Environmental Status Report of Navi Mumbai Municipal Corporation 2015-16

Foreword

Conservation and preservation of natural resources is the key to achieve sustainable development. Mushrooming cities and the escalating population are today the key reason identified which exert pressure and exploit these resources. This results in degrading of the environment ultimately disturbing the ecosystems. Various strategies have been formulated worldwide through numerous initiatives not only to reduce the pressures and impact but also to improve the quality of the natural resources.

One such strategy has been integrated in the section 67 A of the Maharashtra Municipal Corporation Act, 1949 which mandates the A class ULB's to document an annual ESR (Environmental Status Report). Towards this NMMC has been documenting the ESR for more than 15 years and this year the 16th edition of Navi Mumbai's Environmental Status Report for the year 2015–16 is being published with full enthusiasm and commitment towards the environment.

NMMC has not only taken initiatives to reduce the pressures on the natural resources such as Air, Water and Land, but have also taken initiatives for its mitigation and improving its quality. This has led to a slight improvement in the Environmental indices of the city such as the Environment Quality Index, Urban Infrastructure Index and Quality of Life Index of the city. The overall Environmental Performance Index has also shown an increase in its score this year.

It could be noted that the PM pollution has been relatively reduced, as compared to the last year, in the city due to several initiatives such as completion of major road projects between last two years 2014-2016. NMMC is dedicatedly working to reduce the PM pollution and is already in process to implement various new strategies to reduce the same. Even though a slight increase in NOx and CO is observed, the overall air quality could be seen to be improving as rest of the pollutants are already under the standards as prescribed by CPCB. Water pollution levels in Navi Mumbai are already under control, owing to the initiative implemented under the Lake Vision project, erection of gabion walls, efficient sewage treatment facilities and so on. This year realising the need to conserve water resources, NMMC has undertaken initiatives such as recirculation of back wash water at the water treatment saving water to the tune of 10–12 MLD. Owing to water crunch and scanty rainfall last year NMMC also significantly reduced the excessive water supplied to the city and is supplying around 300 MLD since December 2015 as compared to around 435 MLD last year.

The corporation is well equipped with state of art process to scientifically dispose the Solid waste generated in the city. Along with this, initiative such as segregation of solid waste at source has helped in proper collection, segregation and disposal of solid waste. Several other key initiatives, under Swachh Bharat Mission have also been proposed which shall help in recycling of the waste, especially C&D waste and waste to energy options which could be used for several applications.

The cumulative effect of the above initiatives taken by NMMC has enabled to improve the environmental health of the city. With this, I am glad to present this report and I am sure this report would serve as a useful tool not only for NMMC but also for the citizens of Navi Mumbai.

Shri. Tukaram Mundhe, I.A.S

Municipal Commissioner, NMMC

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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
GTIPL	Gateway Terminal India Private Ltd
HSD	High Speed Diesel
IOCL	Indian Oil Corporation Limited
IT	Information Technology
JNPCT	Jawaharlal Nehru Port Container Terminal
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
NSICT	Nhava Sheva International Container Terminal
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
SO2	Oxides of Sulphur
STP	Sludge Treatment Pool
tCO_2e	Tons of Carbon Dioxide Equivalent
TERI	The Energy and Resources Institute
TEU's	Twenty foot Equivalent Units
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

- HUDCO AWARD: For the Best Practices to Improve the Living Environment (2015-2016)
- JCB Clean Earth Award for Excellence in Solid waste Management (2015)
- Award for Solid Waste Management 2014 by EPC World Media Group.
- National Urban Water Award 2011 for contracting O &M services.
- First prize award for Family Welfare Programme, TB prevention & Control program and Second award for Mother Child Health Care Programme in Maharashtra state.
- Best Urban ICT award for E-Governance project of NMMC by Government of Maharashtra.
- Best practices award for NMMC centre of Education and Training for Handicap by Social Justice & Special aid department of Government of Maharashtra.
- EPC World Award for Outstanding Contribution in Urban Civic Amenities (STP Project).
- Sant Gadge Baba Nagri Swachata Abhiyan special Award - 2008-09 from Government of Maharashtra for best Sanitation practices in city.
- Indian Municipal Vision-2020 Award for "WISITEX Green Urban Development Award of the Decade".
- Government of India National Urban Water Awards (NUWA) 2010 for "Sanitary Improvements and Safe Disposal Practices, Integrated Storm Water Disposal System".
- Government of India National Urban Water Awards (NUWA) 2010 for "Improved Customer Satisfaction, Governance, Public Disclosure and Transparency".
- Best City Award for Improvement in Waste Water and Sanitation Services under JNNURM (2009).
- Vasundhara Award – 2009 by Hon. Chief Minister of GOM for excellence in city environment.
- National Urban Water Award-2009, by Hon. President of India for “Services to Urban Poor.”
- 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 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.
- 1st prize under the Sant Gadgebaba urban cleanliness campaign twice (2002-2003 & 2005-2006) with cash reward of Rs 50,00,000/-

Executive Summary

Being one of the most successful planned city, Navi Mumbai is well equipped with state of art technologies specifically pertaining to urban services like water supply, sewage treatment, solid waste management, public transport, health facilities and so on to cater to the needs of population. Navi Mumbai, in true terms has lived to its expectations of absorbing the population shock from the mega city of Mumbai which is evident from the fact that Navi Mumbai recorded a decadal population growth by more than 51% between 2001 and 2011

The population of NMMC (Navi Mumbai Municipal Corporation) area was estimated to be about 14.5 lakhs 2015–16 which 0.7% more compared to last year as per the survey data of UHPs (Urban Health Posts), Health department NMMC. The total number of properties have also increased to 2,94,629 with residential properties having the highest share of 81% followed by commercial buildings (17%) and industrial properties (1%). This increase in population coupled with growth in industrial, educational hub, economic activities and infrastructure are the major driving forces for the growth of a city which exert pressure on the resources of the city 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 which documents the status of the environment has been presented as per the DPSIR (Drivers, Pressure, Status, Impact and Response) framework proposed by MPCB (Maharashtra Pollution Control Board) guidelines 2009.

Environmental Indices for Navi Mumbai

To have a comprehensive overview of the environmental performance and the state of resources NMMC has been annually calculating indices such as, EQI (Environmental Quality Index); UII (Urban Infrastructure Index); and QOLI (Quality of Life Index), since the past 15 years. For the year 2015-16 the EQI (71.59%), UII (80.29%) and QOLI (75.94%) have improved as compared to the previous year; EQI (71.38%), UII (79.65%), QOLI (75.52%). Overall improvement of EQI is attributed to completion of concretization and development of roads, source segregation of solid waste, development of sanitation facilities by installing additional public toilets under the Swachh Bharat Mission, transportation of solid waste through use of compactors, continuous monitoring and disinfection by chlorination of drinking water and so on.

This year NMMC has calculated the EPI (Environment Performance Index), endorsed by MPCB for the third consecutive year. 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 EPI score for NMMC area was determined to be 664.90 out of 944 and has registered a slight improvement of 1.6 compared to last year owing to three major initiatives undertaken for increasing awareness related to environmental issues, segregation of solid waste and increasing sanitation and sewerage facilities in slums (Table No. 1).

NMMC has recorded an improvement in the EQI, UII and EPI, owing to various pro-environment initiatives like improvement in road quality, increased sanitation facilities in slums, source segregation of waste.

Table No. 1: Environmental Performance Index

Gap Analysis		
Environmental Score	**Achievable Score**	**Achieved Score**
Thematic Indicators	**944**	**664.90**
Growth of cities	250	140.00
State of natural resources	300	225.60
Urban Services	250	198.50
Initiatives for improving city environment	144	100.80

Air Quality

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), Turbhe (near landfill site) and Koparkhairne (near Teen Taki). This year a new CAAQMS has been installed at Wonders Park, Nerul.

The decreasing trend in RSPM levels in NMMC could be attributed to the successful completion of concretization of roads, regular cleaning by vacuum suction machines, plantations along the road side

It is interesting to note that the city of Navi Mumbai is clean for SO_2 (Sulphur dioxide) and NOx (oxides of nitrogen) pollution and the only concern of air pollution is higher PM (Particulate Matter) concentrations. However, even though the concentrations are exceeding the annual standards for PM (90 µg/m^3), Navi Mumbai still recorded less pollution for PM when compared to other cities of Maharashtra such as Thane, Mumbai, Amravati, Aurangabad, Kalyan and Chandrapur which recorded annual PM concentrations of almost 100 µg/m^3 or above.

A slight increase could be observed in the levels of SOx and NOx this year, although the concentrations are under the standards. A decrease could be observed in the concentrations of PM_{10} and $PM_{2.5}$ compared to the concentrations of last year. This decrease in the concentration of RSPM could be attributed to the completion in the concretisation of roads which has led to decongestion of traffic and reduction in dispersion of dust and concrete during the construction activity.

In 2015-16, it was observed that the SO_2 concentrations for all the 3 CAAQMS were well below the annual standards of 50 µg/m^3. As for the NO_X concentrations, the concentration has increased this year at Koparkhairane (57.40 µg/m^3) and Airoli (42.35 µg/m^3). Both these stations have violated the annual permissible limit (40 µg/m^3) for the past 7 years for NOx concentration. Only, the concentrations at Turbhe is below the permissible limit for the years 2015- 16 and also for the previous 3 years. All the CAAQMS have recorded violation for PM_{10} for the past 5 years which indicates that Navi Mumbai has PM_{10} pollution. Except for Airoli, both Koparkhairane and Turbhe have exceeded the limits for $PM_{2.5}$ concentrations. Since the last five years the $PM_{2.5}$ and PM_{10} levels in Navi Mumbai have been higher than the standards at all sites. NMMC has already noted this issue and is developing and implementing plan to reduce the PM pollution levels.

Airoli AAQMS has recorded the maximum readings for CO concentrations which violated the 8 hourly standards of 2mg/m³. Koparkhairane stations follows next but, with just few readings at a particular time period. For ozone, all the months were well below the standards of 100µg/m³. The methane concentrations was found to be high at Turbhe at all the hours compared to the stations at Koparkhairane and Airoli but the reason could be attributed to the release of methane from the leachate tank at the landfill site. For Noise pollution, almost all the readings from residential areas, traffic areas as well as silence areas have violated the standards.

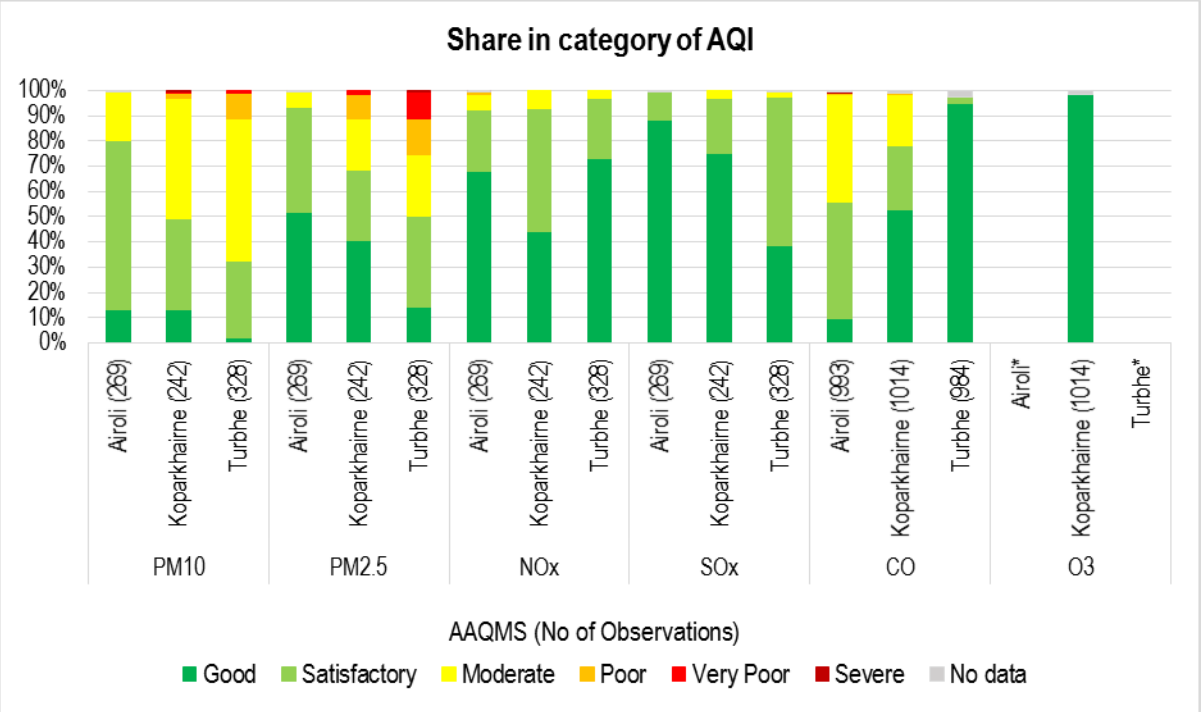

Figure No. 1: Occurrence of AQI classes for air pollutants in NMMC (2015-16)

Source: Environment Laboratory, NMMC

**Note: Ozone was not monitored at Airoli and Turbhe in 2015-16*

Based on the calculations for Air Quality Index (Figure No. 1), it was determined that Turbhe and Koparkhairne areas are polluted with PM2.5 & PM10 pollution. As for the pollutants the sub-index calculation reveals that the NMMC areas is clean for NOx, SO2, CO and Ozone pollutants in either "Good or Satisfactory" category. It's only for 10-12% of the days that the air quality in Navi Mumbai is polluted and may be in the 'Poor' or 'Very Poor' category that too because of PM concentrations.

Water Resource

The NMMC area has abundant water resources in terms of surface as well as ground water. The surface water resources include 24 lakes and ponds, 11 holding ponds and creek front of about 22km, NMMC area merits various vital environmental and physical services provided by these entities in terms of controlling the floods, water logging, surface runoffs and so on. As for the water supply, NMMC relies on the water from Morbe dam which is of a total capacity of 19,089 x 10^3 m^4. In terms of ground water resources there are 132 wells. NMMC regularly monitors the water quality for all the water bodies in NMMC area.

The water quality of water in lakes and ponds in NMMC was under the permissible limits for the many parameters except for SS, TDS and DO. This could be attributed to construction of Gabion walls for restricting idol immersion areas and separate cloth washing area distinct

The lakes in the NMMC area have been maintained in good condition as per the quality analysis reports maintained by Environmental Laboratory of NMMC. Parameters such as SS, TDS and DO were exceeding the limits at some location while all the other parameters were well within the limits. The only cause of concern is the water quality of creek in NMMC area. All the samples exceeded the chlorine concentration while some samples exceeded the concentrations for DO and BOD. This could be attributed to the release of untreated effluents from industrial area and other cities along the thane creek. Even though all the parameters were well within the limits for groundwater, the samples detected the presence of coliforms.

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, thus ensuring 100% coverage (Figure No. 2).

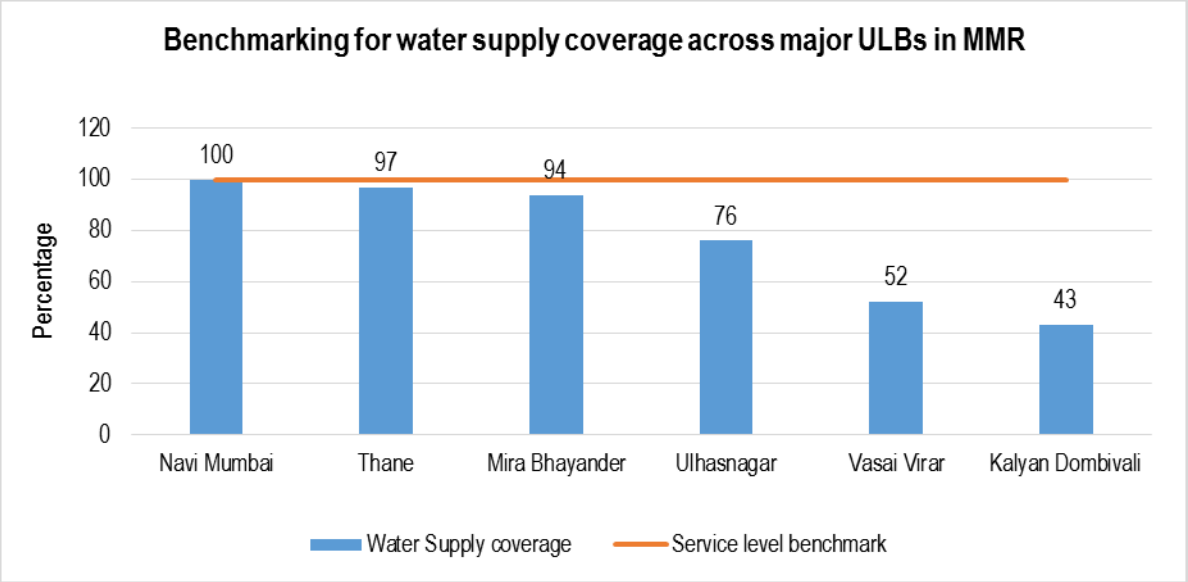

Figure No. 2: Benchmarking for water supply connections across major ULBs in MMR

Source: Performance assessment system[1]

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

Around 389 MLD (Million Litres per Day) water is supplied from Morbe dam to the treatment plant at Bhokarpada in the year 2015–16. NMMC has reduced the water supply this year sensing the low rainfall and the need for conservation of the water resources (Figure No. 3).

