and 23% of all deaths were due to modifiable environmental factors (for example, pollution, occupational risks, land use practices and sanitation). Diseases with the largest absolute burden from environmental exposure included diarrhoea, lower respiratory infections, dengue and malaria. The following section presents the status of various diseases recorded in NMMC in the year 2013-14 and the actions taken in the sensitive wards/ UHPs (Urban Health Posts) in NMMC area.

Water Borne Diseases

Water borne diseases are caused by pathogenic microorganisms, which are directly transmitted when contaminated water is consumed. Gastroenteritis, diarrhoea, hepatitis and typhoid are some of the commonly occurring water borne diseases in Navi Mumbai. The status and occurrence of the diseases is presented below in Figure No. 45.

As seen in the figure there is a continual and remarkable decrease in all the water borne diseases except dysentery, for which the number of reported cases increased from 3 cases in 2012-13 to 30 cases in 2013-14. The major cause of dysentery is due to consumption of food and water which may be contaminated with faecal coliforms and is known to usually occur in impoverished areas with poor sanitation.

Apart from decrease in total number of cases of water borne diseases, the UHPs (Urban Health Posts) of Shirvane, Khairane and Rabade also recorded a drastic increase in the cases of water borne diseases.



	2010-11	2011-12	2012-13	2013-14
Gastro	369	259	173	152
Dysentery	32	17	3	30
Hepatitis	33	17	9	10
Typhoid	15	179	122	85

Figure No. 45: Trend in number of cases for water borne diseases reported in NMMC area

Source: Health Department, NMMC

Vector Borne Diseases

Vectors are organisms that transmit pathogens and parasites from one infected person (or animal) to another, causing serious diseases in human populations. These diseases are commonly found in the regions where access to safe drinking-water and sanitation systems is challenging. According to WHO, vector-borne diseases account for 17% of the estimated global burden of all infectious diseases with dengue and malaria topping the list.

Malaria

Malaria, a parasitic infectious disease, is transmitted by mosquitoes which breed in fresh or occasionally brackish water. The species of *Plasmodium*, a causal parasite of malaria resides in the body of *Anopheles* mosquito, which acts as a vector in transmission of the malarial infection. Table No. 46 enlists UHP (Urban Health Posts) wise total number of malaria cases reported by NMMC's health department in the last 4 years. As seen in the table, the total number of malaria cases reported in NMMC area has decreased from 1138 (2010-11) to 396 (2013-14), however there has been a slight increase in the number of cases reported in the year 2012-13.

In the UHP's of Karave, Nerul-II, Shiravne, Sanapada, Turbhe and Ghansoli, the number of Malaria cases reported almost doubled in one year, and the UHP's of Pawane and Indranagar reported a drastic increase in Malaria cases in the year 2013-14. (Figure No. 46)

Table No. 46: UHP wise reported malarial cases in past four years in NMMC area

Nodes/ Year	2010-11	2011-12	2012-13	2013-14
CBD Belapur	88	53	14	18
Karave	43	36	14	33
Nerul	49	30	13	19
Nerul II	121	87	17	39
Shiravane	58	40	12	23
Sanpada	93	61	13	24
Turbhe	61	47	16	30
Pawane	69	55	7	27
Indranagar	69	56	22	54
Juhugaon	20	7	0	2
Vashi	26	19	2	5
Khairne	94	76	17	21
Mahape	79	39	6	8
Ghansoli	32	39	10	21
Rabade	31	18	5	8
Katkaripada	37	12	9	12
Airoli	44	28	4	10
Chichpada	45	23	4	10
Digha	37	27	14	20
Ialthanpada	42	22	8	12
Total	**1138**	**775**	**207**	**396**