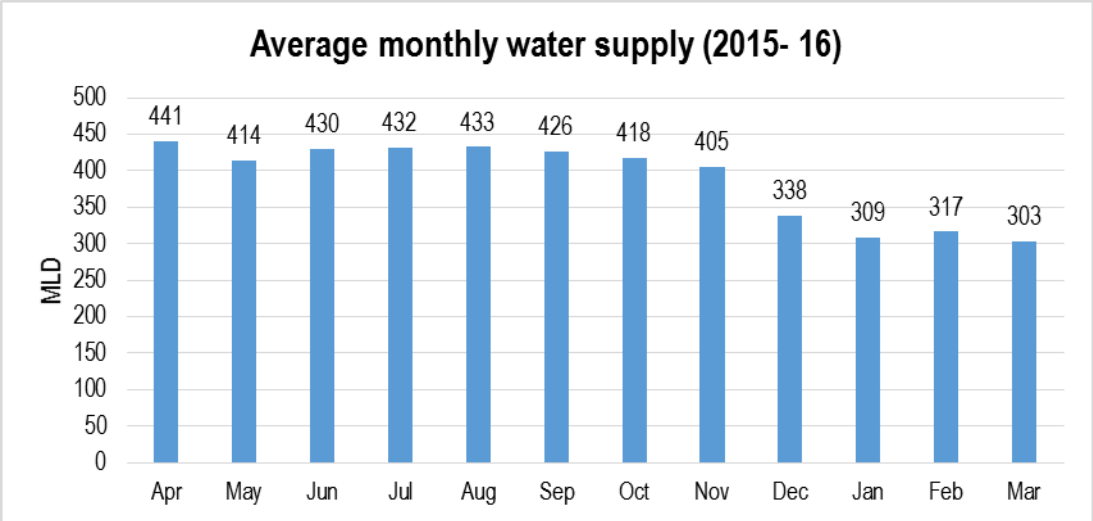

Figure No. 3: Average Monthly supply of water in Navi Mumbai in 2015-16

In the year 2015-16, on an average, NMMC billed about 315 MLD (19% losses) of water supply, translating to per capita supply of about 197 LPCD (Litres Per Capita Per Day), almost 0.6 times the service level benchmark of 135 LPCD recommended by Ministry of Urban Development, Government of India. In the year 2015-16, NMMC monitored more than 20 thousand drinking water samples at the tap end, from all the nodes. Out of these about 2.96% (579) samples were detected to be non–potable which indicated high potability, ensuring that the water supplied by NMMC was of good quality.

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 is estimated that around 180- 200 MLD of sewage is generated in the NMMC area and all the generated sewage is treated indicating that almost 100% of water is treated before releasing in the creek. NMMC regularly monitors the inlet and outlet water samples for bacteriological and chemical parameters. In the year 2015-16, the efficiency of the STP's were almost 100% in terms of regulating the BOD (Biochemical Oxygen Demand), COD levels, suspended solids, pH, oil and grease, nitrate, nitrite and dissolved oxygen levels and the average effluent water quality released from the STP's was well within the standards for all the parameters. The nallah water samples recorded high concentration of chlorine at many locations while rest of the pollutants were well within limits. The sewage from slums is also let directly into the nallahs which needs to be addressed.

Irrespective of several direct and indirect pressures on the water resources, the corporation has undertaken several necessary initiative to reduce these threats (Table No. 2).

Table No. 2: Key initiatives undertaken to reduce pressures on water resources

Sr. No	Pressure/ Threat	Initiative
1.	Loss of water during distribution due to leakages and pipe breaks	100% addressal of complaints for pipe breaks and leakages
2.	Around 200 MLD of sewage is generated in 2015- 16	NMMC has taken the initiative of selling the recycled sewerage water to MIDC
3.	Washing of clothes in lakes	Development of a gabion wall and a specific section for washing of clothes in the lake
4.	Lack of rainfall	Back flushing of water at Morbe dam leading to conservation of around 12 MLD of water

Biodiversity and Gardens

Navi Mumbai is bestowed with high biodiversity due to presence of several habitats ranging from low hills with tropical semi-evergreen to mangroves forests. Navi Mumbai is currently home to 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 Lesser Flamingos are observed to visit mangrove and mudflats of the city for breeding and feeding purposes increasing the bio wealth of the city.

Considering the manmade habitats, there are a total of 167 gardens and 80 open spaces which also support the biodiversity of the city.

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. 1). This initiative will also allow citizens to connect with nature.

Picture No. 1: Proposed watch tower at mangroves area for Bird watching

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 (**Figure No. 4**).

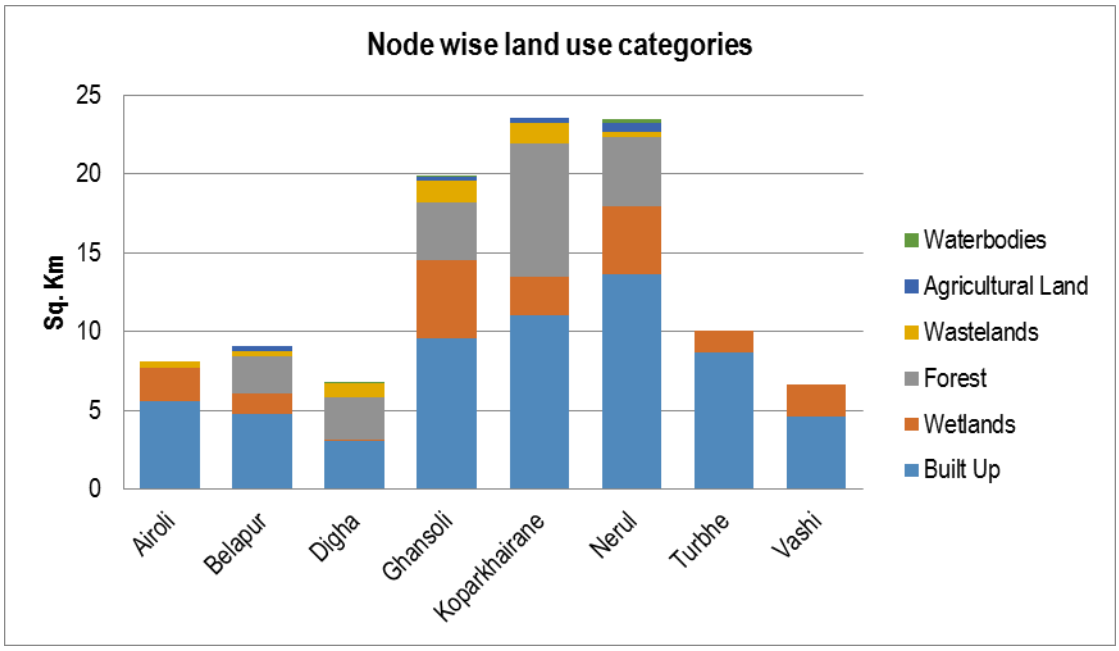

Figure No. 4: Ward wise land use categories in NMMC

Source: MRSAC

Navi Mumbai's 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. This makes them highly significant for conservation from ecological point of view.

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.

Today, 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. Mining and quarrying activities induce pressure on the land resources as well as significantly increase the PM levels in the air.

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.

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. In the year 2015-16, the daily average MSW increased by about 25 tons from the last year and accounted to about 695 MT waste. The waste generated from the residential, commercial and industrial areas is comprised mainly of biodegradable waste (**Figure No. 5**).

NMMC has undertaken an important initiative of segregation of solid waste at source for better solid waste management.

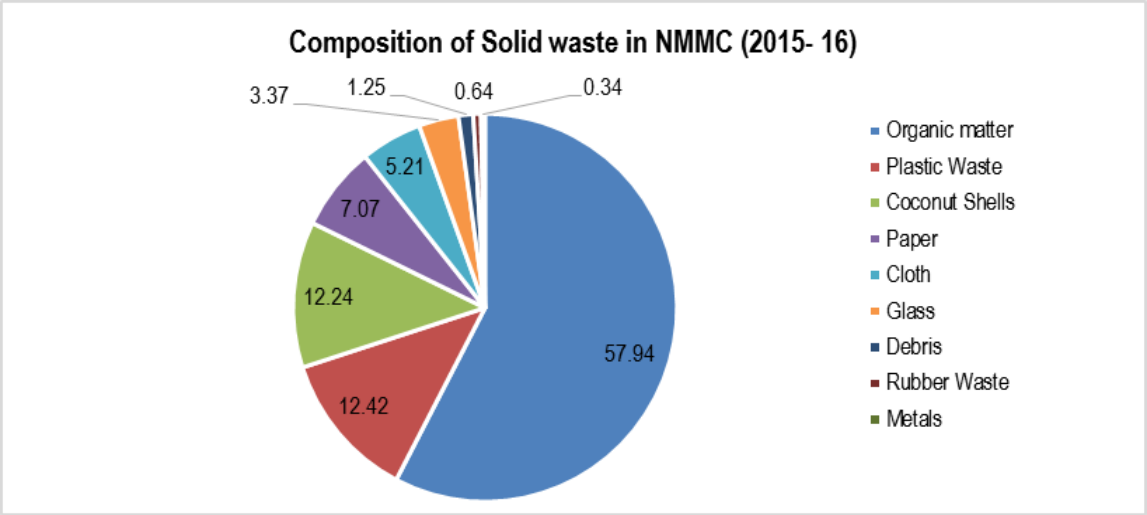

Figure No. 5: Composition of solid waste in NMMC

Source: Environment Laboratory, NMMC

Waste from the roads is collected through sweeping while household waste is collected by door to door collection. NMMC has been implementing sweeping of roads using 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. In 2015-16 more than 13500 kg of biomedical waste was generated in NMMC. 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.

To address the issue of solid waste management NMMC is planning to set up the following

- Construction and demolition waste debris recycling plant realizing the need for conservation of environment.
- Set up of an E-waste recycling plant has been proposed by NMMC.
- Decentralized biogas plants of 10-30 MT capacity to be installed at the ward level in order to generate energy which could be used for area lighting at the ward level.
- Waste to Energy plant in the module of 600 TPD which shall help convert the Refuse derived fuel (RDF) to Energy.
- Waste to energy plant based of biomass gasifier technology to process coconut shell waste and generate electricity. A pilot plant of 20kWe is proposed at the Turbhe land fill site and the power thus generated would be used for area lighting.

Health

The status of health of residents is one of the most crucial indicators of the environmental status of a city. 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. In 2015- 16, around 476 patients were detected for water borne diseases out of which maximum patients were detected for Gastroenteritis disease. A decrease was observed in vector borne diseases such as malaria but a steep rise was seen in the no. of dengue patients from 2 patients in last year to 76 patients this year. The patients of air borne diseases such as Tuberculosis have also shown a rise by 1.11%. NMMC is undertaking necessary measures to reduce the diseases in the city.

Conclusion

As it is observed, the growing demand for resources has exerted pressure on the air, water and land resources, but NMMC has undertaken the necessary initiatives to meet these increasing demand and have also reduced the threats on the resources. The corporation has realised that in order to conserve the resources in the city, it is necessary to adopt sustainable strategies .Thus it could be concluded that NMMC is transforming with the objective of sustainable development in mind which shall lead it to become India's first successful Eco City.

Environmental Indices for Navi Mumbai

The information on environmental parameters is often complex and technical for common man. The problem further complicates 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 environmental 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 calculated annually for the past 15 years 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 computation of these indices has been presented in Annex-I. Overall improvement of EQI is attributed to the completion of concretization of roads and major junctions, higher share in recycling of plastic from MSW (Municipal Solid Waste), continuous monitoring of water quality and disinfection by chlorination and so on. While the increase in value of UII is attributed to increase in the development of sanitation facilities by increasing the number of toilets in slum area, transportation of solid waste through use of compactors, improvement in footpaths for physically challenged people and improvement in gardens and road side greenery. The improvement of EQI and UII has thus improved the QOLI for citizen of NMMC. The trend of the EQI, UII and QOLI for the past four years is presented in Figure No. 6 and Table No. 3.

Table No. 3: Environmental Indices of Navi Mumbai

Sr. No	Index	2012-13	2013-14	2014-15	2015- 16
1	Environmental Quality Index (EQI)	70.02%	70.69%	71.38%	71.59%
2	Urban Infrastructure Index (UII)	78.94%	79.06%	79.65%	80.29%
3	Quality of Life Index (QOLI)	74.48%	74.88%	75.52%	75.94%

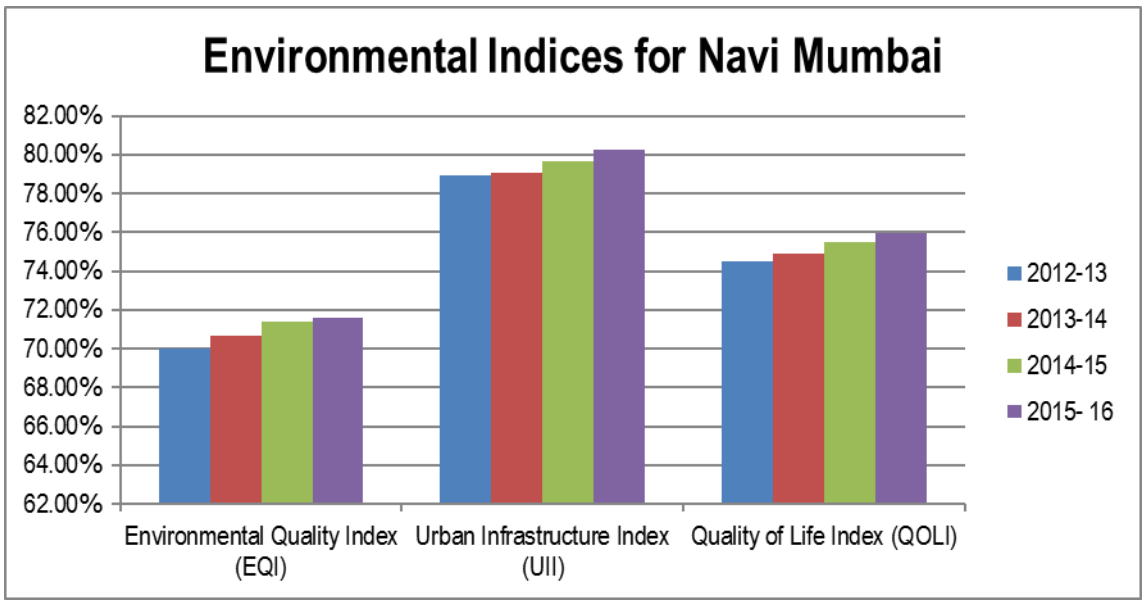

Figure No. 6: Environmental Indices of Navi Mumbai

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 (Annex -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.

The EPI has been calculated based on the model developed by MPCB using MS™ Excel software. The EPI score for NMMC area was determined to be 664.90 out of 944 in the year 2015-16 and recorded an improvement of 1.6 as compared to last year 2014-15 which was 663.30. This improvement is attributed to the initiatives taken by NMMC for increasing awareness related to environmental issues, responsibly managing the issue of construction and demolition waste and increasing sanitation and sewerage facilities in slums (Figure No. 7 and Table No. 4).

Table No. 4: Environmental Performance Index

Gap Analysis		
Environmental Score	**Achievable Score**	**Achieved Score**
Thematic Indicators	**944**	**664.90**
Growth of cities	250	140.00
State of natural resources	300	225.60
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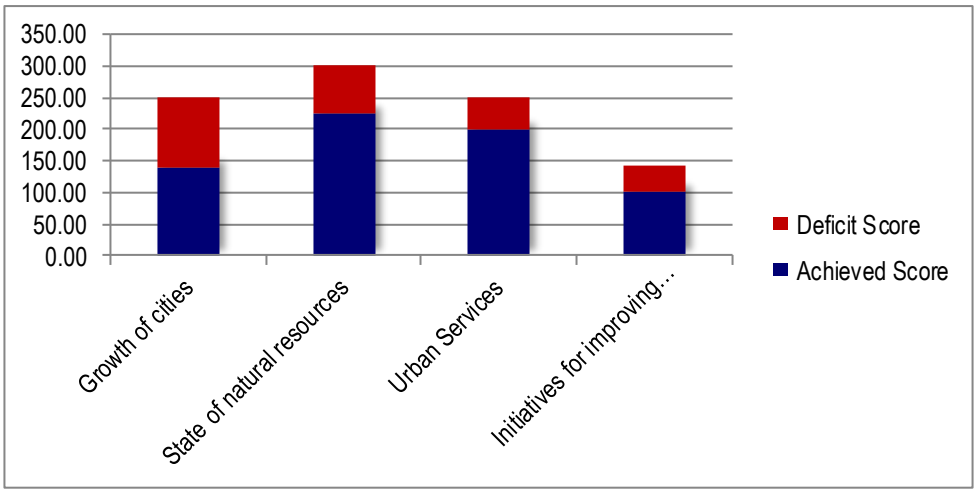


Figure No. 7: Environmental Performance Index

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 (Figure No. 8), TERI developed the carbon inventory to estimate the carbon footprint of the city and subsequently developed a comprehensive action plan.

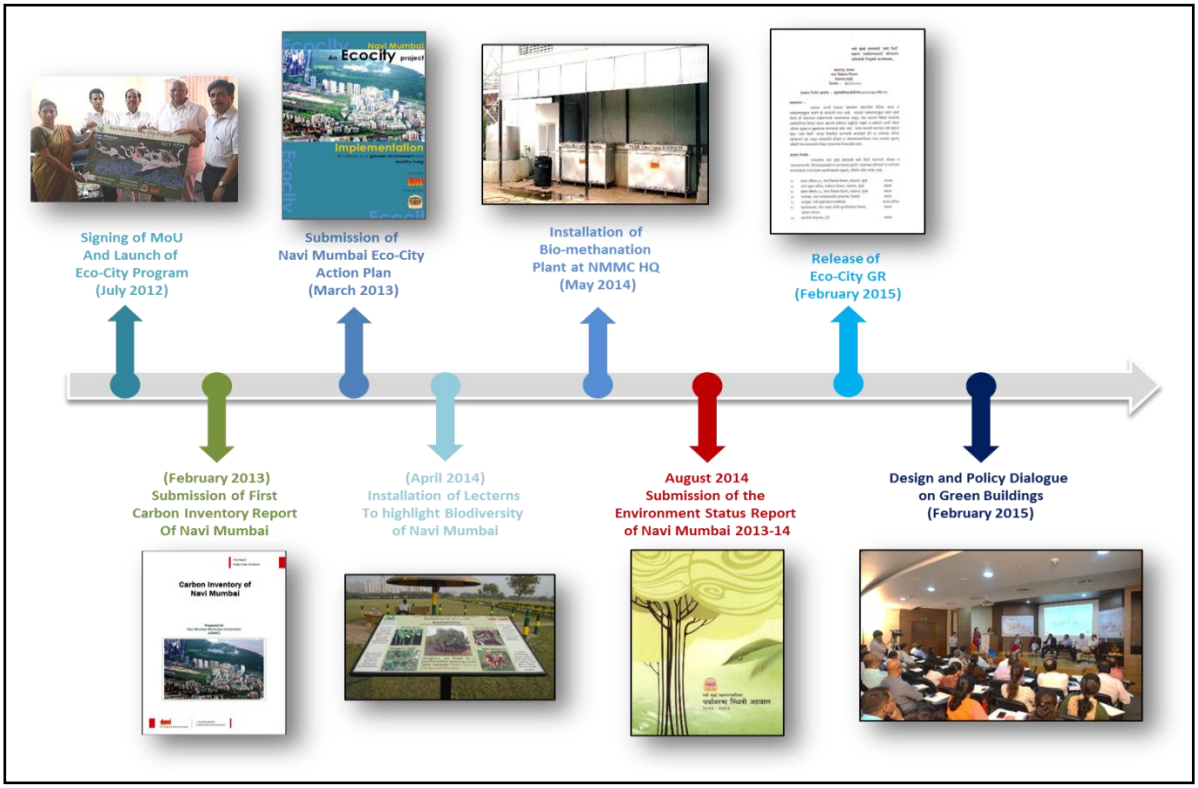


Figure No. 8: Timeline depicting progress and accomplishments under Eco-city program

Swaccha Bharat Mission

Maharashtra state government decided to implement central government's Swachcha Bharat mission via government resolution (GR) dated 15.5.2015. Through this GR, Maharashtra government directed all municipal corporations on May 25, 2015 to establish 'Project Implementation Cell' for implementation of Swachcha Maharashtra mission.

Navi Mumbai Municipal Corporation established its project implementation cell with a clear objective to eradicate open defecation practice and building private as well as public toilets which was proposed under the mission. A block level survey was undertaken in July 2015, which identified 3398 families in NMMC region being involved in open defecation practice. NMMC received the total grant of INR 179.96 lakhs in two phases to implement the mission and achieve the desired impact. The first grant payment of INR 150.02 lakhs was received from the central and the state government along with the target of installing 1850 toilet seats (1150 toilet seats for personal/ private use and 750 toilet seats for public use). NMMC regularly provides grant of INR 17,000 to the beneficiaries with a motto to help them build the toilets. The second grant payment of INR 29 lakhs was sanctioned in March 2106.

As of now, a total of 437 public toilets (5215 seats) have been built which includes 9 E-toilets as well. 10 e-toilets are further proposed along with 12 modern 'she toilets' through CSR activity by the company Reliance Geo. Besides this, building 4 public toilets is under tendering process via local development program -2015-16 by CBD Belapur's Member of Legislative Assembly (MLA). Building modern NAMMA type toilets is also proposed at 9 locations[2]. Under 'Right to Pee' following Hon. High courts decision, all required steps are being taken to build toilets exclusively for women. Besides this, building toilets at public places such as gardens, grounds and other is also ongoing. Along with the above initiatives, NMMC is also undertaking initiatives for Street plays, awareness campaigns and cleanliness drives in order to spread the message of Swacch Bharat Abhiyan and achieve the needed impact (Figure No. 9).

Figure No. 9: Container toilet installed in the city (Left) and women cleaning their surroundings under Swacchta campaign (Right)

[2] http://swachhbharaturban.gov.in/writereaddata/Namma_Toilets_FAQ.pd

Navi Mumbai – City Profile

Navi Mumbai is one of the largest planned cities of India conceived in the year 1972 and was designed to decongest Mumbai. In 1970 CIDCO (City & Industrial Development Corporation) was incorporated with purpose to plan, develop and maintain the city of Navi Mumbai under 'Companies Act' of 1956'. CIDCO has planned to develop 14 nodes in Navi Mumbai out of which 8 nodes were handed over to NMMC (Navi Mumbai Municipal Corporation) in 1991 for its maintenance. The development of industrial belt in Navi Mumbai attracted a large population as it gave rise to employment opportunities. Further given the ease of connectivity to Mumbai, the city witnessed quick progress in term of urbanisation.

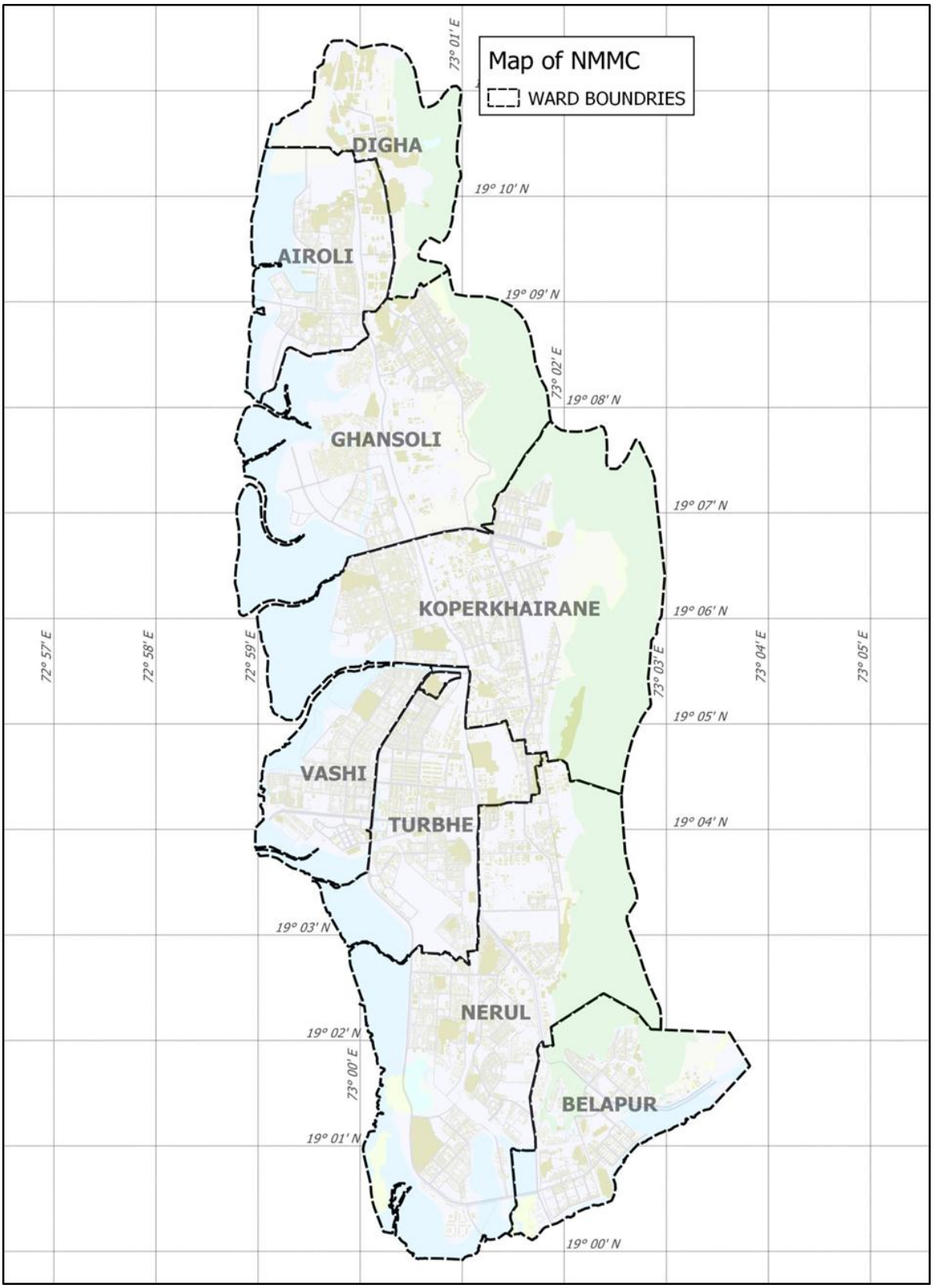
Navi Mumbai is a part of Konkan coast line and is located in centre of MMR (Mumbai Metropolitan Region) with Thane creek on west side while the Parsik hill ranges surrounded on east side, whereas Thane and Panvel region covers the North and South zone. NMMC jurisdiction is divided in eight zones starting with Digha in north and Belapur in south (Map No. 1). Out of the total area of 343.70 sq. km for Navi Mumbai, 108.63 Sq. km area is under NMMC[3]. As per Urban Health Post (UHP) estimate for the year 2014-15 the population residing within NMMC, area is more than 14 lakhs (14,37,379) with an average population density of about 13,231 persons per sq. km. The geographic and demographic profile of Navi Mumbai is represented in Table No. 5.

Table No. 5: Geographic and demographic highlights of Navi Mumbai

Heads	Attributes
Longitude Latitude	72°58′ to 73°03′E 19°00′ to 19°12′N
Mean Height above Sea Level	3.25 Metres
Nodes under NMMC	Belapur, Nerul, Turbhe, Vashi, Koparkhairane, Ghansoli, Airoli and Digha.
Total area under NMMC jurisdiction	108.63 sq. km
Estimated Population (UHP Survey)	14,48,506
Population (Census of India-2011)	11,20,547
Population Density (Census data-2011)	10,315 persons per sq. km
Sex Ratio (As per census data-2011)	837 Females per 1000 Males,

Source: Census of India 2011

[3] CE, NMMC



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

Climate

Navi Mumbai lies in the tropical climatic zone and has three seasons' summer, monsoon and winter. The annual temperature in Navi Mumbai varies from 22°C to 36°C while in summers the maximum temperature ranges between 36°C to 41°C and the minimum temperatures in winter ranges between 17°C to 20°C. The average annual rainfall is 2000-2500 mm and humidity is 61-86 %. Based on IMD's (Indian Meteorology Department) observations recorded at TBIA (Thane Belapur Industry Association) premises, the predominant wind direction in Navi Mumbai is southwest in monsoon and north-east during rest of the year.[4]

Based on the data recorded at the CAAQMS (Continuous Ambient Air Quality Monitoring Stations), for NMMC, the monthly average temperatures (**Figure No. 10**) were recorded to be between 25°C to 33°C for the year 2015-16. The highest maximum average temperature of 32°C was recorded in the month of May (summer season) and the lowest temperature of about 25°C was recorded in the January month. The maximum fluctuation of the temperatures was recorded in the August month.

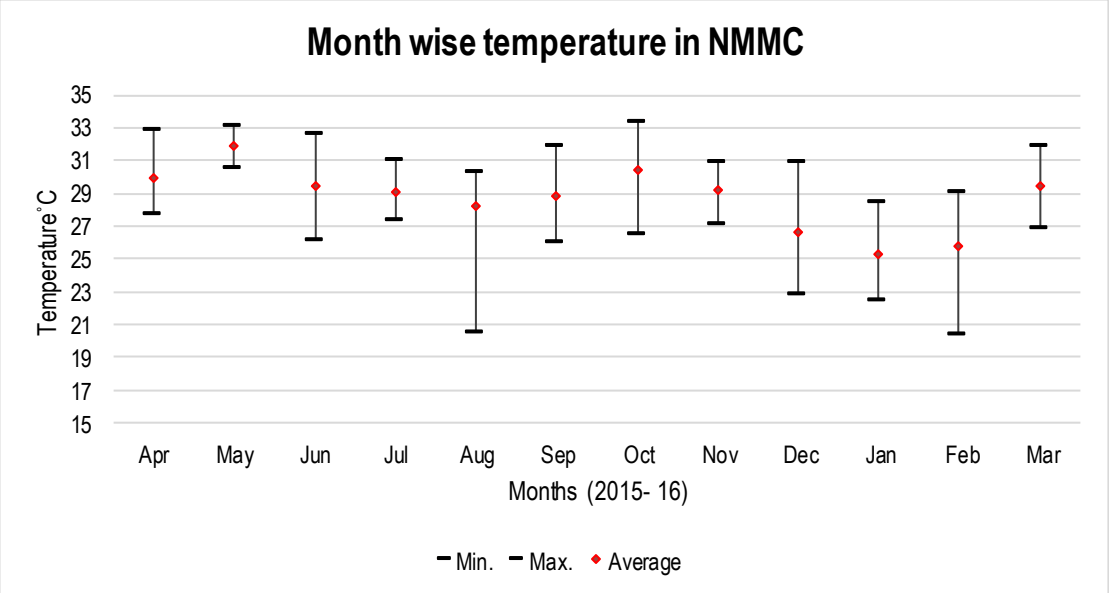


Figure No. 10: Month wise temperatures recorded in NMMC area 2015-16

Source: CAAQMS of NMMC at Airoli, Turbhe and Koparkhairne

[4] http://www.nmmconline.com/web/guest/climate

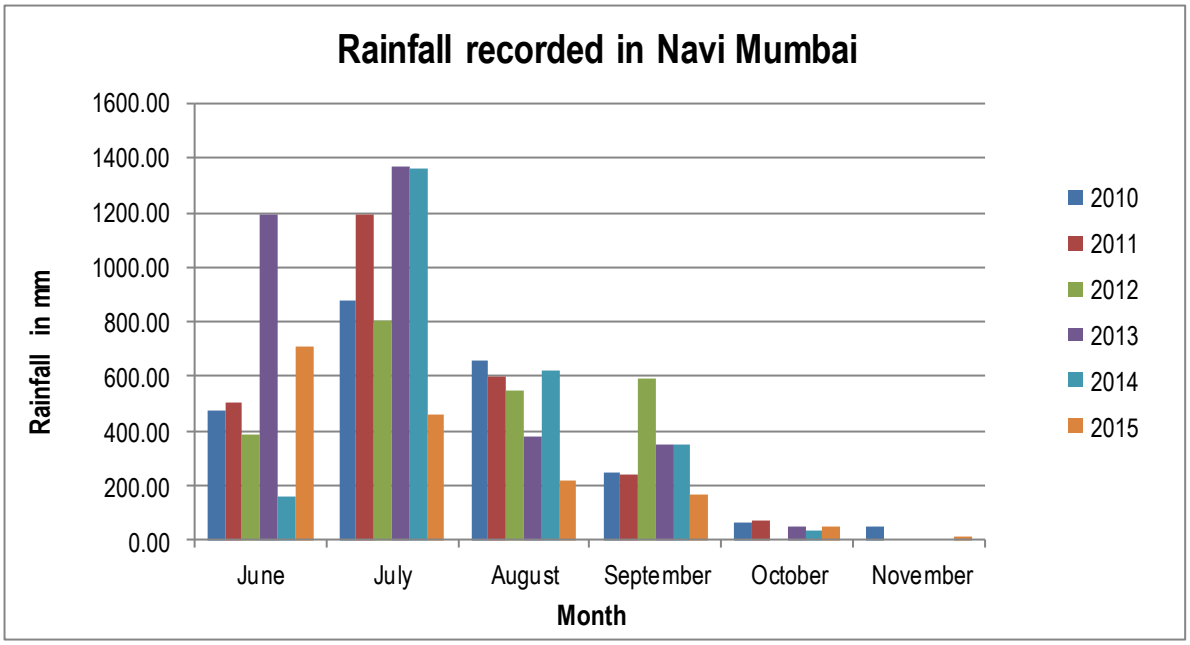


Figure No. 11: Trend of rainfall in Navi Mumbai

Source: Environmental Laboratory, NMMC

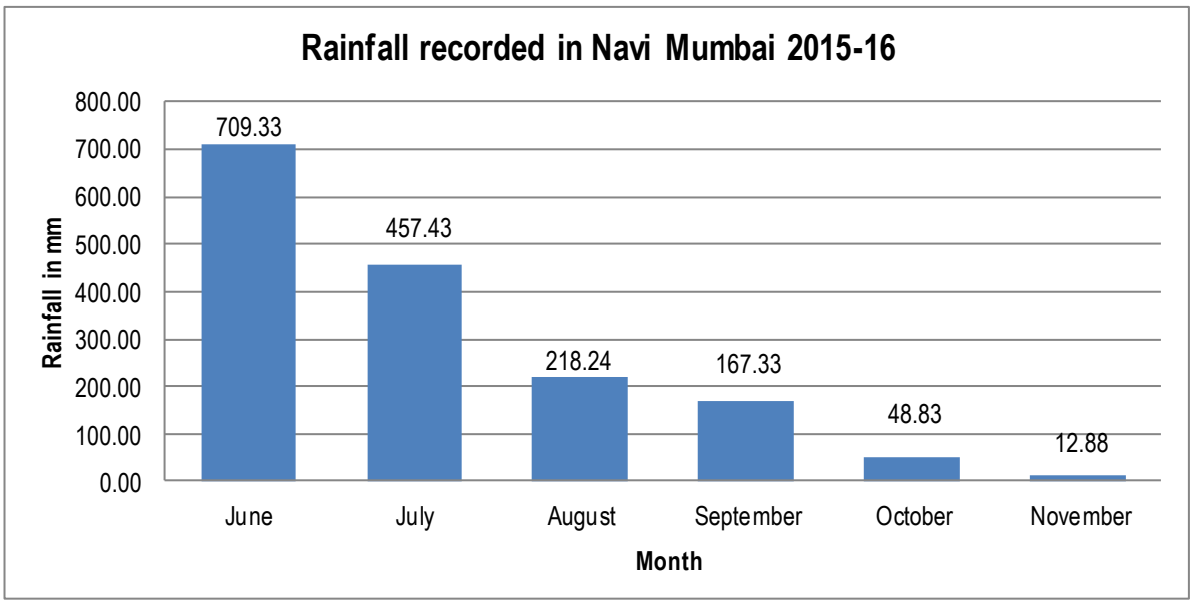


Figure No. 12: Rainfall recorded in Navi Mumbai

Source: Environmental Laboratory, NMMC

It could be observed from Figure No. 11 that Navi Mumbai has experienced almost three times less rainfall in the months of July (457.43mm) and August (218.24mm) and September (167.33mm), compared to previous year 2014. The month of June recorded almost 4 times more rainfall compared to the year 2014 and was also the second highest rainfall (709.33mm) recorded in in June compared to the years. Thus the rainfall was overall less compared to the last 5 years. In this year, the June month recorded the highest rainfall while the least rainfall was in November (12.88mm) (Figure No. 12).

Connectivity

In terms of rail connectivity, Navi Mumbai has six rail corridors, 157 km railway system and an independent mainline rail terminal connecting the city directly to Chhatrapati Shivaji Terminus (town side) as well as western parts of Mumbai.[5] The city also has good accessibility to Pune and Pimpri regions through road as well as rail transport.

The road transport wing of Navi Mumbai includes connectivity from bus operators of Brihanmumbai Electric Supply and Transport (BEST), Navi Mumbai Municipal Transport (NMMT), Kalyan- Dombivali Municipal Transport (KDMT) and Khopoli Municipal Transport (KMT) which provide bus services to entire Navi Mumbai city as well as to certain parts of Mumbai, Thane, Kalyan, Dombivli, Badlapur, Taloja, Panvel and Uran.

The number of operational buses under NMMT was 390 in the year 2015-16. As seen in Figure No. 13, NMMT had 30 more buses plying in this year (390) as compared to the previous year (360). As per the data records of NMMT, the average number of passengers travelling per month by NMMT buses is around 55,37,375. The distance travelled by buses per day is on an average 281.1 km.