Source: Health Department, NMMC

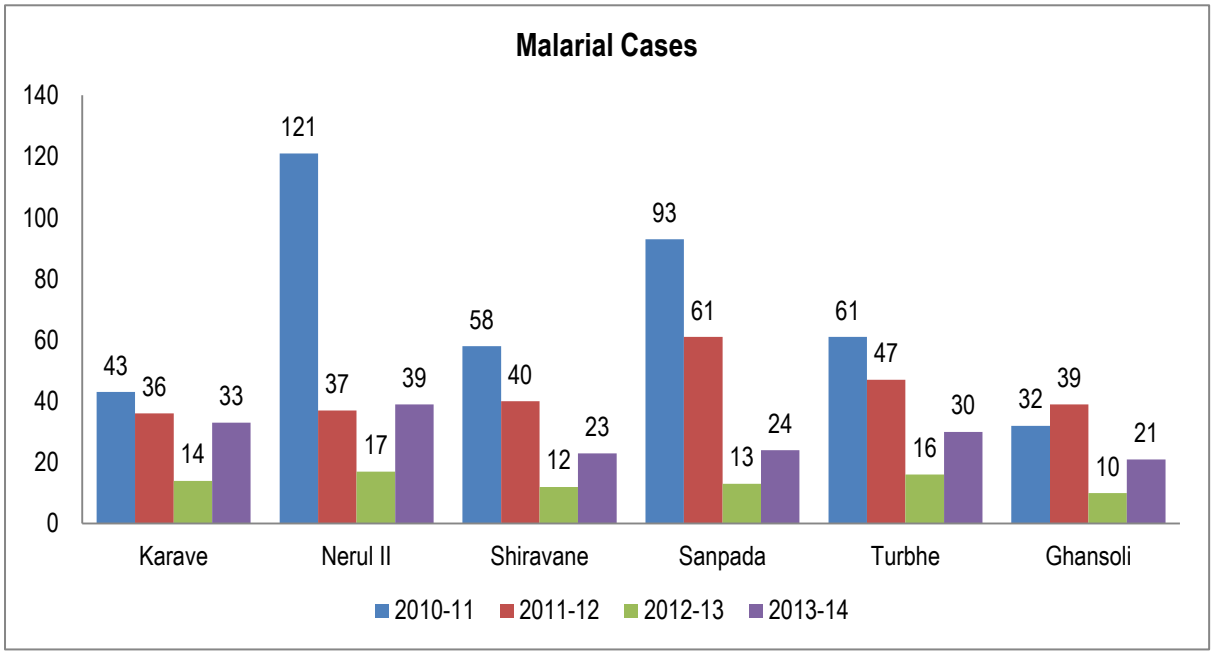


Figure No. 46: UHP wise reported cases of malaria in the past four years

Source: Health Department, NMMC

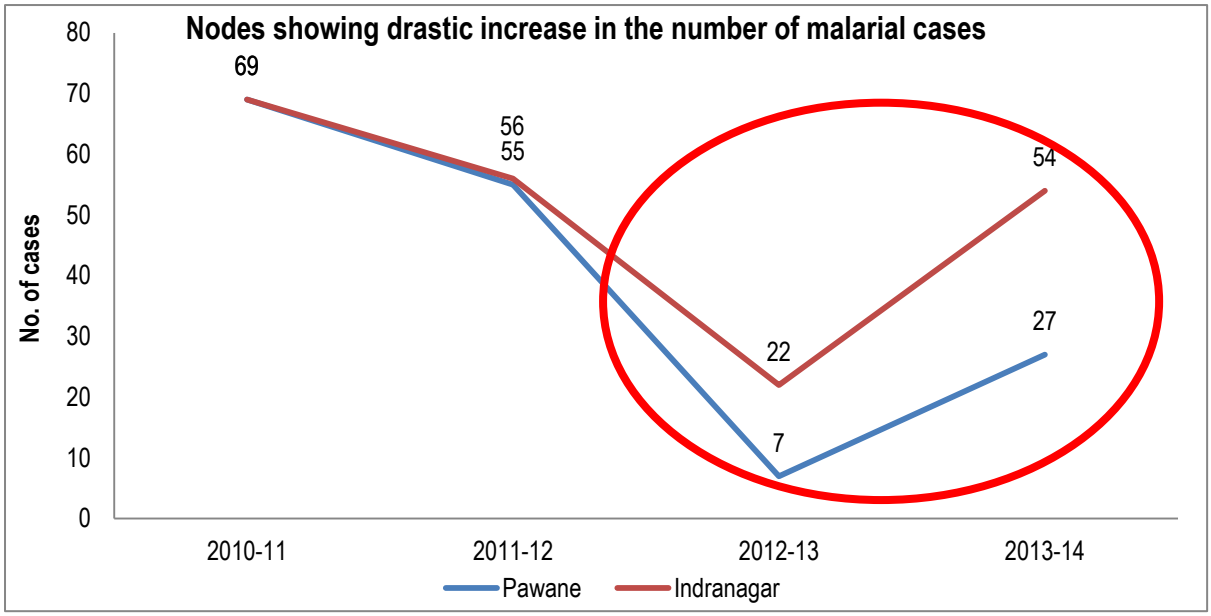


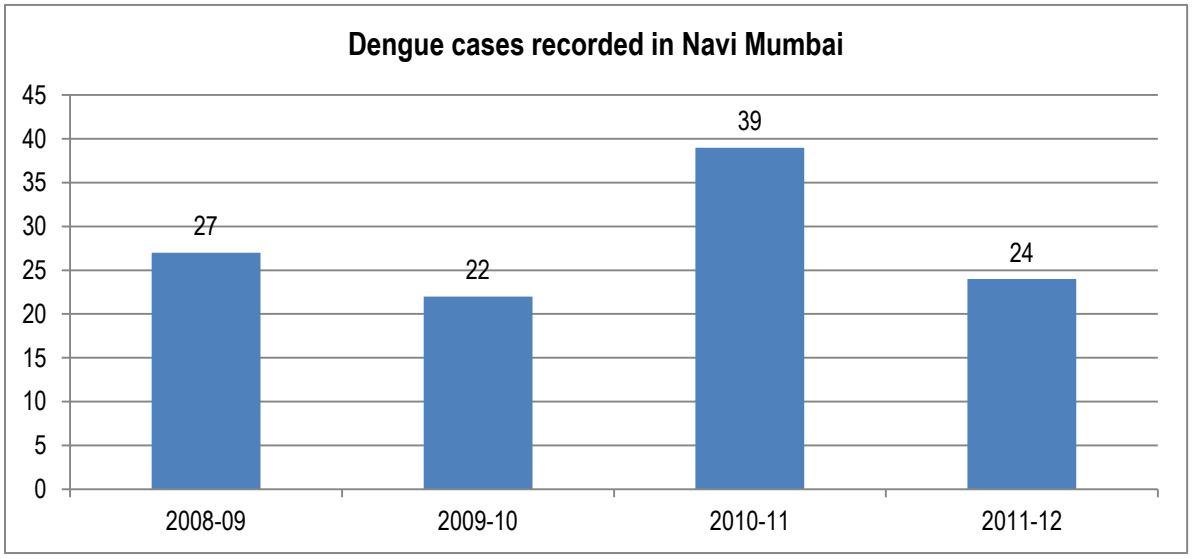
Figure No. 1: Increase in reported cases of Malaria at Pawane and Indranagar UHP in past two years

Source: Health Department, NMMC

Dengue

Dengue fever, also known as breakbone fever, is a mosquito-borne tropical disease caused by the dengue virus. Symptoms include fever, headache, muscle and joint pains, and a characteristic skin rash that is similar to measles. The *Aedes* sp. of mosquito acts as the vector for transmission of dengue infection. As shown in the Figure No. 47, there is a significant decrease in the total number of dengue cases from 2010-11 (39) to 2011-12 (24) which accounts to decrease of almost 40percent. In the year 2013 and 2014 more 9 and 7 suspects were tested for Dengue however they were reported negative for Dengue.

Figure No. 47: Total number of cases reported in Navi Mumbai between 2008-09 and 2011-12



Source: Health Department, NMMC

Response

NMMC's Health Department is vigilant enough to check and initiate effective measures for the control and eradication of vector-borne diseases like malaria & dengue and water borne diseases. There is a special wing under the expert medical team established by NMMC for detection, prevention, surveillance of these diseases and they actively run a control program for the same. The NMMC has undertaken preventive as well as therapeutic measures to eradicate the vector-borne diseases.

Preventive measures

1. Chemical spraying and fumigation of the breeding sites
2. Direct surveys by visiting the patient's home, collecting blood samples and providing medication
3. Indirect surveys by examining the blood samples of the patients suffering from fever and visiting the primary health care centers, women and child hospitals and other government hospitals.

Therapeutic measures

NMMC hospitals and health care centres are providing medicines to the patients.

Action Plan

1. Development of a yearly calendar and action plan for eradication of the diseases.
2. Identification and mapping of household level mosquito breeding sites
3. Special assessment of areas with higher parasite loads, collection of blood samples of patients and CRT (Chloroquine resistance transporter) distribution
4. Random assessment of 2 to 3 PHC's for effective assessment of action plan.
5. Special notice given to all type of hospitals and labs in the area to share information and data about new recorded cases
6. Mass awareness programs during festivals like Ganesh-utsav and Navratris.

Apart from the above measures, MPCB and NMMC have also proposed different industries situated in the MIDC areas in Navi Mumbai to upgrade/improve existing effluent treatment systems[65]. Provision of good drainage systems as well as good treatment systems may reduce the number of casual water pools, which would contribute to the control of vectors such as mosquitoes.

Air Borne Diseases

An airborne disease is any disease that is caused by pathogens and transmitted through the medium of air. As per Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, TB (Tuberculosis) is considered as the prototypic disease of airborne transmission. TB causing bacteria spread from person to person in tiny microscopic droplets when a TB patient coughs, sneezes, speaks, sings, or laughs. Tuberculosis (TB) is caused by bacteria (*Mycobacterium tuberculosis*) that affects the lungs and the condition is

[65] http://mpcb.gov.in/CEPI/pdf/Action%20Plan%20CEPI-Navimumbai.pdf

known as pulmonary tuberculosis whereas when the infection is outside the lungs and affects other internal body parts it is known as extra pulmonary TB.

NMMC is continuously implementing a TB eradication program in the region. As a result, the total number of cases and deaths reported in the region are decreasing from the past few years (Figure No. 48). Along with preventive measures, NMMC is also planning to have awareness programs to sensitize the citizens about the impacts and threats of TB. All civic hospitals in NMMC are equipped with staff and medicines to treat TB patients.

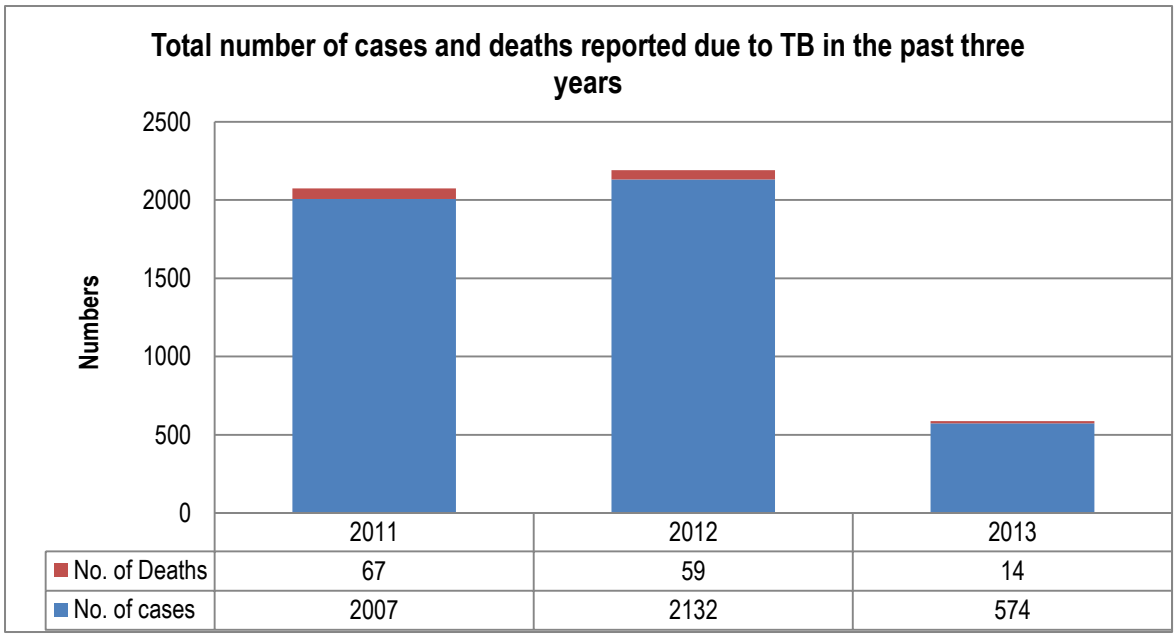


Figure No. 48: Total number of cases and deaths reported due to TB in the past three years

Source: Health Department, NMMC

Diseases caused by air pollution

Air pollution is playing a significant role in deteriorating the health quality of the urban dwellers as they are more prone towards its ill effects. According to the National Institute of Environmental Health Sciences (NIEHS) long-term exposure to air pollutants increases a person's risk to acquire respiratory illnesses. NIEHS notes that children and the elderly are especially vulnerable to the detrimental health effects of ozone, fine particulate matter (PM) and other airborne toxicants. The cases of respiratory disorders like Asthma, COPD (Chronic Obstructive Pulmonary Disorder) such as chronic bronchitis and emphysema and lung cancer are increasing day by day due to air pollution. As per WHO, 80% of outdoor air pollution-related premature deaths were due to ischaemic heart disease and strokes, while 14% of deaths were due to chronic obstructive pulmonary disease or acute lower respiratory infections; and 6% of deaths were due to lung cancer.[66] Hence it is necessary to keep a check on diseases like bronchitis and asthma.

[66] http://www.who.int/mediacentre/factsheets/fs313/en/

Monitoring of these diseases is an important parameter to know the status of the health conditions of a developing city, however there are gaps in collection and maintenance of the data regarding the above mentioned diseases in NMMC area. Hence it is recommended that NMMC could coordinate and maintain data for patients suffering from these disorders through a joint effort between the private and public hospitals. A survey could also be conducted to determine the baseline and formulate new guidelines to regulate air pollution in the city.

Health services and facilities by NMMC

NMMC regularly carries out the following measures for the well-being of citizens:

- 4-tier hospital services including Homeopathic/Ayurvedic / Dental care & treatment
- 24 hour ambulance
- Post mortem facility
- TB eradication programme
- Management & control of communicable diseases
- AIDS detection and guidance centre
- Registration of private practitioners, sonography centre and hospitals
- Action against unauthorized practitioners
- Sterilisation of stray dogs
- Malaria/Dengue detection, prevention and control programme

Other

For animal health care in Navi Mumbai, veterinary doctors are available. The NMMC takes care of the health of stray dogs by vaccinating them against various diseases.