Many projects, like the Navi Mumbai Metro, trans-harbour link between Mumbai (Wadala) and Navi Mumbai (Ulwe), elevated corridor on Palm Beach road, as well as the ambitious international airport proposed near Panvel, are expected to enhance the connectivity as well as the status of the city.

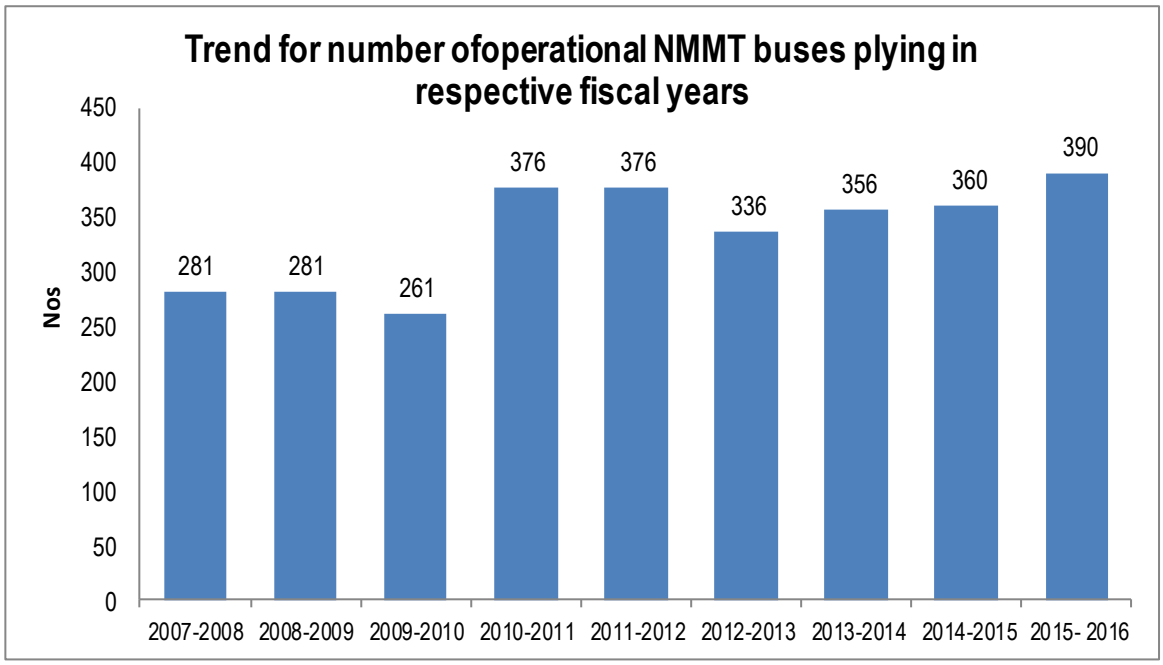


Figure No. 13: Trend for number of operational NMMT buses plying in respective fiscal years

Source: NMMT

[5] http://www.nmmconline.com/nmmt

Drivers

The process of urbanization is one of the most important dimensions of economic, social and physical change. Urbanisation provides opportunities for employment, better housing, education, knowledge and technology transfer, and ready markets for various products but also leads to enormous stress on natural resources. The population of India has increased by more than 22% (181 million) during the decade 2001-2011[6]. The increase in population directly increases the demand for land, water as well as other natural resources, indirectly impacting their natural status, thus population growth acts as crucial driver to urbanisation, which may impact various resources. The drivers like growth in industrial activities, urban facilities, educational facilities, infrastructure development and so on are the main reason for population growth, indirectly impacting the resources like air, water and land. These resources have been analysed in separate sections for their status, the—Pressures being exerted on them, the —Impact of various urban activities on these resources, and the —Response taken by the corporation to reduce the impacts.

Population growth

NMMC, formed in 1991, comprises 8 nodes developed by CIDCO from Airoli to CBD Belapur. NMMC estimates the population of the city every year based on the survey data of the UHPs (Urban Health Posts) in NMMC. In the year 2015-16 the population of NMMC was estimated to be about 14,48,506 and registered a growth of about 0.7% as compared to 2014-15. The development of industrial belt with ample job opportunities, higher income leading to better lifestyle, and other facilities has led to migration of people into the city. The population growth for last 5 years for Navi Mumbai has been represented in Figure No. 14.

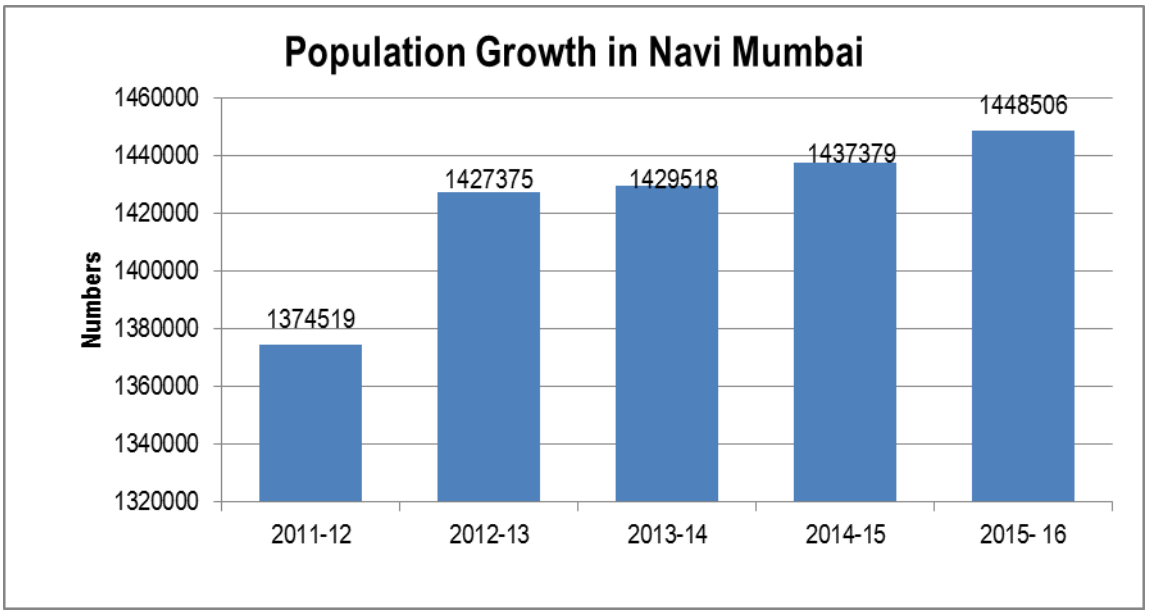


Figure No. 14: Population growth in Navi Mumbai

Source: UHP Survey, NMMC

[6] http://censusindia.gov.in/2011-prov-results/data_files/india/pov_popu_total_presentation_2011.pdf

Industrial and Commercial growth

Development of industrial belt in Navi Mumbai has led to rapid industrialization in the city which is the prime economic driver. About 16% of total area in Navi Mumbai falls under MIDC (Maharashtra Industrial Development Corporation) zone[7]. The city is also known for its dedicated and planned space developed for corporate offices, government offices, educational centres, APMC (Agricultural produce market committee) market and so on. The key industrial growth centres have been discussed below.

MIDC areas

The Trans Thane creek (TTC) Industrial area and Taloja MIDC are main industrial zones in Navi Mumbai. The TTC industrial area accounts for more than 3000 industries while the Taloja industrial area consists of large, medium and small industrial units. Various types of processing industries including chemical, paper, plastic and so on are located in these industrial areas. Some of the well-known industries in these areas include Balmer Lawrie & Co. Ltd., Reliance Paper Products, E Merck (I) Ltd., Hindustan Lever Ltd. and Pidilite Industries Ltd, Pfizer, Lubrizol India Ltd., Polyolefins Industries Ltd., Herdillia Chemicals Ltd., BASF (India) Ltd., Star Chemicals, Indofil Chemicals Ltd., and Phoenix Chemical Works and so on[8].

Apart from industrial units, there exists a CBD (Central Business District) located at Belapur spreads over 575 hectare which has been developed to house various corporate as well as government offices. The area is known to account for country's most prominent IT- BPO establishments. Employments observed in CBD Belapur are around 32% while 37% jobs are IT-BPO establishments located in Vashi.[9]

Jawaharlal Nehru Port Trust

JNP, commissioned on 26th May 1989, is ranked 24th among the top 100 container ports in the world. It is considered as hub port on the western coast of India handling around 60% of the country's containerized cargo. It has three dedicated container terminals namely JNPCT (Jawaharlal Nehru Port Container Terminal), NSICT (Nhava Sheva International Container Terminal) & GTIPL (Gateway Terminal India Private Ltd). The port has handled 57.29 million tons of cargo in 2008-09 including 3.96 TEU's (Twenty foot Equivalent Units) containers and poised to handle 10 million TEUs of containers by the year 2015-16.[10]

APMC market

Built on a 7.92 hectare area, the APMC market at Navi Mumbai is one of the biggest agricultural markets in Asia and has given a unique identity to the city. After its establishment in 1996, about 13 major wholesale agricultural produce markets from Mumbai were shifted to APMC Vashi. The APMC has an estimated annual trade turnover of INR. 6000 crores, and generates employment for about 1 lakh people. APMC comprises of four markets divided into two phases.- Phase-I comprises Market-I which is the onion and potato market and Market-II which is the fruit and vegetable market whereas Phase-II has Market-I which is the commodity market and Market-II which is the grain, rice and oilseed market.

[7] http://www.nmmconline.com/web/guest/land-usage
[8] http://www.tbiaindia.org/Industry.html
[9] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx
[10] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx

Belapur Railway Station Complex, CBD Belapur

Belapur Railway Station Complex is the largest among the commercial complexes in Sector 11, CBD Belapur Navi Mumbai which has a tremendous potential for business growth. It caters to the passenger demand of CBD-Belapur node, Sector 1 to 31. Office premises are provided above deck level from 3rd to 7th floor which is attached with a sprawling shopping arcade located at ground & deck level. Facility has been provided for helicopter landing on the deck. This station caters for two corridors viz. Mankhurd- Belapur- Panvel & Nerul/Belapur-Uran[11] (Picture No. 2).

Picture No. 2: Belapur railway station complex

Source: http://mapio.net/o/893119/

Education Industry

A number of premier schools and colleges have been set up in Navi Mumbai. Each of the nodes is self-sufficient in terms of providing quality education. Navi Mumbai has all types of educational institutes including Pre-primary (245), Primary and Secondary schools (471), Junior & Senior colleges (71), Engineering (9), Law colleges (3) and Medical (2) providing quality education in streams of Arts, Commerce and Science.

Malls & Retail Stores

There are 6 major operational malls in this zone. Vashi is clearly the dominant micro-market in this zone, housing 3 active malls such as Center One, Raghuleela Mall and Inorbit Mall. D-Mart has launched hypermalls in Navi Mumbai at Koparkhairne and Nerul In addition to this there is many medium to small format retail outlets in Navi Mumbai.

[11] https://cidco.maharashtra.gov.in/NM_Railway_Infrastuture.aspx

Urbanization and spatial growth

India is witnessing increasing levels of urban population. Nearly 31 percent of the country's population lives in cities and urban areas as per census of 2011. While cities are regarded as 'Engines of growth', they continue to face enormous challenges. Increasing urbanization has led to tremendous pressure on land, civic infrastructure, transport, open spaces and so on. It is projected that the urban population would grow to about 470 million in 2021 and 700 million in 2041[12]. The rapid expansion of urban areas due to rise in population and economic growth is increasing additional demand on natural resources thereby causing land-use changes especially in megacities.

The steady growth of humans, the current phase of economic growth and trade liberalisation, are exerting heavy pressures on India's limited land resources for competing uses in forestry, agriculture, pastures, human settlements and industries. This has led to very significant land degradation.

Navi Mumbai shows 0.7% increase in population in the year 2015-16 as compared to last year (2014-15) .The nodal areas of Navi Mumbai are expected to grow in population at faster rate which increase in use of land resource to accommodate the population.

The number of properties in NMMC has been increased by almost 28% since 2007-08 as observed in Figure No. 15. For the current year 2015-16, the residential properties mark the highest recording 81% of total 2,94,629 properties. This is followed by commercial buildings with 17% share and MIDC commercial with least of 2% share. The sector wise property for the year 2015-16 is shown in Figure No. 16.

[12] Ministry of Statistics & Programme Implementation, Government of India, Conference of Central and State Statistical Organisations (COCSSO), page 6

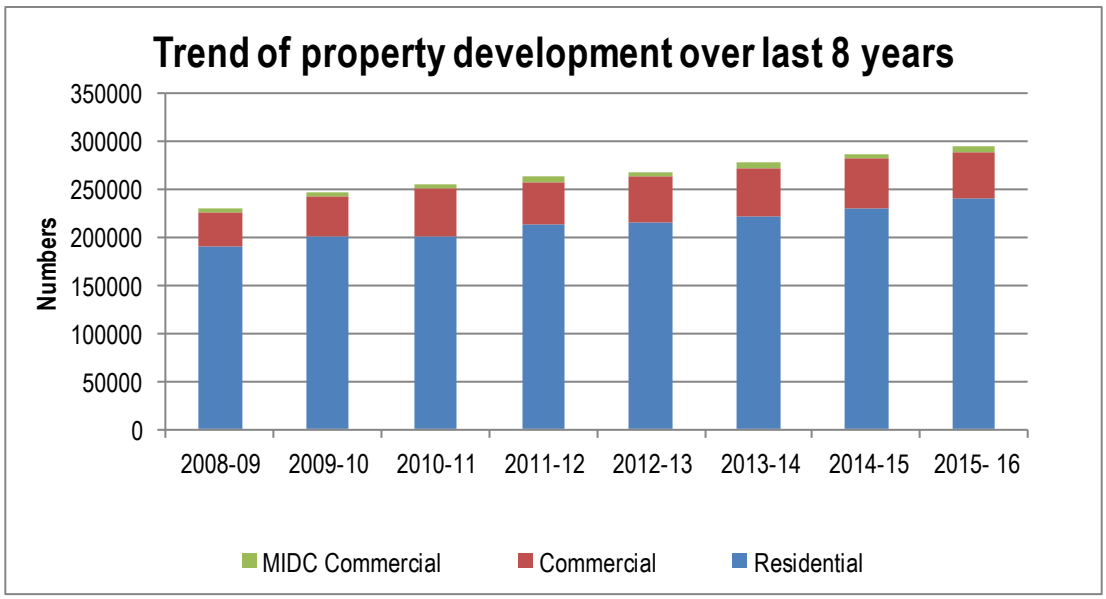


Figure No. 15: Trend of property development over last 8 years in Navi Mumbai

Source: Town Planning Department, NMMC

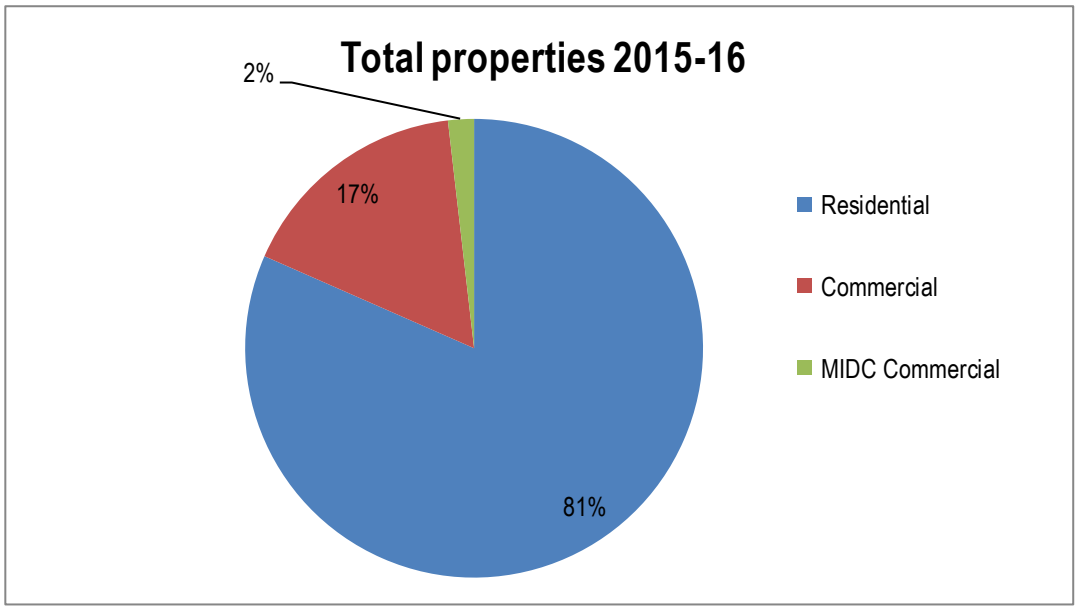


Figure No. 16: Sector wise breakup of property for year 2015-16

Source: Town Planning Department, NMMC

Air Quality

Pure air is a mixture of several gases that are invisible and odourless and the air quality is the status of air present around us[13]. Air plays an important role in deciding the state of environment and also the human well-being. Poor air quality not only affects humans but is also known to severely impact the local flora and fauna. The composition of air usually changes due to change in quantity of gases, dust, fumes or odour causing air pollution[14]. Poor air quality i.e. the change in the composition of air is caused from the release of harmful pollutants by sources such as factories, power plants, and smelters and smaller sources such as dry cleaners and degreasing operations; mobile sources such as cars, buses, planes, trucks, and trains; and naturally occurring sources such as windblown dust, and volcanic eruptions, all contribute to air pollution[15]. The air pollutants released from the above sources may cause disorders by entering the human body through respiratory system and affect throat, bronchi and lungs.

WHO (World Health Organization) in its Ambient Air Pollution Database Report has cited that Air quality in most cities worldwide, which monitor ambient air pollution, fail to meet WHO guidelines for safe levels, putting people at additional risk of respiratory disease and other health problems. It has also found that ambient air pollution contributes to 6.7 % of all deaths worldwide[16].

Thus it is of utmost importance to regularly monitor the air quality in order to understand the air quality status and develop management strategies accordingly. At national level, CPCB (Central Pollution Control Board) 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.

Figure No. 17 gives a comparative analysis of performance of air pollution among major cities of Maharashtra based on the report published by MPCB in June 2016. Air quality in terms of Sulphur dioxide was found to be within permissible limits in Navi Mumbai, whereas it has exceeded the standards (50 µg/m^3) for Nitrogen dioxide and lies in the border line category. Even though the concentrations are exceeding the standards for RSPM, it is comparative less than the other cities of Maharashtra such as Thane, Mumbai, Amravati, Aurangabad, Kalyan and Chandrapur.