Actions taken/Proposed by NMMC for health related projects

Department	Environmental related projects	Remarks
Health	Construction of 100 beds hospital each at Nerul and Airoli	Nearing Completion
Health	Pulse polio, Malaria reduction programme.	Under Implementation
Health	Reproductively & Child health Project-sponsored by GOI	Under Implementation
Health	Construction of two new 50 beds hospital at Ghansoli	Proposed
Health	Free Medical check-up & health card for slum dwellers	Under Implementation

Budgetary Expenses and Provisions

This section presents the budgetary expenses and provisions made towards environment related infrastructure and management by NMMC. In the year 2013-14, NMMC incurred about 223 crores, about 15% of the total budget of NMMC, for infrastructure, monitoring, facilities and initiatives for the environment. The activities included environmental monitoring done by NMMC for air and water pollution, sweeping, collection and transportation of municipal solid waste, disposal of solid waste, water supply and sanitation. Around 20 crores were spent on the maintenance and development of gardens in NMMC area.

To enhance the network for air quality monitoring, NMMC has proposed to install two more CAAQMS, one each at Belapur and Nerul. A separate budget of around 3 crores has allotted for the year 2014-15 for installing the same. Also for the year 2014-15 around 50 Lakhs has been allotted to promote the Eco-City program in NMMC area.

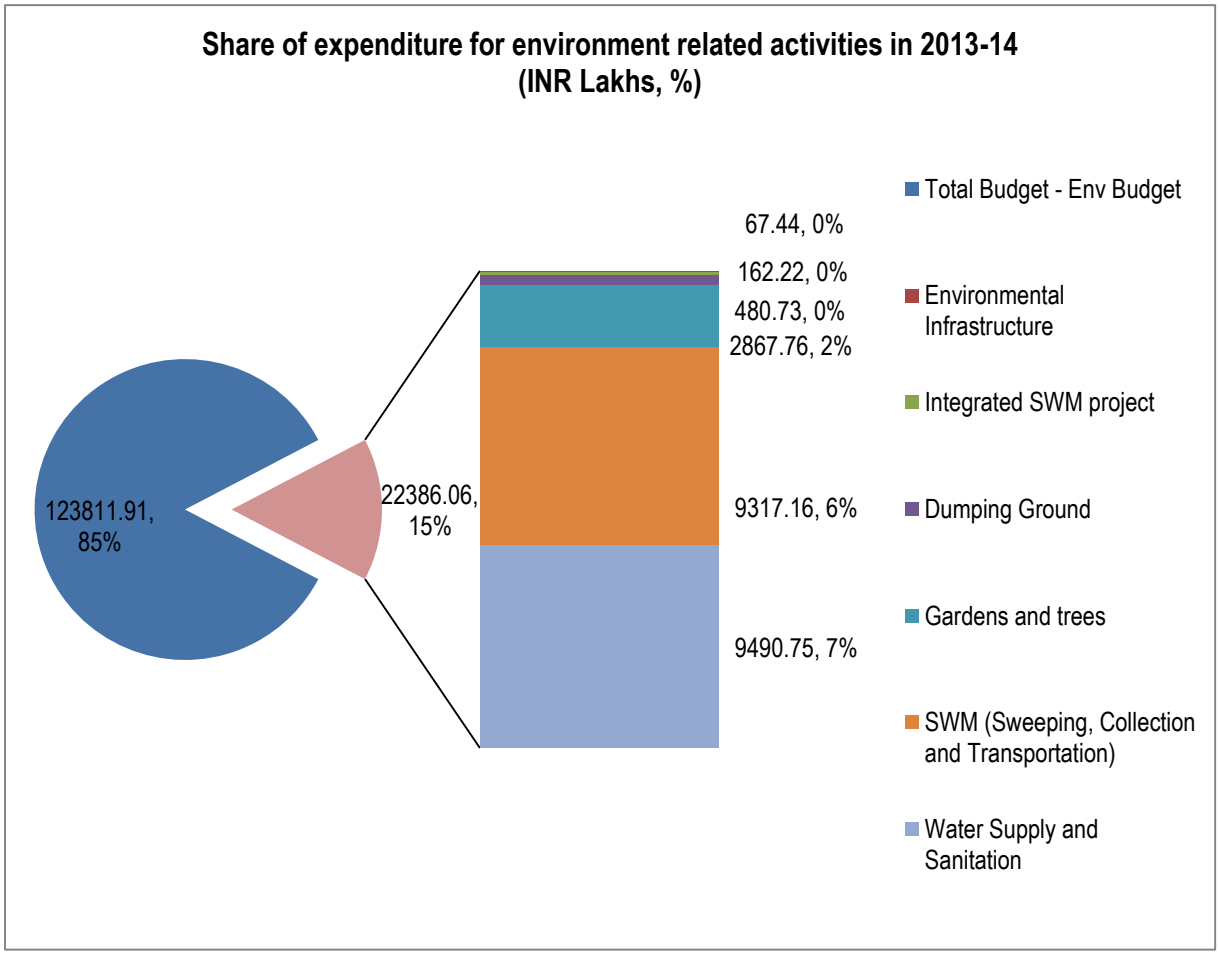
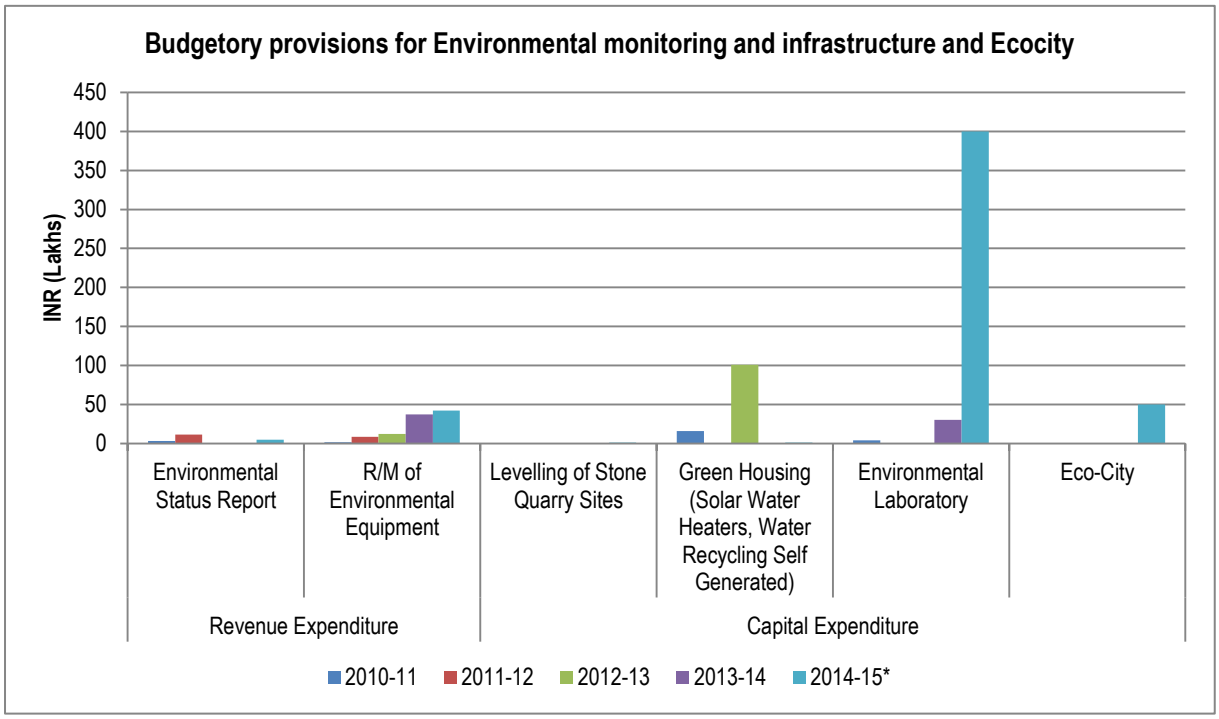
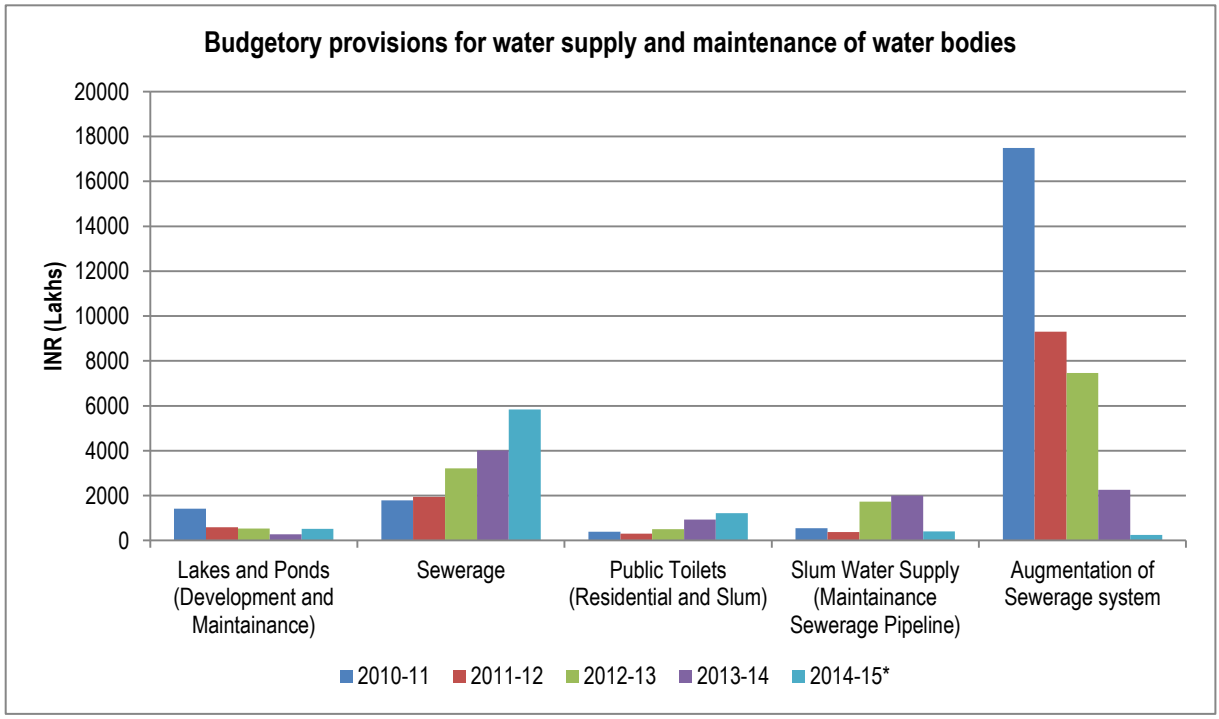


Figure No. 49: Share of budget spent for environment related activities in 2013-14



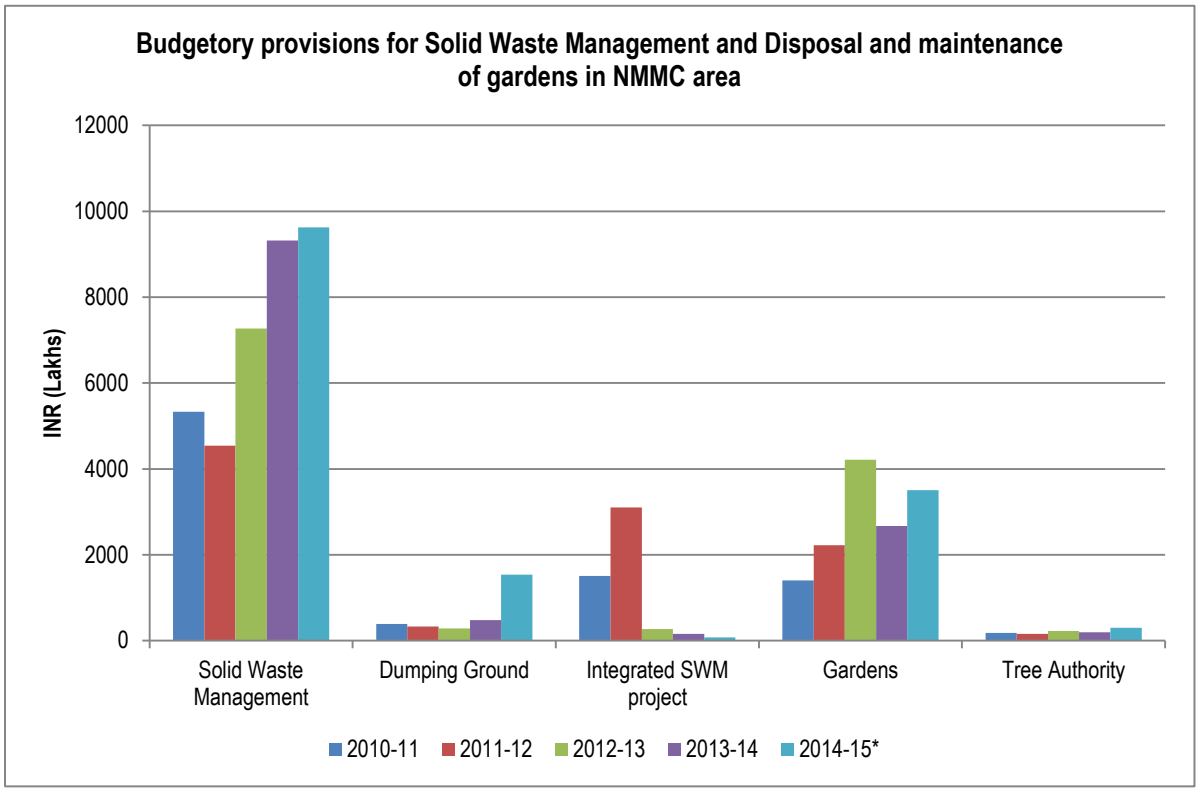
*2014-15 budget is estimated budget while all other are actual expenses