[13] http://www.bcairquality.ca/101/what-is-air-quality.html
[14] http://www.epa.vic.gov.au/air/aq4kids/pollution.asp
[15] https://www3.epa.gov/airquality/cleanair.html
[16] http://www.who.int/gho/phe/outdoor_air_pollution/burden/en/

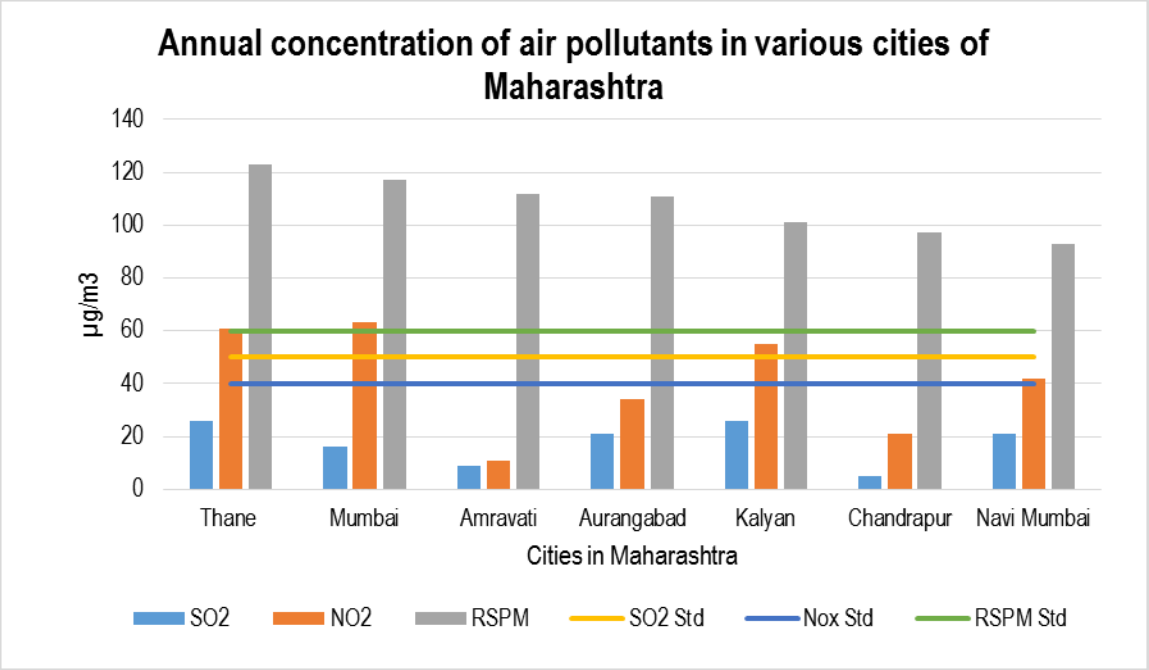


Figure No. 17: Annual concentration of air pollutants in various cities of Maharashtra

Source: Air quality status of Maharashtra 2015- 16, MPCB

Status

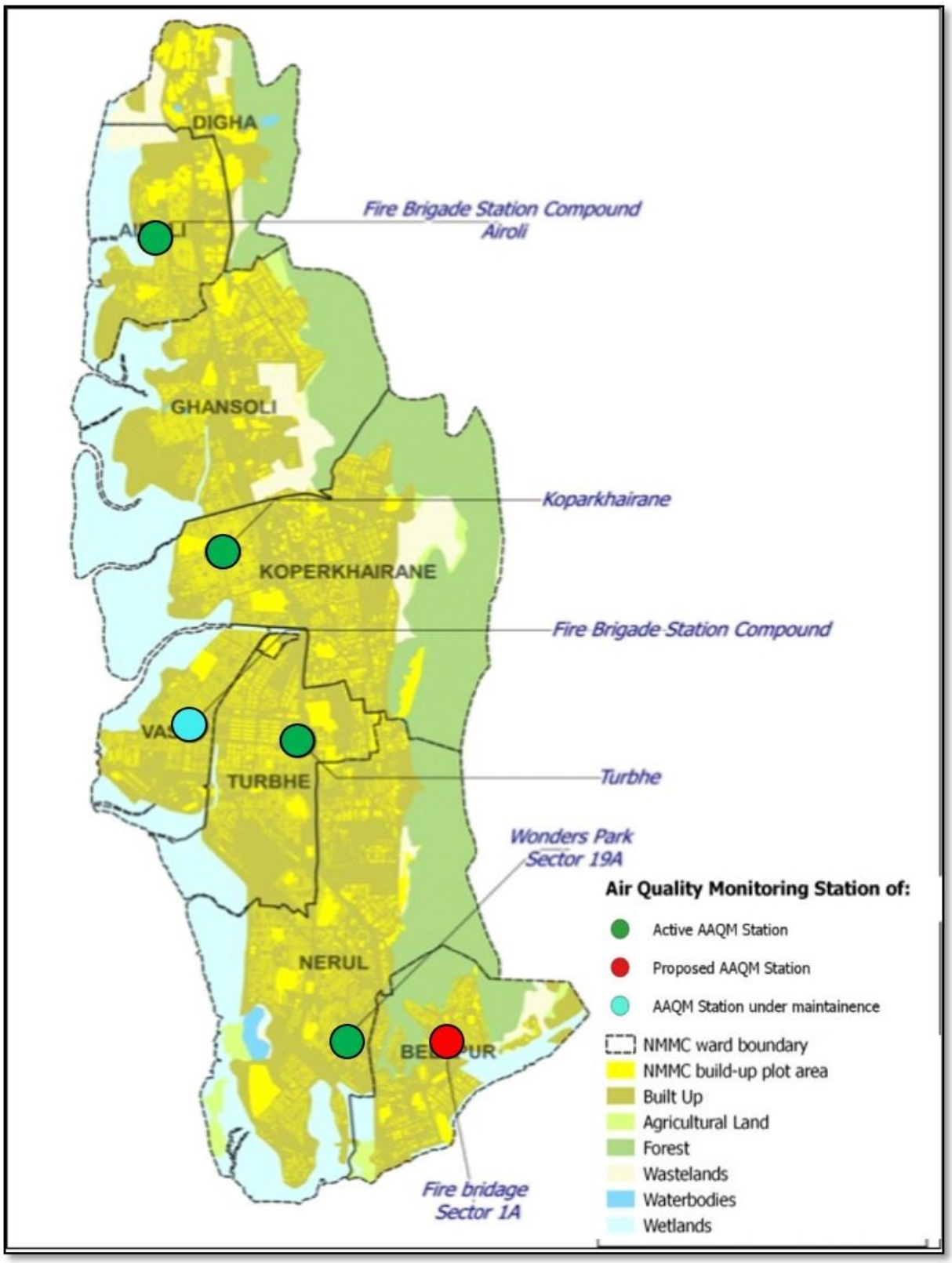
Air Quality Monitoring Network

At present there are 5 CAAQMS (Continuous Ambient Air Monitoring Stations) installed at Airoli, Koparkhairane, Turbhe, Vashi and Nerul. The CAAQMS at Nerul was installed by IITM (Indian Institute of Tropical Meteorology) in 2015-16. In addition to this NMMC's also possess a mobile van for monitoring the air quality. Table No. 6 provides the tally of active ambient air quality monitoring stations in NMMC region. Out of the 5 continuous monitoring stations maintained and operated by NMMC, which monitor air quality parameters in addition to climatological parameters, in the year 2015-16 only three CAAQMS were active. The Vashi CAAQMS was non-operational due to renewal of contract of the agency as well as maintenance of the machine. The spatial representation of these monitoring stations is depicted in Map No. 2. To further cover the entire city and nodes in the city, NMMC has proposed installation of a CAAQMS at CBD-Belapur. Currently the mobile monitoring van is deputed at various locations in these nodes to monitor the air quality.

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

Station name	Location	Latitude and Longitude	Operating Agency	Status (2015- 16)
Airoli	Airoli fire station	19° 09' 21.4" N 72° 59' 35.4" E	Chemtrols	Operating
Koparkhairne	Teen Taki Area	19° 06' 17.4" N 73° 01' 09.3" E		Operating
Turbhe	Turbhe Landfill site	19° 04' 42.5" N 73° 01' 34.6" E		Operating
Nerul	Wonders Park	19° 01' 32.0" N 73° 01' 36.0" E	IITM	Operating
Vashi	Fire Brigade compound	19° 03' 20.4" N 72° 55' 19.5" E	Thermo Fischer	Closed for Maintenance
CBD Belapur (Proposed)	Belapur Fire station	19° 01' 28.7" N 73° 02' 25.1" E	To be ascertained	Proposed

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 mainly emitted from fossil fuel combustion at power plants (73%) and other industrial facilities (20%) while the smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives and so on[17]. SO_2 is linked with a number of adverse effects on the respiratory system.

As seen in Table No. 7 and Figure No. 18, the annual SO_2 concentrations for all the 3 continuous stations are well below the annual average standards for SO_2 (50 µg/m³) as per NAAQS (National Ambient Air Quality Standards) set by CPCB. Even though the concentration is below the standard the concentration has been more than doubled in Koparkhairane (37.36 µg/m³) and slightly increased in Airoli (26.05 µg/m³) compared to last year.

Table No. 7: Yearly trend of concentration of SO_2 at CAAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Permissible limit	50	50	50	50
2009-10		23.05	53.60	
2010-11		20.01	44.72	
2011-12	13.906	19.82	45.14	
2012-13	32.245	21.25	24.28	50.08
2013-14	20.3	22.00	31	45
2014-15	14.46	17.92	Site shifting under process	42.79
2015-16	37.36	26.05		44.46

Source: Environmental Laboratory, NMMC

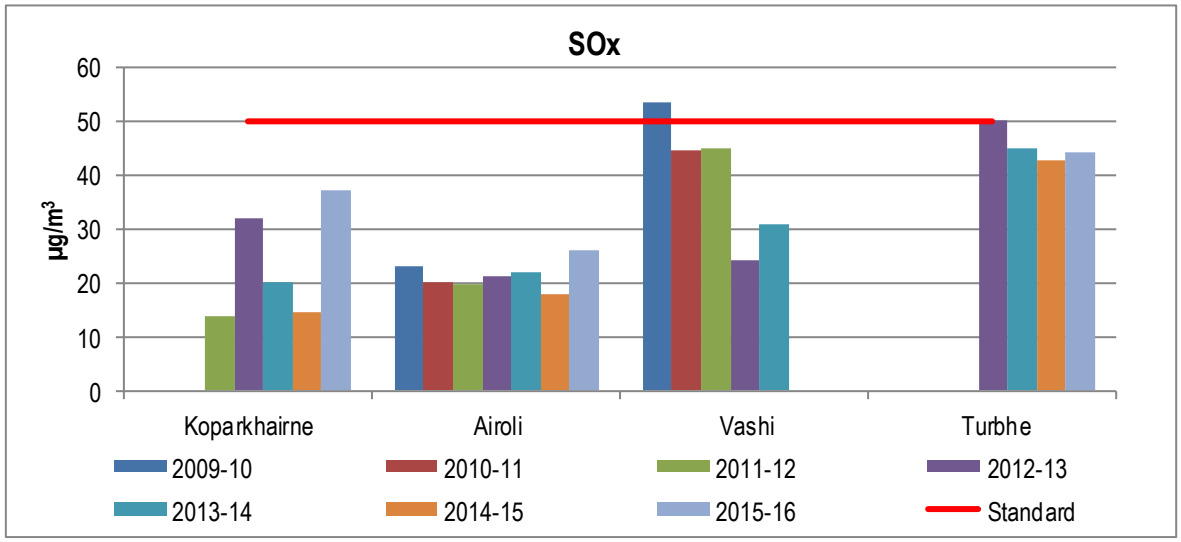


Figure No. 18: Yearly Trend in concentration of SO_2 at AAQMS in Navi Mumbai

Source: Environmental Laboratory, NMMC

[17] https://www3.epa.gov/airquality/sulfurdioxide/

Trend of NO_X concentrations

NO_X is an air pollutant emitted by combustion of fuel in vehicles, industrial processes, and domestic usage. Among the NO_X family, NO_2 has adverse effect on human health since it causes lung disorders. It is also a contributor to formation of secondary pollutants such as PM and Ozone. The yearly trend in concentration of NOx at 3 CAAQMS can be observed in Table No. 8 and Figure No. 19.

It can be clearly observed that, even though there was a decreasing trend for NOx concentrations at Koparkhairne and Airoli areas till last year, the concentration has increased this year for Koparkhairane (57.40µg/m³) and almost doubled at Airoli (42.35 µg/m³). Both these stations have violated the annual permissible limit (40 µg/m³) all the years. Only, the concentrations at Turbhe is below the permissible limit for the years 2015-16 and also for the previous 3 years.

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

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Permissible limit	40	40	40	40
2009-10		82.69	57	
2010-11		66.56	45	
2011-12	79.34	59.13	43	
2012-13	80.34	77.69	56	22
2013-14	63.83	46.38	44	30
2014-15	42.53	27.25	Site shifting under process	35
2015-16	57.40	42.35		33.30

Source: Environmental Laboratory, NMMC

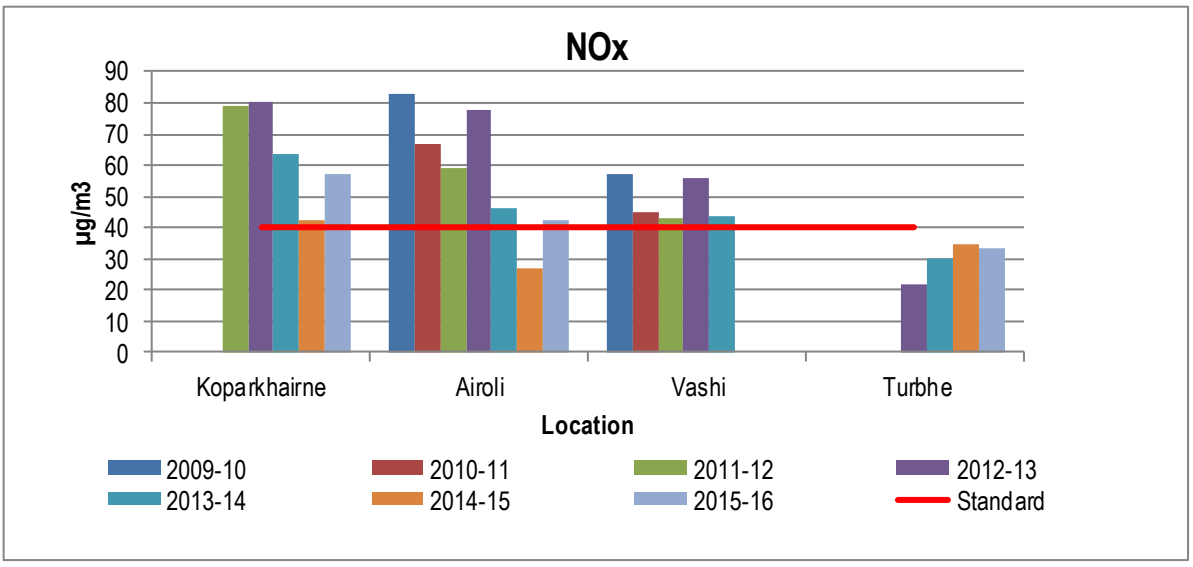


Figure No. 19: Yearly Trend in concentration of NOx at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Trend of PM_{10} concentrations

Particulate matter, a complex mixture of extremely small particles and liquid droplets which are made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles[18]. 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.

Table No. 9 and Figure No. 20 clearly indicates that all the 4 CAAQMS have recorded violation for PM_{10} compared to the permissible limits (60µg/m³)for the past five years which indicates that Navi Mumbai is polluted with RSPM. Airoli (78.43 µg/m³) and Turbhe (154.95 µg/m³) have shown a decrease in their values compared with last year (2014- 15).

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

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Permissible limit	60	60	60	60
2009-10		154.26	96	
2010-11		141.25	92	
2011-12	162.37	141.53	111	
2012-13	176.41	161.41	110	204.64
2013-14	135.53	74.60	108	151.2
2014-15	137.31	139.67	Site shifting under process	187.87
2015-16	138.62	78.43		154.95

Source: Environmental Laboratory, NMMC

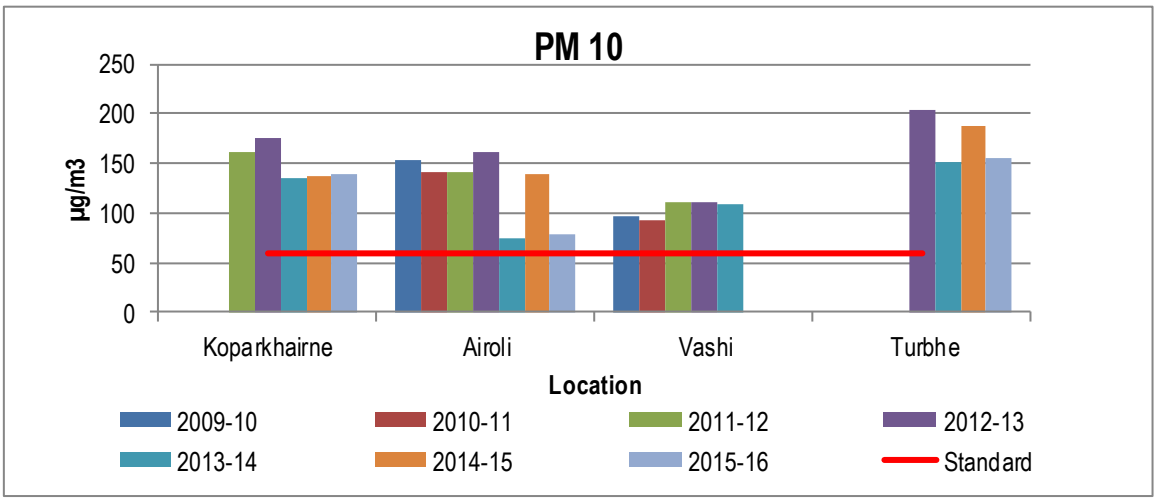


Figure No. 20: Yearly Trend in concentration of PM_{10} at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

[18] https://www3.epa.gov/pm/

Trends in $PM_{2.5}$ concentrations

$PM_{2.5}$ is particulate matter of 2.5 micrometers in diameter which is smaller - 1/30th the diameter of a human hair which are emitted directly or formed secondarily in the atmosphere such as sulphates, nitrates and so on[19].

Since the last five years the $PM_{2.5}$ levels in Navi Mumbai have been higher than the standards (40µg/m³) at all regions. Koparkhairne and Turbhe areas have continuously violated the standards. Only the Airoli region has less concentration of $PM_{2.5}$ (31.85 µg/m³) this year compared to the standards. As for the trend, Koparkhairne region has recorded a decreasing trend for PM concentrations. The trend for $PM_{2.5}$ concentrations have been presented below in Table No. 10 and Figure No. 21.

Table No. 10: Yearly trend in concentration of $PM_{2.5}$ at AAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Turbhe (µg/m³)
Annual Permissible Limit	40	40	40
2009-10		41.58	
2010-11		39.38	
2011-12	78.40	33.11	
2012-13	74.89	50.46	71.16
2013-14	64.63	18.11	54.2
2014-15	63.98	42.82	71.57
2015-16	61.62	31.85	65.50

Source: Environmental Laboratory, NMMC

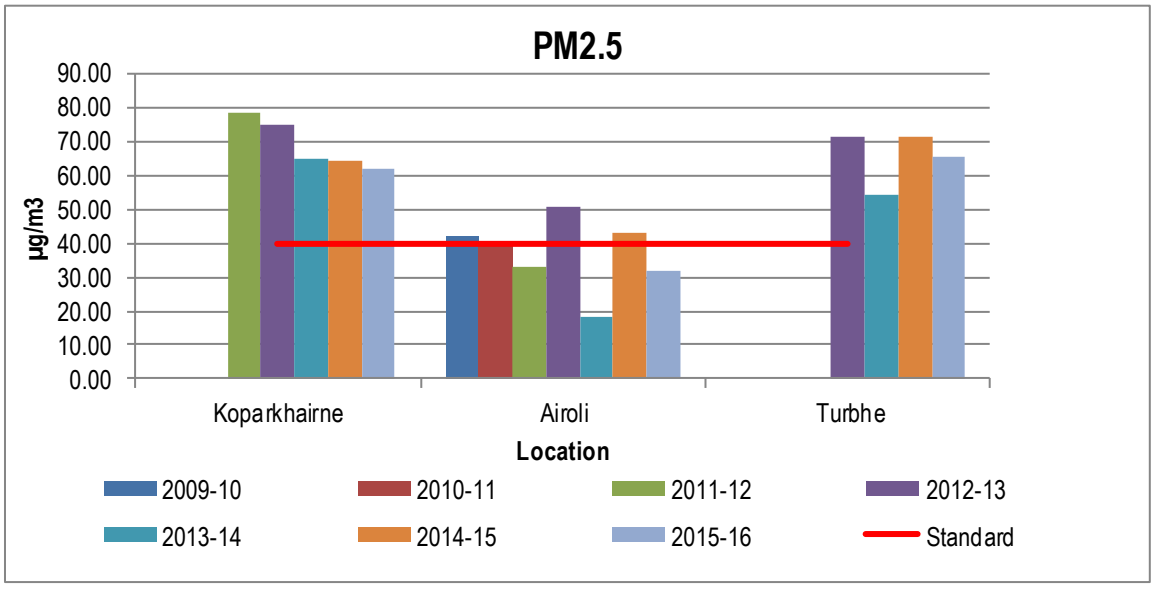


Figure No. 21: Yearly Trend in concentration of $PM_{2.5}$ at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

[19] https://www3.epa.gov/pm/designations/basicinfo.htm

Inter Station Analysis

The interstation analysis of SO_2, NOx, $PM_{2.5}$ and PM_{10} have been presented below for 3 CAAQMS namely Airoli, Koparkhairane and Turbhe.

SO_2

The interstation analysis for concentration of SO_2 presented in Table No. 11 and Figure No. 22 indicates that the SO_2 concentrations at all the 3 stations are under the annual standards (50µg/m³). Even the 98th percentile values for daily concentrations are well below the daily standards (80µg/m³) except for Turbhe (88.42 µg/m³) which just exceeds the standards. Even though all the annual averages are well below the daily standards, Turbhe stations records the daily peak value as 287.60µg/m³, more than 3.5 times the daily standards followed by Koparkhairane which is almost double the (180.72 µg/m³) the daily standard value.

Station Name	Max of SO_2	98th Percentile	Average of SO_2	Min of SO_2	Daily Standard (µg/m³)	Annual Standard (µg/m³)
Airoli	70.28	50.85	26.05	7.75	80.00	50.00
Koparkhairne	180.72	69.24	37.36	1.07	80.00	50.00
Turbhe	287.60	88.42	44.46	8.8	80.00	50.00

Table No. 11: Concentration of SO_2 across NMMC region (2015-16)

Source: Environmental Laboratory, NMMC

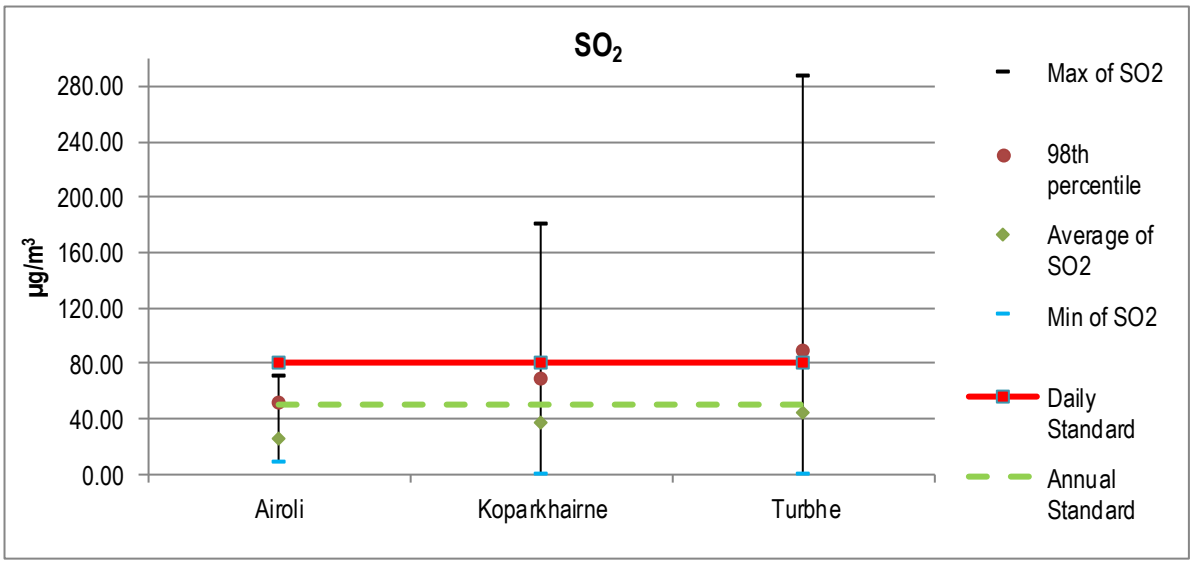


Figure No. 22: Concentration of SO_2 in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

NOx

The interstation analysis for concentration of NOx displayed in Table No. 12 and Figure No. 23 indicate that except for Turbhe (33.30µg/m³), Koparkhairane (57.40µg/m³) and Airoli (42.35µg/m³) exceed the annual standards of 40 µg/m³. The 98th percentile values have also exceeded the daily standard values (80 µg/m³) for all the stations which indicate the rise in pollution. Turbhe had the highest 98th percentile value (112.81µg/m³). Koparkhairane station recorded the max of NO_X (525.76µg/m³) almost 6.5 times more than the daily standard while Airoli recorded the concentration (437.60µg/m³) to be almost 5 times. This indicates that the concentration of NOx were very high during some days at Koparkhairane and Airoli.

Table No. 12: Concentration of NO_X across NMMC region (2015-16)

Station Name	Max of NOX (µg/m³)	98th Percentile (µg/m³)	Average of NOX (µg/m³)	Min of NOX (µg/m³)
CPCB Standards	80.00	80.00	40.00	80.00
Airoli	437.60	84.92	42.35	10.03
Koparkhairne	525.76	93.71	57.40	6.20
Turbhe	168.50	112.81	33.30	4.20

Source: Environment Laboratory, NMMC

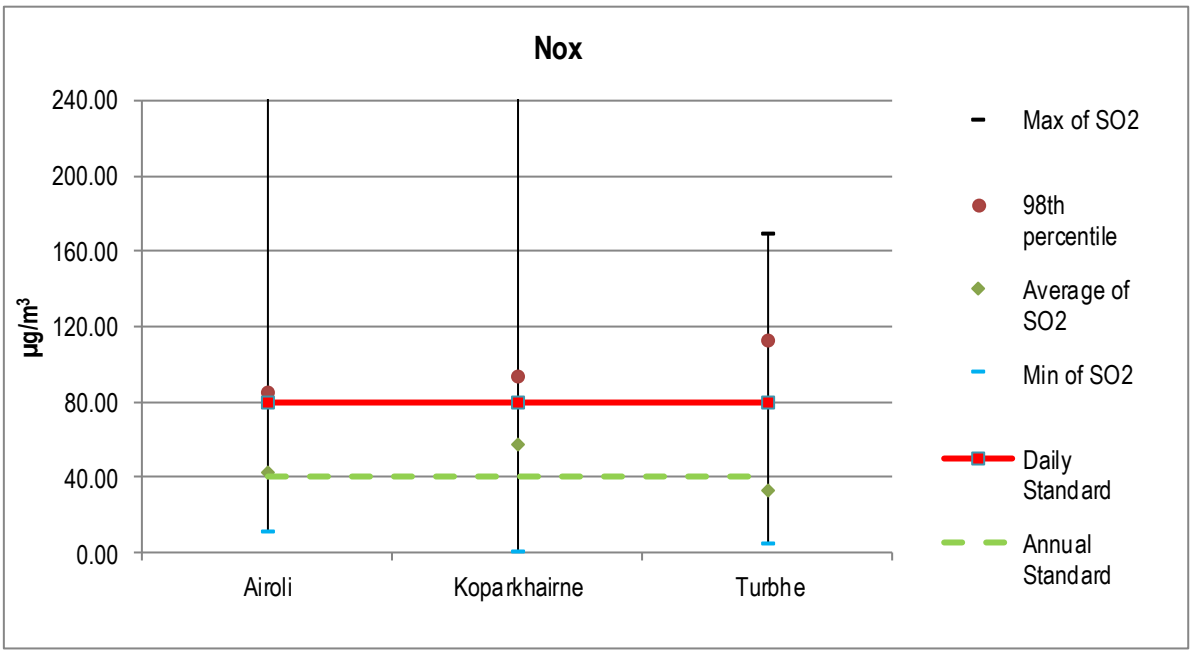


Figure No. 23: Concentration of NO_X in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

$PM_{2.5}$

The interstation analysis for concentration of $PM_{2.5}$ are presented below in Table No. 13 and Figure No. 24. The analysis indicates that except for Airoli (31.85µg/m³), Koparkhairane (61.62µg/m³) and Turbhe (65.60µg/m³) exceeds the annual standards of 40 µg/m³. Similarly, the daily standards (60 µg/m³) are also being exceeded by the 98th percentile values for Koparkhairane (103.94 µg/m³) and Turbhe (145.98 µg/m³). Turbhe has the highest max PM2.5 value (215.18 µg/m³) which is almost 3.5 times higher the daily standard followed by Koparkhairane (174.06 µg/m³) which exceeds the standard by almost 3 times. This indicates the rise in the pollution mainly due to activities like traffic congestion and quarrying.

Table No. 13: Concentration of $PM_{2.5}$ across NMMC region (2015-16)

Station Name	Max of RSPM (µg/m³)	98th percentile (µg/m³)	Average of RSPM (µg/m³)	Min of RSPM (µg/m³)
CPCB Standards	60.00	60.00	40.00	60.00
Airoli	87.68	55.50	31.85	6.63
Koparkhairne	174.06	103.94	61.62	0.00
Turbhe	215.18	145.98	65.50	8.35

Source: Environment Laboratory, NMMC

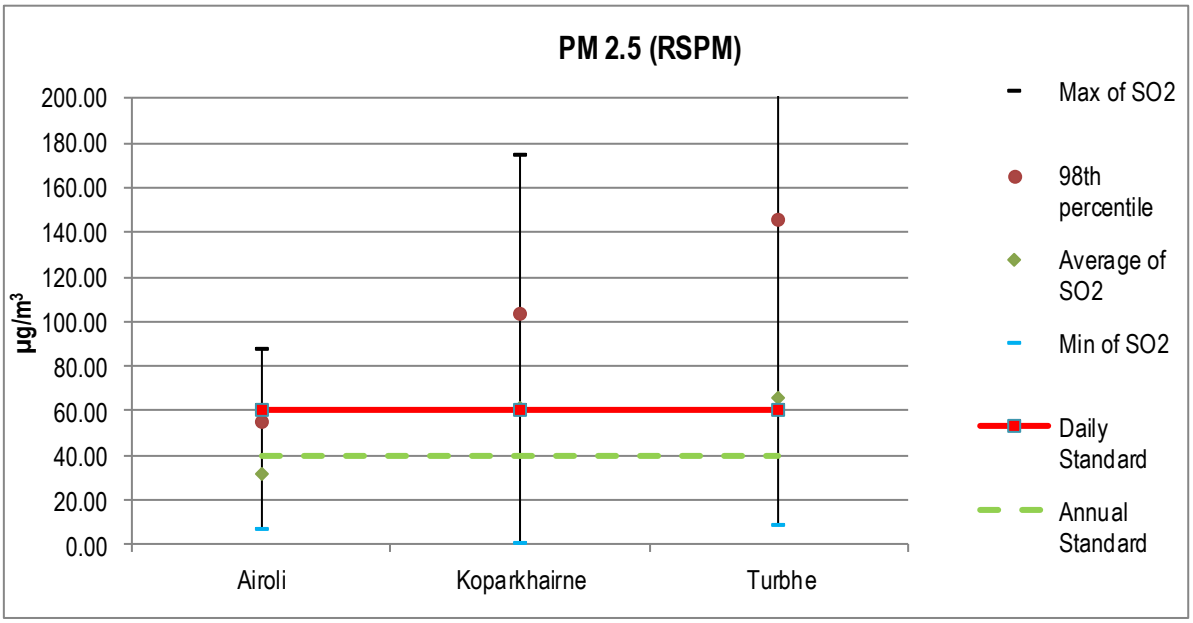


Figure No. 24: Concentration of $PM_{2.5}$ in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

PM_{10}

The interstation analysis for concentration of PM_{10} are projected below in and Figure No. 25. Concentrations of PM_{10} at all the CAAQMS are more the annual standards (60 µg/m³) indicating high levels of pollution. The concentration of PM_{10} was found to be highest at Turbhe (154.95µg/m³) followed by Koparkhairane (138.62µg/m³) and Airoli (78.43µg/m³).

The 98th percentile value are also exceeding the standards (100 µg/m³) for all the stations. Turbhe stations records the 98th percentile value to be almost 3 times more (305.67µg/m³) the daily standard, followed by Koparkhairane which doubles (213.84 µg/m³) the standards followed by Airoli (136.19 µg/m³).

All the daily peak values for PM_{10} were also highly exceeding the daily standards indicating serious threat of PM_{10} pollution. The least could be observed for Airoli (240.88 µg/m³) while Koparkhairne (467.01 µg/m³) and Turbhe (481.19 µg/m³) are exceeding almost more than 4 times the daily standard. The concentrations of PM_{10} are very high in the city mainly due to the growing industrialization and traffic congestion.

Table No. 14: Concentration of PM_{10} across NMMC region (2015-16)

Station Name	Max of PM_{10} (µg/m³)	98th percentile (µg/m³)	Average of PM_{10} (µg/m³)	Min of PM_{10} (µg/m³)
CPCB Standards	100	100	60	100
Airoli	240.88	136.19	78.43	10.20
Koparkhairne	467.01	213.84	138.62	0.00
Turbhe	481.19	305.67	154.95	35.13

Source: Environmental Laboratory, NMMC

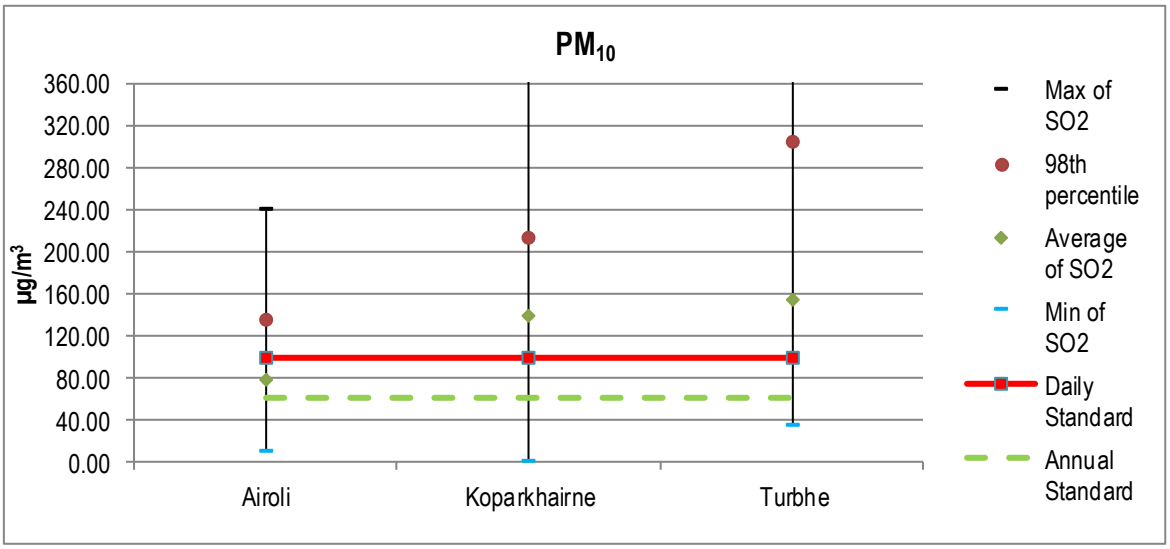


Figure No. 25: Concentration of PM_{10} in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

Carbon monoxide

It can be observed from Figure No. 26 that Airoli AAQMS has recorded the maximum readings which violated the 8 hourly standards (2mg/m^3). Koparkhairane stations follows next but, with just few readings at a particular time period. A seasonal pattern could be strongly observed in the concentration of CO recorded by both stations. As observed, the concentrations for both the stations are increasing drastically from November to February which is the winter season. Otherwise the observations are seen to be either lower or in line with the standards for rest of the seasons. Airoli station has recorded the highest readings (24.33 mg/m^3 and 21.65 mg/m^3) between December and February which is exceeding almost 12 times the standards. But there could be a possibility where these readings could be outliers due to various reasons. Thus seasons play an important role in the concentration of CO in the city.