Figure No. 50: Budgetory provisions for Environmental monitoring, infrastructure and Ecocity



*2014-15 budget is estimated budget while all other are actual expenses

Figure No. 51: Budgetory provisions for water supply and maintenance of water bodies



#Solid Waste Management includes (Sweeping, Collection and Transportation)

**2014-15 budget is estimated budget while all other are actual expenses*

Figure No. 52: Budgetory provisions for Solid Waste Management and Disposal and maintenance of gardens in NMMC area

Annexure – I: Calculation of indices

Approach

The information on environmental parameters is often too complex and non-comprehendible to non-environmental professionals. The problem is further complicated as environment covers broad spectrum of areas from air quality to biomedical waste management. The goal of assessing status of environment is planning for sustainable development by ensuring that quality of life of the people is maintained and, if possible, improved while maintaining quality of environment.

The findings of present environmental assessment are discussed in details in the earlier sections and same have been used in this section for computations of indicators. The basis has been maintained same to assess the change in environmental status in NMMC area for the current year.

Methodology

Three indicators have been used in the present assessment:

1. Environmental Quality Index (EQI);
2. Urban Infrastructure Index (UII); and
3. Quality of Life Index (QOLI).

For computation of EQI, ambient air quality (in residential areas & traffic junctions), noise levels in residential areas & traffic junctions), quality of drinking water, quality of surface water, quality of ground water, adequacy of sewage treatment, adequacy of solid waste treatment, and adequacy of biomedical waste treatment are used as parameters. While air quality, noise levels and drinking water quality affects human health both in short term as also in long-term, impact of changes in other parameters are comparatively less important in short-term. Hence, while computing EQI following procedure has been used:

Out of total score of 100, scores have been assigned to individual parameter based on importance. This is termed as Parameter Importance Unit (PIU).

For assessing status of individual parameter, a scale has been developed by assigning zero score to totally un-acceptable parameter measurement and 1 score to desired parameter measurement. This is termed as Parameter Environmental Quality (PEQ). For various measurements of parameter in NMMC, PEQ has been estimated based on data collected for ESR, and values have been averaged to estimate overall PEQ for NMMC area.

Environmental Quality Index (EQI) for an individual parameter has been worked out by multiplying PEQ and PIU.

Values of EQI for all parameters have been added to compute EQI.

Using this method, if values of all parameters are as desired ones the value of EQI will be 100.

For assessing UII, population density, water supply system, sewerage system and storm water collection system, solid waste collection system, slum development, health facility, educational facility, public transport, employment opportunity, parks & gardens, roads network, entertainment facilities, and public grievance redressal mechanism have been used as parameters. As assessment of infrastructure facility is more a subjective judgment than quantitative evaluation, a seven-point scale has been used for evaluation of UII for individual parameters as follows:

- Very Poor: 0.0
- Poor: 0.20
- Satisfactory: 0.40
- Good: 0.60
- Very good: 0.80
- Excellent: 0.90
- Outstanding: 1.00

Values of UII for individual parameters have then been converted into percentage for easy comprehension. Quality of Life Index has been computed as average of EQI and UII.

Estimation of Environmental Quality Index

The importance assigned to various parameters selected for computing EQI and scale used for assessing the present status is presented in Table No. 47. PEQ for individual parameters have been computed based on data collected for ESR. Overall EQI is summarised in Table No. 48 while details of computation are presented in Table No. 49. EQI computed for various nodes of NMMC and it has been found out that present EQI in NMMC area is 70.69%.

Estimation of Urban Infrastructure Index

In the case of urban infrastructure, mere numbers may be misleading (e.g. average per capita water supply may be satisfactory but due to uneven distribution satisfaction level may be low). Hence, for computing UII subjective assessment has been used. Results of computation are presented in Table No. 50. It has been found out that present UII in NMMC area is 79.06%.

Estimation of QOL

Quality of environment and availability of infrastructure facilities together decide quality of life. As the impact of these considerations is synergistic, equal importance needs to be given to both. Hence, QOL has been computed as average of EQI and UII. Present QOL Index for NMMC area has been worked out as 74.88%.

Table No. 47: Assignment of importance units and PEQ scale for parameters selected for computing EQI

Sr. No.	Parameter	Parameter Importance Unit (PIU)	Parameter Measurement for	
			PEQ = 0.0	PEQ = 1.0
A.	Ambient Air Quality	15		
A.1	Air Quality Index-Residential Area (RSPM)	10	200	0
A.2	Air Quality Index-Traffic Junctions (RSPM)	5	200	0
B.	Ambient Noise Levels	15		
B.1	Noise Level : Residential Area	10	100	0
B.2	Noise Level : Traffic Junctions	5	100	0
C.	Ambient (Surface/Ground) Water Quality	15		
C.1	Surface (drains) Water Quality, BOD mg/l	3	100	0
C.2	Surface (Lake) Water Quality, BOD mg/l	3	10	0
C.3	Ground (Well) Water Quality, BOD mg/l	3	10	0
C.4	Efficiency of Sewage Treatment Plants	6	0	100
D.	Solid Waste Management	15		
D.1	Solid Waste Collected, percentage	3	0	100
D.2	Solid Waste Segregation at Household Level, percentage	2	0	100
D.3	Solid Waste Segregation at Disposal Site, percentage	2	0	100
D.4	Solid Waste Recycle at Household Level, percentage	2	0	100
D.5	Solid Waste Recycle at Disposal Site, percentage	2	0	100
D.6	Biomedical Waste Collected, percentage	2	0	100
D.7	Road/Public Places Cleanliness *	2	0	1
E.	Protection of Ecosystem	20		
E.1	Protection of mangroves*	10	0	1
E.2	Protection of hills and quarry restoration*	10	0	1
F.	Public Health	20		
F.1	Drinking Water Quality, % samples fit for drinking	5	0	100
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	5	100	0
F.3	No of cases of malaria in node	5	100	0
F.4	Cases of TB, percentage population affected	3	1	0
F.5	Control of Street Dogs*	2	0	1
	Total	**100**		