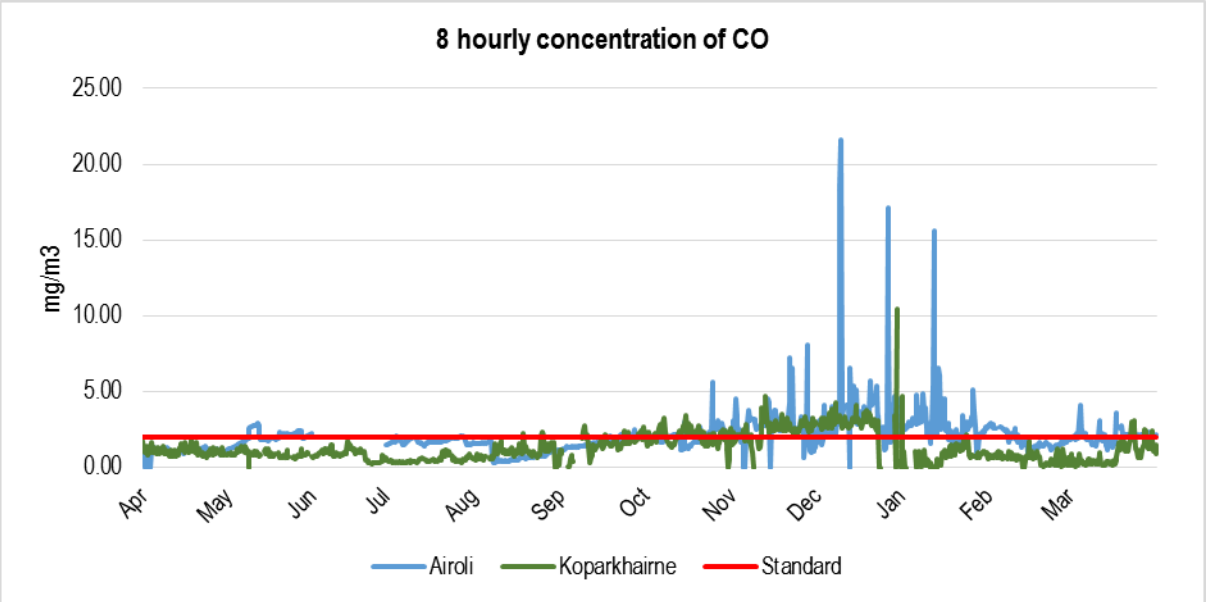


Figure No. 26: Concentration of CO in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

Ozone

Presently ozone concentrations are monitored only at the Koparkhairne station and the status of Ozone concentrations at Koparkhairne for 2015-16 is presented in Figure No. 27. It is clearly observed that for all the months the ozone concentrations are well below the standards (100µg/m^3). A sudden peak in the concentrations of Ozone is observed in the month of January while majority of the readings lie well below 20µg/m^3. Thus the level of Ozone is found to be very low in the city and Navi Mumbai is non-polluted for ozone pollution as recorded by the station at Koparkhairane.

Methane

Methane is a greenhouse gas and not a pollutant and is known to impact the phenomenon of Global warming. It is naturally present in the atmosphere and the natural source includes volcanic eruptions and gases released from animals. Methane gas is 21 times more potent than carbon-dioxide in terms of its global warming potential. It is released from degradation of biodegradable waste.

The concentration of Methane recorded at 3 AAQMS namely Airoli, Koparkhairane and Turbhe are presented below in Figure No. 28. Given the fact that the Turbhe station is close to the Landfill site the methane concentration at that were recorded to be higher As it is observed the methane concentrations are found to be high at Turbhe at all the hours compared to the stations at Koparkhairane and Airoli. The average 8 hourly readings at Turbhe are between 7- 15 ppm while readings for other stations are between 0- 5 ppm. The reason for high methane concentration at Turbhe could be attributed to the absence of lid on leachate container at the Turbhe landfill site which may be responsible for the release of methane gas. .

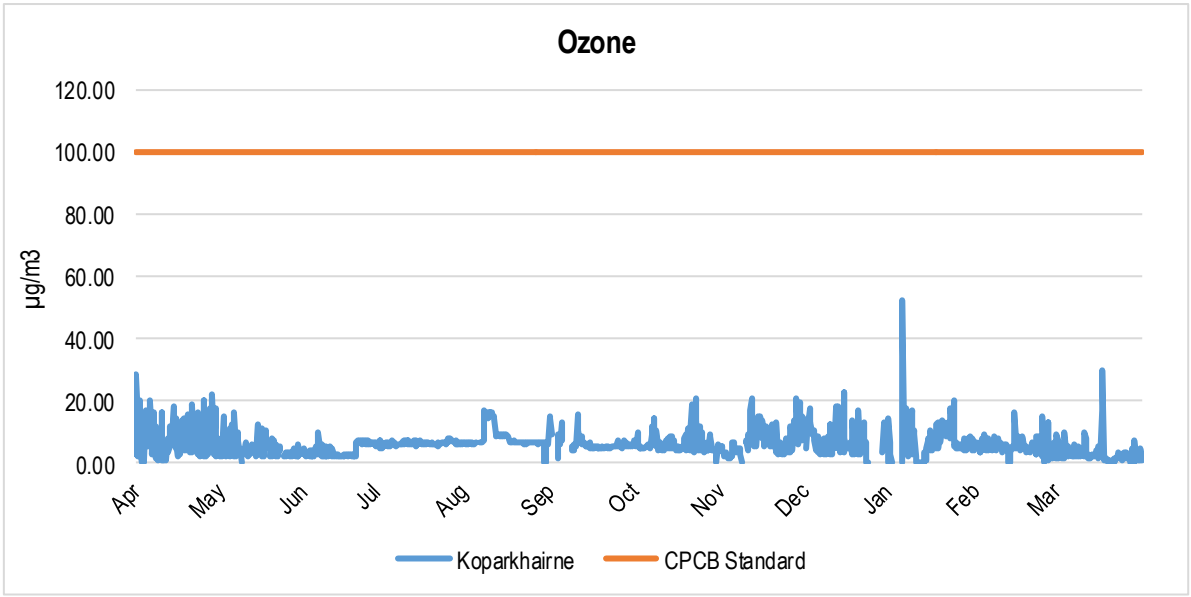


Figure No. 27: Concentration of Ozone in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

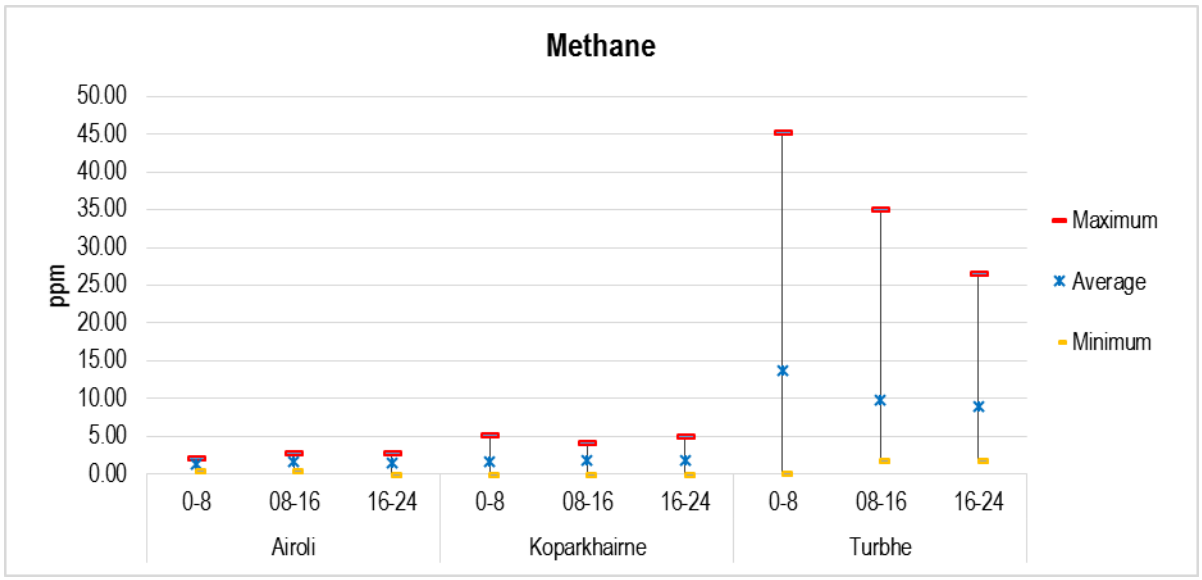


Figure No. 28: Concentration of Methane in NMMC region for the year 2015-16

Source: Environment Laboratory, NMMC

Air Quality Index

Air Quality Index (AQI) is a tool for effective communication on the status of the air quality. AQI transforms complex air quality data of various pollutants into a single index value, which are easy to understand. The categories of the AQI usually are expressed in terms of the air quality being Good, Satisfactory, Moderate, Poor, Very Poor or severe based on the concentrations of various pollutants and their health impacts at various concentrations. The AQI for Navi Mumbai has been calculated based on the calculation of AQI developed, specifically for India, by CPCB in consultation with IIT (Indian Institute of Technology) Kanpur in the year 2014[20].

Based on the calculations (Figure No. 29), it was determined that Turbhe and Koparkhairne areas are polluted with $PM_{2.5}$ & PM_{10} pollution. As for the pollutants the sub-index calculation reveals that the NMMC areas is clean for NOx, SO_2, CO and Ozone pollutants is either Good or Satisfactory category. It's only for 10-12% of the days that the air quality in Navi Mumbai is polluted and may be in the 'Poor' or 'Very Poor' category that too because of PM concentrations.

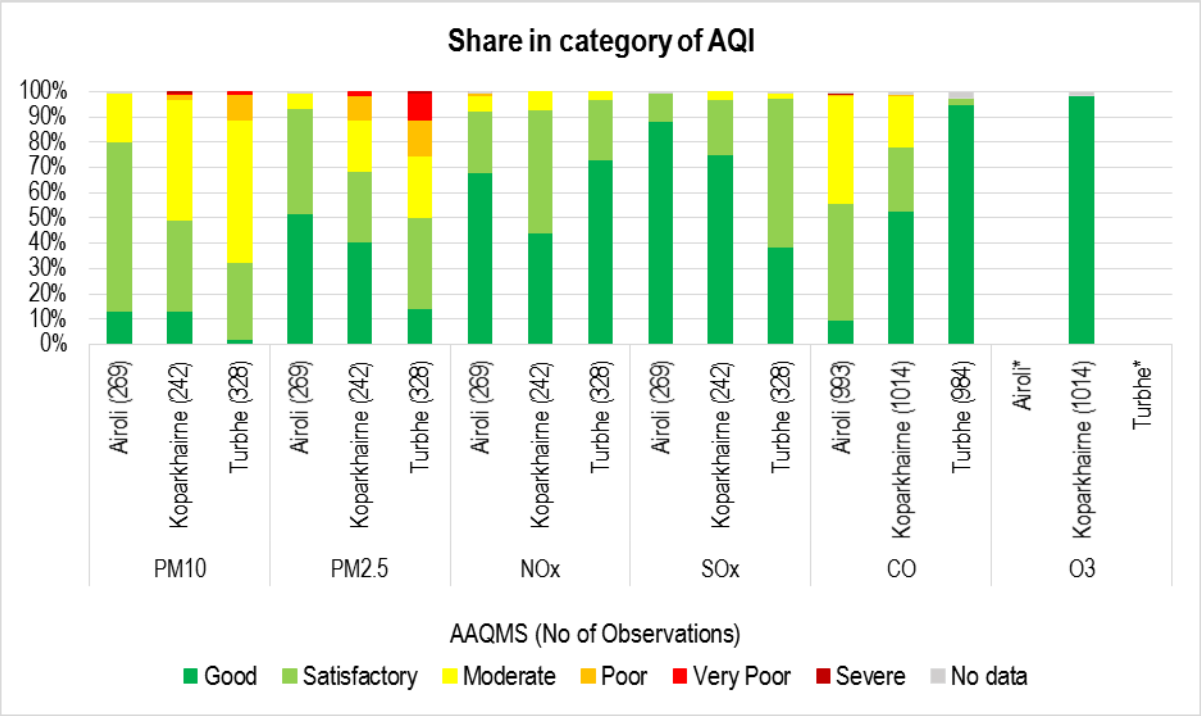


Figure No. 29: Occurrence of AQI classes for air pollutants in NMMC (2015-16)

Source: Environment Laboratory, NMMC

**Note: Ozone was not monitored at Airoli and Turbhe in 2015-16*

[20] CPCB 2014, *National Air Quality Index*, Central Pollution Control Board, Ministry of Environment & Climate Change, Government of India

Noise Pollution

It can be observed from Figure No. 30 that almost all the readings from commercial areas are violated the day (55dB) and night (45dB) time standards. Juinagar ESR, Sector 11 (61.5dB) area recorded the highest noise level followed by Turbhe MCH, Sector 22 (61dB); Sanpada ESR, Sector 4 (60dB) and Nerul GSR Sector 21 (58 dB). Similar is the case with the residential sector where all the noise levels are above the standards. Highest levels (59.5dB) are recorded at Ghansoli ward office and Vashi Pump house, Sector 6. These are followed by Airoli ESR Sector 18 and 19 (58.5db), Nerul ESR Sector 22 (58.5dB) and Vashi hospital Sector 10 (58dB). The lowest reading was recorded for Agroli SCADA control Panel, Belapur (55dB). The highest daily peak value was recorded for Turbhe MCH, Sector 22 (71dB) while the lowest daily peak was recorded at Agroli SCADA control Panel, Belapur (64dB).

All the 6 traffic areas have recorded high pollution levels, than the standards of residential areas. The main reason for such high pollution level is due to the movement of dense traffic at these areas. Mahape Bridge (70.5dB) has recorded the highest noise pollution reading while Vashi Ward Office, Juhugaon area (66dB) has recorded the lowest noise pollution level. Rest all the stations have readings between 65- 70 dB.