Note: (*) Measured as V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0

Table No. 48: Estimation of Environmental Quality Index

Sr. No.	Parameter	Environmental Quality Index, %				
		Max	Average 2012-13	Average 2013-14	Variation	Remarks
A.		**Ambient Air Quality**				
A.1	Air Quality Index-Residential Area (RSPM)	10	8.00	7.23	-0.77	
A.2	Air Quality Index-Traffic Junctions (RSPM)	5	3.45	3.26	-0.19	
B.		**Ambient Noise Levels**				
B.1	Noise Level: Residential Area	10	7.07	4.39	-2.68	
B.2	Noise Level: Traffic Junctions	5	3.59	1.79	-1.80	
C.		**Ambient (Surface/Ground) Water Quality**				
C.1	Surface (Drains) Water Quality, BOD mg/l	3	0.00	1.59	+1.59	
C.2	Surface (Lake) Water Quality, BOD mg/l	3	0.89	1.54	+0.65	
C.3	Ground (Well) Water Quality, BOD mg/l	3	2.50	2.10	-0.40	
C.4	Efficiency of Sewage Treatment Plants	6	6.00	5.84	-0.16	
D.		**Solid Waste Management**				
D.1	Solid Waste Collected, percentage	3	2.70	2.70	0.00	
D.2	Solid Waste Segregation at Household Level, percentage	2	1.40	1.40	0.00	
D.3	Solid Waste Segregation at Disposal Site, percentage	2	1.60	1.80	+0.20	

Sr.	Parameter	Environmental Quality Index, %			
D.4	Solid Waste Recycle at Household Level, percentage	2	1.80	1.80	0.00
D.5	Solid Waste Recycle at Disposal Site, percentage	2	0.50	1.00	+0.50
D.6	Biomedical Waste Collected, percentage	2	1.40	1.40	0.00
D.7	Road/Public Places Cleanliness	2	1.80	1.80	0.00
E.		**Protection of Ecosystem**			
E.1	Protection of mangroves	10	8.0	8.0	0.00
E.2	Protection of hills and quarry restoration	10	6.23	6.00	-0.23
F.		**Public Health**			
F.1	Drinking Water Quality, % samples fit for drinking	5	4.45	4.81	+0.36
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	5	4.38	4.31	-0.07
F.3	No of cases of malaria in node	5	3.26	4.06	+0.80
F.4	Cases of TB, percentage population affected	3	0	2.67	+2.67
F.5	Control of Street Dogs	2	1	1.20	+0.20
	Total	**100**	**70.02**	**70.69**	**+0.67**

Table No. 49: Measurement of Parameters for calculation of EQI of NMMC area

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
A.	**Ambient Air Quality**								
A.1	Air Quality Index-Residential Area (RSPM)	60.15	51.98	57.05	59.68	59.53	55.68	45.05	54.50
	EQI	7.00	7.40	7.15	7.02	7.03	7.22	7.75	7.28
A.2	Air Quality Index-Traffic Junctions (RSPM)	74.95	71.40	75.30	37.10	67.23	80.47	73.58	78.19
	EQI	3.13	3.22	3.12	4.08	3.32	2.99	3.16	3.05
B.	**Ambient Noise Levels**								
B.1	Noise Level : Residential Area	53.0	52.8	58.0	54.9	55.8	54.7		
	EQI	4.70	4.72	4.20	4.51	3.70	4.53		
B.2	Noise Level :Traffic Junctions	62.8	63.3	62.3	60.9	66.8	67.8	66.1	
	EQI	1.91	1.84	1.89	1.96	1.66	1.61	1.70	
C.	**Ambient (Surface/Ground) Water Quality**								
C.1	Surface (drains) Water Quality, BOD mg/l	41	38	53	59	45	62	32	46
	EQI	1.77	1.86	1.41	1.23	1.65	1.14	2.04	1.62
C.2	Surface (Lake) Water Quality, BOD mg/l	5	6	5	4	4	5	5	5
	EQI	1.5	1.2	1.5	1.8	1.8	1.5	1.5	1.5
C.3	Ground (Well) Water Quality, BOD mg/l	3	3	4	4	3	2	2	3
	EQI	2.1	2.1	1.8	1.8	2.1	2.4	2.4	2.1
C.4	Efficiency of Sewage Treatment Plants	95.80	97.33	97.69	97.55	97.58	97.63		
	EQI	5.75	5.84	5.86	5.85	5.85	5.86		

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
D.	**Solid Waste Management**								
D.1	Solid Waste Collected, percentage	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	EQI	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
D.2	Solid Waste Segregation at Household Level, percentage	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
	EQI	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
D.3	Solid Waste Segregation at Disposal Site, percentage	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	EQI	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
D.4	Solid Waste Recycle at Household Level, percentage	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	EQI	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
D.5	Solid Waste Recycle at Disposal Site, percentage					50.00			
	EQI					1.00			
D.6	Biomedical Waste Collected, percentage	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
	EQI	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
D.7	Road/Public Places Cleanliness, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	EQI	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
E.		**Protection of Ecosystem**							
E.1	Protection of mangroves, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0		0.8	0.8		0.8			
	EQI		8.0	8.0		8.0			
E.2	Protection of hills and quarry restoration, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0				0.6	0.6			
	EQI				6.0	6.0			
F.		**Public Health**							
F.1	Drinking Water Quality, % samples fit for drinking	96.17	96.17	96.17	96.17	96.17	96.17	96.17	96.17
	EQI	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	05	16	09	20	31	15	09	05
	EQI	4.75	4.20	4.55	4.00	3.45	4.25	4.55	4.75
F.3	No of cases of malaria in node	18	29	4	36	19	15	11	16
	EQI	4.10	3.55	4.70	3.20	4.05	4.25	4.45	4.20
F.4	Cases of TB, percentage population affected	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
	EQI	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67
F.5	Control of Street Dogs, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	EQI	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Table No. 50: Estimation of Urban Infrastructure Index for NMMC area

Sr. No.	Infrastructure Facility/Amenity/Service	Status*	Score		Remarks
			2012-13	2013-14	
1.	Drinking water supply	Excellent	0.95	0.96	Construction of 450 MLD new water treatment plant.
2.	Sewerage	Excellent	0.93	0.93	No major change,
3.	Storm water Drainage	Excellent	0.93	0.93	No major change,
4.	Public toilets	Good	0.70	0.70	No major change
5.	Solid Waste Collection and transportation	Excellent	0.94	0.82	Transportation of solid waste carried out by open trucks
6.	Health Services	Good	0.66	0.66	Excellent work in control of TB & water borne diseases
7.	Public Transport	Good	0.67	0.67	No major change.
8.	Road Network & footpaths	Good	0.78	0.82	Concretization of roads & circles.
9.	Education Facilities	Excellent	0.93	0.93	No major change,
10.	Parks/gardens & Tree Plantation	V. Good	0.86	0.88	Koparkhairne Phase II garden commissioned & redevelopment of balance gardens.
11.	Entertainment	Good	0.65	0.65	No major change.
12.	Public library	Good	0.61	0.61	No major change.
13.	Playgrounds	Good	0.6	0.60	No major change
14.	Fire Fighting	V. Good	0.81	0.88	
15.	Slum Development	Good	0.65	0.65	No major change
16.	Public Grievance Redressal and Participation	Excellent	0.9	0.90	No major change
17.	Employment Opportunities	V. Good	0.85	0.85	No major change
	Total		**13.42**	**13.44**	
	Urban Infrastructure Index for NMMC Area = (13.44/17)*100 = 79.06%				

***Based on data available for overall NMMC area.**

Annexure – II: Details for determining Environmental Performance Index

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
Growth of cities	Demographic growth (% 2001)	Population growth rate	%		Census	59.18	2
		% of slum population to total population	%		Census	16.66	10
	Economic growth	Work participation ratio	%		Census	260	10
		% of people below poverty line.	%		Statistical Handbooks	0.17	10
		% of budget spent on Environmental Infrastructure		Budget spent on Bio Medical Waste, Municipal Solid Waste and Sewage Treatment Plants to be considered.	ULB Budget	15	2
	Industrial growth	% of polluting industries to total industries	%	Number of polluting industries is the number of orange and red category industries. % of these industries to the total number of industries to be entered.	MPCB Regional Offices	51.84	4
	Spatial growth (Decadal)	Population density	Persons/ sq Km		Census	10472	2
		% of slum area to city area	%		Census	21	2
State of Natural resources	Landuse	% of green area to the total city area	%		Town planning department	38	10
		Green area per 1000 persons	Ha/person	To be calculated from total green area of the city and total population of the city.	Town planning department	3.72	10

Thematic	Primary	Data variables	Unit	Instructions	Source	Value	Score
	Air	Ambient air quality	Score	Refer to Box A in Scoring Details worksheet for assigning values	MPCB Regional Offices	B	8
	Noise	Noise levels				B	8
	Water	Water quality				B	8
	Energy	Per capita energy consumption	Kwh/ Annum		Maharashtra Energy Development Agency	930	2
		Share of renewable energy in total energy consumed	%			0	0
		Number of hours for load shedding	hours			0	10
	Human	Crude death rate	%		Census	4.32	8
		Infant mortality rate	%		Census	11.10	10
Urban services	Water Supply	Net LPCD supplied	lpcd		Water supply department	250	10
		% of households connected by service connection	%			100	10
		Unaccounted for water	%			19	6
		Duration of water supply	hours			24	10
		Staff per 1000 connections	Persons			5.4	2
	Sewerage Sanitation	% of population catered to by underground sewer network	%		Sewerage Department	85	10
		% area covered with collection to total city area	%			85.00	10
		Staff per 1000 connections	Persons			1.05	2
	Solid Waste Mgmt	Total SW generated per capita	gm		Solid Waste Management Department	450	4
		Life of landfill site	Years			69	10

Thematic	Primary	Data variables	Unit	Instructions	Source	Value	Score
		% of waste disposed into landfill site to total waste generated	%			100	10
		% of waste collected to total waste generated	%			100	10
		% biomedical waste treated to total BM waste	%			100	10
	Transport	Road area as % of city area	%		Town Planning Department	13.6	8
		% of population travelling by public transport	%		Regional Transport Authority	60.0	4
Initiatives for improving city environment	Environmental awareness and education	Are the training programs for school teachers on Environmental education adequate?	Score	Qualitative values to be assigned based on extent of initiative in the City/Town as given below: VH for Very High H for High M for Moderate L for Low A for Absent		M	4
		To what extent are awareness programs on environment launched during festivals or other times of the year?				M	4
		To what extent exhibitions / street plays etc organized to spread environmental awareness?				M	4

Thematic	Primary	Data variables	Unit	Instructions	Source	Value	Score
		To what extent does the city/town have any local Television channel running programs, advertisements related to environment sponsored by the respective ULB?				M	4
		To what extent do the local newspapers include a section on environment sponsored by the ULB?				H	6
	Waste Management	To what extent has the segregation of dry and wet waste substantially reduced the volume of waste disposed to the landfill?				VH	8
		To what extent is waste management decentralized to NGO / CBO?				L	2
		To what extent is the activity of recycling of waste by ragpickers formalized by the ULB?				VH	8
		To what extent is management of demolition and construction waste addressed in the policy and regulations of the ULB?				L	2

Thematic	Primary	Data variables	Unit	Instructions	Source	Value	Score
		To what extent is the city/town responding to PPP efforts in managing hazardous waste, plastic, electronic waste and waste oil?				VH	8
	Slum Improvement	To what extent are the regularised slum areas formally provided with sanitation and sewerage facilities?				H	6
		To what extent do the residents of slums have access to public health centres and regular health checkups?				VH	8
		To what extent are adult education programs run by the ULB in slum areas?				H	6
		To what extent is the solid waste in slum areas managed by the ULB?				VH	8
		To what extent does the ULB have regulations on use of fuel like banning firewood and providing alternate fuel?				L	2

Thematic	Primary	Data variables	Unit	Instructions	Source	Value	Score
	Traffic	To what extent are paths dedicated to bicycle or pedestrian movement?				M	4
		To what extent are steps taken to prevent adulteration of fuel?				L	2
		To what extent are clean fuels like CNG used?				M	4
	Water	To what extent does the ULB have regulations/ schemes encouraging Rain Water Harvesting?				M	4
		To what extent do building codes have regulations for using water saving fittings and fixtures?				M	4
		To what extent has the ULB taken measures to identify leaks and reduce water losses?				VH	8
		To what extent does the ULB check whether the water quality is satisfactory at the consumers end?				VH	8

Concerned divisions / project related brief note to be included here

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