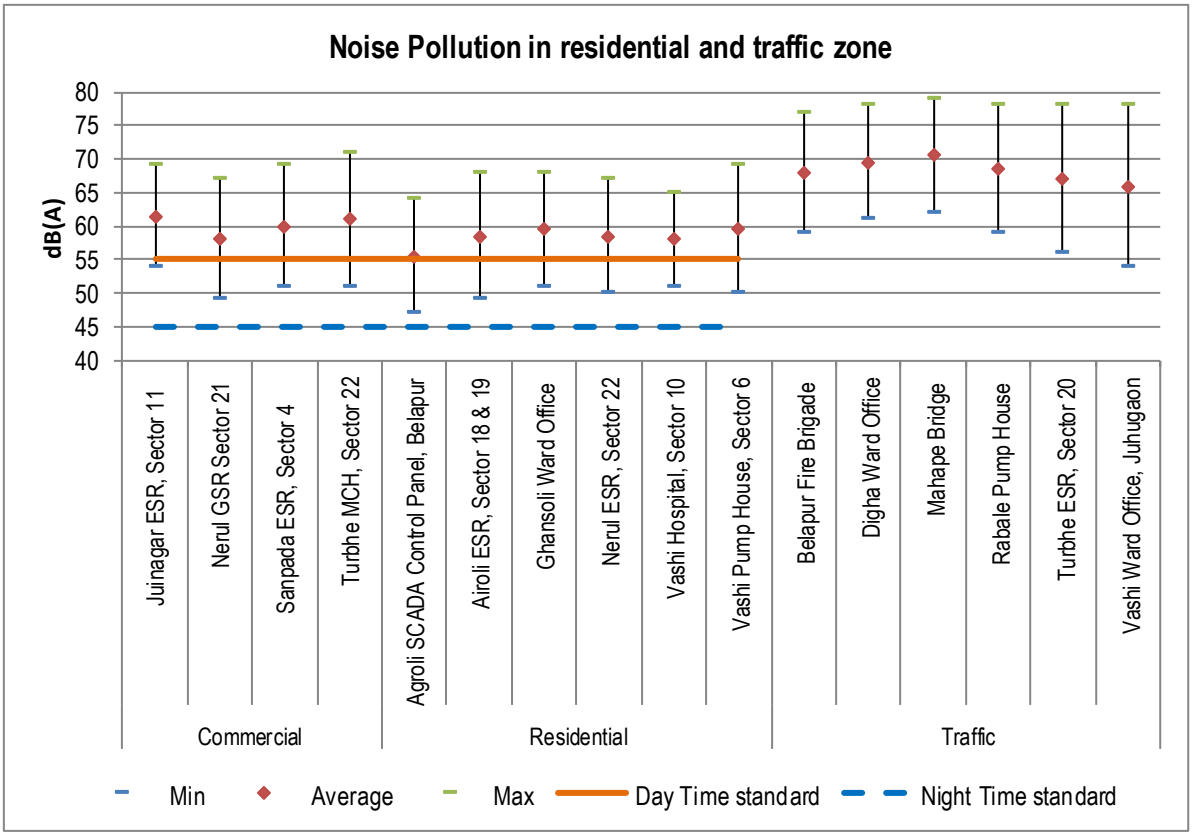


Figure No. 30: Level of noise pollution in various areas of Navi Mumbai

Source: Environment Laboratory, NMMC

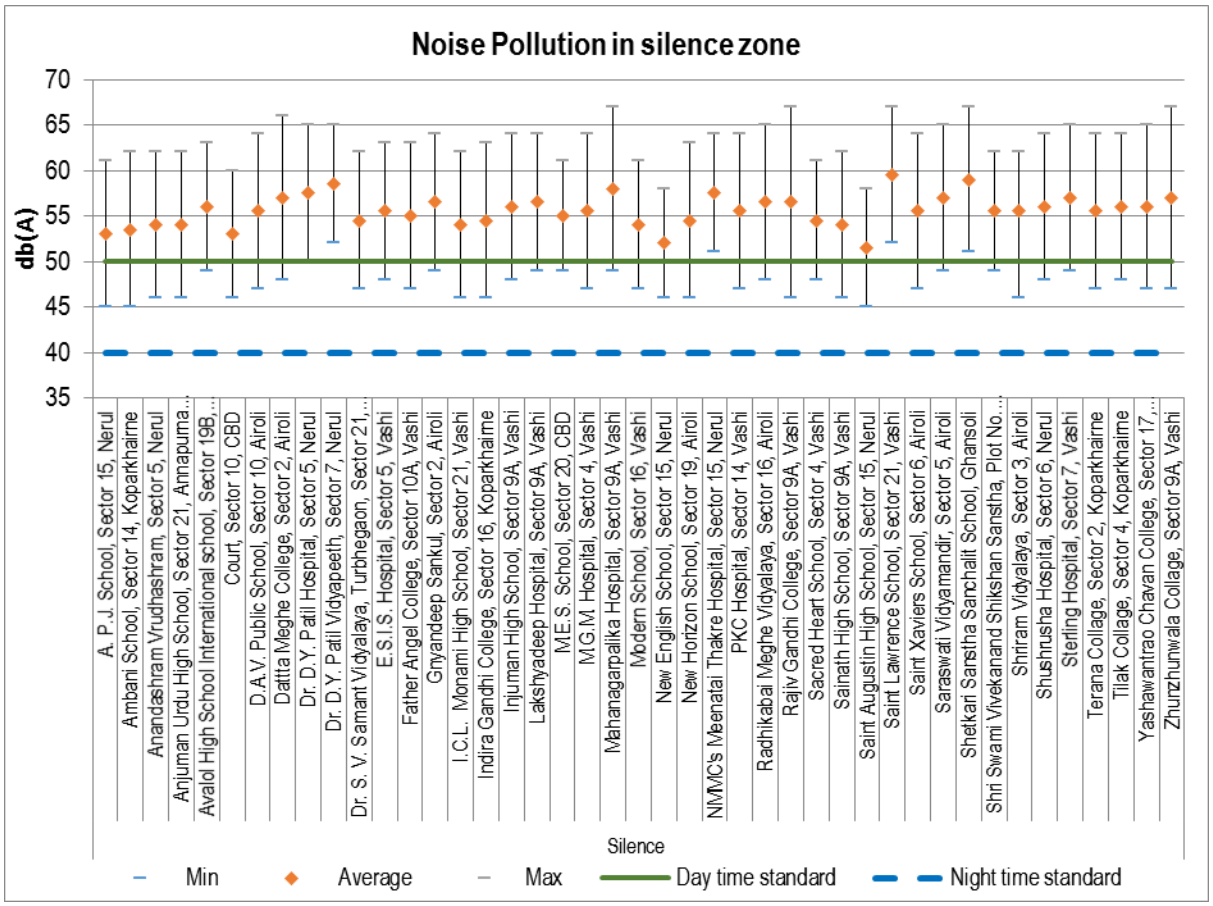


Figure No. 31: Level of noise pollution in silent areas NMMC area

Source: Environment Laboratory, NMMC

Figure No. 31 represents the silence zones in NMMC area. In the year 2015-16, all stations in silence zones under NMMC exceeded the standard average limits of 50dB. Mahanagarpalika hospital, Vashi; Rajiv Gandhi college, Vashi; Saint Lawrence school, Vashi; Shetkari Sanstha Sanchalit School, Ghansoli and Zhunzhunwala college, Vashi recorded the highest average daily noise levels of 67 dB. The highest average noise level (59.5dB) was recorded at Saint Lawrence School, Vashi and the lowest average noise level (50dB) was recorded at Saint Augustine High School, Nerul.

The average night standards for silent zones is 40dB and as it can be observed even the minimum daily peak value are exceeding the night average standards. Thus the readings indicate heavy noise pollution in silent zones.

Pressures

Vehicular Growth

Detailed statistics on the number of vehicles which were registered year wise at Vashi RTO are shown below in Figure No. 32. As per the figure 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 3.84 lakhs. The major increase in registered vehicles is observed in the two wheelers which recorded a growth of almost 1.3 times (Figure No. 33) the previous year. No significant growth is observed in the number of 4 wheelers, Taxi/ Autorikshaw and Bus/ Carriages. A slight increase by 1.2 times was observed in the number of other heavy vehicles. One may note that although the registration may have taken place at Vashi RTO, the actual usage of vehicle may not be in the city directly. The total number of vehicles registered in Navi Mumbai (Category wise) are presented in Annex –III

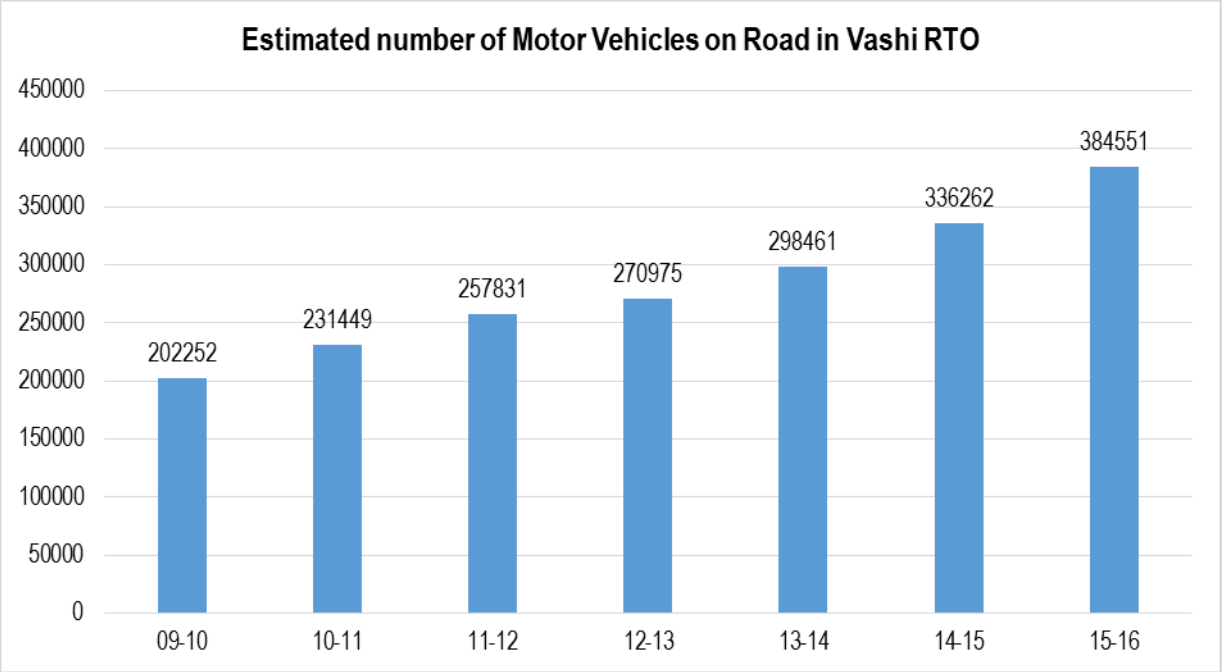


Figure No. 32: Estimated number of Motor Vehicles on Road in Vashi RTO

Source: RTO Publication 2015-16

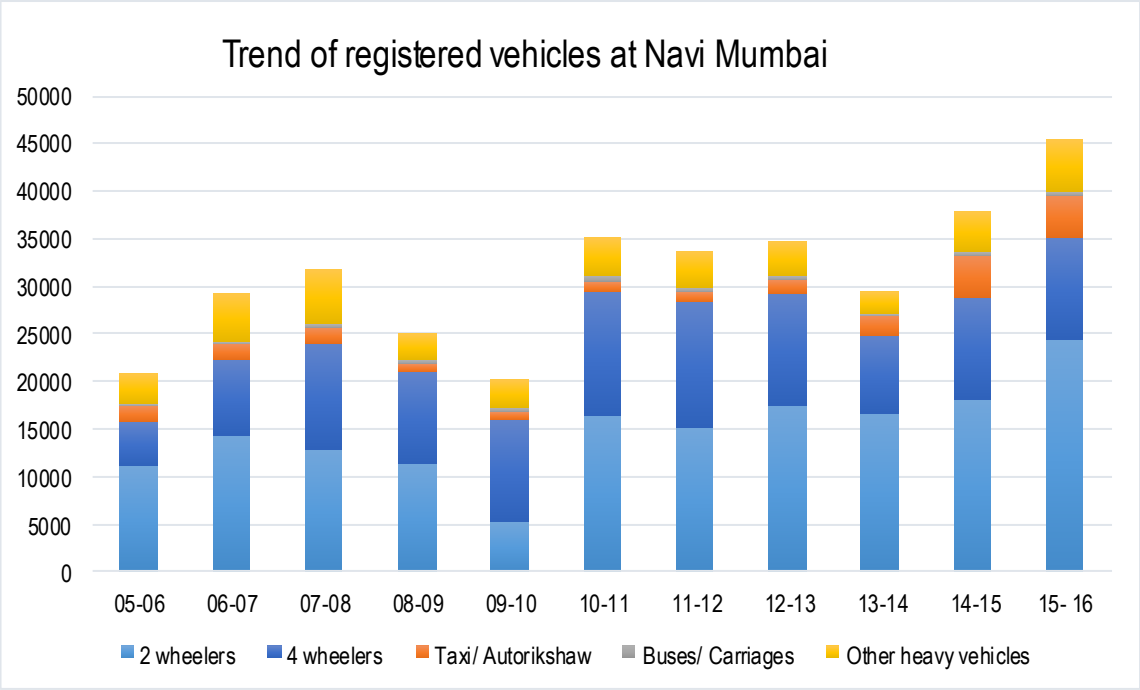


Figure No. 33: Decadal trend in annual vehicle registrations in Navi Mumbai

Source: RTO Publication 2015-16

Impact

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 NIEHS (National Institute of Environmental Health Sciences[21]) 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[22]. Hence it is necessary to keep a check on diseases like bronchitis and asthma.

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

[21] http://www.niehs.nih.gov/
[22] http://www.who.int/mediacentre/factsheets/fs313/en/

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.

Response

NMMC has taken various measures to tackle the issue of air pollution in the. The key reasons behind these improvements in air quality as well as steps taken by the corporation have been highlighted below:

- Addition of a new air monitoring station was completed this year at Wonders Park, Nerul. This station was installed by Indian Institute of Tropical Meteorology (IITM) (Picture No. 3).
- NMMC has successfully completed the concretisation of the MIDC road which shall help reduce traffic congestions in the city resulting in the reduction of air pollution. This initiatives shall help in the reduction of NOx and RSPM level in the city (**Picture No. 4**)
- NMMC has successfully completed the concretization of roads at 19 junctions which has largely helped to reduce the issue of traffic congestion. Also the work of Sion-Panvel highway has been completed by NMMC which has resulted in diverting a large amount of traffic from entering the city.
- Timers have been installed at traffic signals to reduce the idling period and thus indirectly the emissions.
- 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.
- Within the Navi Mumbai municipal limits completion of activities related to stone quarrying has resulted in decline of dust pollution

Picture No. 3: New CAAQMS installed at Wonders Park, Nerul

Picture No. 4: Completion of roads at MIDC

Water Resources

Water is one of the vital renewable resources on earth. Globally, 1600 million cubic km of water is available on earth out of which 97.5% is saline water and remaining 2.5% is fresh water. Two thirds of this fresh water is frozen in glaciers and polar ice caps and about 0.26% of water is readily available for mankind.[23] Water resources include lakes, rivers, streams, groundwater and oceans. Water is used for drinking, cleaning, agriculture, transportation, industry, recreation, animal husbandry and so on. It is also used for producing electricity for domestic, industrial and commercial use. Due to its multiple benefits and the problems by its shortages and quality deterioration, water as a resource requires special attention.

Status of Water Resources

Water resources in terms of surface and groundwater are available within NMMC region. The surface water resources include ponds, creeks, lakes, dams and reservoirs whereas groundwater resource includes wells and bore wells. The population of Navi Mumbai depends on these water resources for daily water supply and other activities. Realising this fact, NMMC regularly monitors the water resources in order to check and record the quality of water.

Surface Water

Dam (Reservoir)

The Navi Mumbai Municipal Jurisdiction area has Hetwane, Barvi and Morbe dam within its vicinity, out of which NMMC selected Morbe dam as source of water supply. Morbe Dam, located on Dhavri River, tributary of river Patalganga in Karjat Taluka stands at a height of 194 ft. above sea level with surface area of around 9,780 sq km. It was constructed by MJP (Maharashtra Jeevan Pradhikaran), Government of Maharashtra in 1999, who then granted possession of Morbe dam to NMMC in November 2002. NMMC areas depends upon Morbe dam to meet its water requirements which is about 450 MLD[24]. The silent features of Morbe dam is presented in Table No. 15.

Table No. 15: Speciation 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	53.40 m
Length	3,250 m
Dam volume	18,075 x 10^3 m^3
Total capacity	19,089 x 10^4 m^3
Surface area	978 hectares

Source: Central water commission [25]

[23] K.Chatterjee, Climate Change Centre,Water Resources of India
[24] http://www.nmmconline.com/water-supply
[25]http://www.cwc.nic.in/main/downloads/National%20Register%20of%20Large%20Dams%202009.pdf

NMMC monitors the water quality at the reservoir daily before supplying the water to the city. The raw water from the dam is initially pumped to the water treatment plant at Bhokarpada for treatment. Chlorine is added as a disinfectant at source as well as at water treatment plant and is maintained at desired level of 0.2mg/l. NMMC, thus elaborates water quality checking and monitoring system at Morbe dam. The Table No. 16 below represents the average water quality of raw and treated water supplied by NMMC as per BIS standards.

Table No. 16: Average water quality of raw and treated water before supply

Sr.No	Test Parameters	Units	Raw Water (Bhokarpada)	Pure Water (W.T.P)	BIS Specifications 10500:2012 Normal Values	
					Desirable Limits	Permissible Limits
1	Physical Appearance		Clear	Clear		
2	Odour		Odourless	Odourless	Agreeable	Agreeable
3	Turbidity	N.T.U	0.36	0.24	1	5
4	pH Value		8.1	7.9	6.5 to 8.5	No relaxation
5	Chlorides (as Cl)	mg/l	35.98	35.98	250	1000
6	Nitrates (as NO_3)	mg/l	0.23	0.22	45	No relaxation
7	Total Hardness ($CaCO_3$)	mg/l	28	28	200	600
8	Alkalinity ($CaCO_3$)	mg/l	64	60	200	600
9	Total Dissolved Solids	mg/l	126	106	500	2000
10	Iron (as Fe)	mg/l	0.76	0.10	0.3	No relaxation
11	Fluoride (as F)	mg/l	0.002	nil	1	1.5
12	Other Tests (if any)	mg/l				
13	Permanent Hardness	mg/l	36	36		

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

Lakes and ponds

Accounting for 0.26% of the Earth's surface, lakes and ponds are vital habitats, and provide essential resources for a wide range of species, including humans. There are total 24 lakes with coverage area of 2.23 Lakh sq.m area within NMMC. The Belapur node accounts 28% of the share area with maximum number of lakes. This is followed by Ghansoli node with 25% of share area and having 4 lakes within the node. The Gothivali Lake in Ghansoli is recorded as biggest lake having surface area of 32,635 sq. m. The Mahape Lake in Koparkhairne node is smallest lake with area of 1,338 sq. m. Node wise details of the lakes with coverage area are described in the Table No. 17 below. Most of the lakes are observed to be surrounded by residential areas and have Gabion wall structures.

Table No. 17: 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: Environmental Laboratory, NMMC

NMMC monitors the water quality of lakes at frequent intervals (Table No. 18 and Table No. 19). On analysing the samples it is observed that the pH levels for all the lakes are well within the limits. The concentrations of suspended solids at Juhugaon Lake, Vashi (230 mg/l) were almost double the permissible limit (100 mg/l) followed by Vashigaon lake, Vashi (159 mg/l), Gothivali, Ghansoli (116 mg/l), Mahapegaon, Koparkhairane (108 mg/l) and Diva, Airoli (107 mg/l). Juhugaon Lake is the only lake which has recorded the Total Dissolved Solids (TDS) level (5688 mg/l) by almost double the standard (2100 mg/l). This indicated high stress conditions in Juhugaon Lake, Vashi. The dissolved oxygen (DO) level was found to be high (9 mg/l) in Khairne Lake, Koparkhairane compared to the limits (4-7mg/l) followed by Airoli Naka Lake (8.4 mg/l). No lake exceeds the standard for B.O.D,

C.O.D, Nitrate, Nitrite, Phosphate, Chloride, Hardness and Sulphate which indicates that the overall quality of the lakes are good in Navi Mumbai.

Table No. 18: Annual average water quality of lakes in NMMC area (1 of 2)

Node	Name of Lake	PH	S.S	TDS	D.O	B.O.D	C.O.D
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		5.5-9.0	<100	<2100	4.0-7.0	<100	<250
Airoli	Airoli Naka	7.4	48	719	8.4	1	45
	Diva	7.2	107	775	5.7	3	72
Belapur	Belapur	7.6	66	421	6.4	4	54
	Darave	7.1	66	945	5.8	6	64
	Karave	7.5	35	750	6.5	1	26
	Killegaonthan	7.2	59	475	5.3	2	26
	Agroli	7.6	36	684	5.7	1	16
Digha	Khokad	7.2	82	616	5.7	1	27
Ghansoli	Rabada	7.4	44	787	5.1	2	30
	Gumali	7.4	27	902	4.7	4	49
	Talvali	7.5	26	752	6.3	3	52
	Gothivali	7.0	116	451	4.3	8	81
Nerul	Nerul Sector 20	7.2	57	829	6.3	4	44
	Shirvane	7.2	65	1482	4.5	4	62
Turbhe	Turbhegaon	7.2	99	1116	4.5	4	54
	Sanpada	7.3	65	636	7.0	5	86
Vashi	Vashigaon	7.2	159	1711	5.9	3	52
	Juhugaon	7.1	230	5688	4.6	7	104
Koparkhairne	Koparkhairne	7.4	42	622	7.1	3	64
	Khairne	7.7	43	438	9.0	5	52
	Savaligaon(Kopari)	7.3	57	1962	6.5	2	50
	Bonkode	7.4	44	715	6.1	1	28
	Mahapegaon	6.7	108	1210	5.7	5	76

Source: Environmental Laboratory, NMMC

Table No. 19: Annual average water quality of lakes in NMMC area (2 of the 2)

Node	Name of Lake	Nitrate	Nitrite	Phosphate	Chloride	Hardness	Sulphate
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		<45		<5	<1000	-	<1000
Airoli	Airoli Naka	0.707	0.357	0.439	43.50	279	163.51
	Diva	0.791	0.334	1.337	77.39	361	702.76
Belapur	Belapur	0.996	0.185	0.768	62.52	197	140.81
	Darave	0.881	0.111	0.352	61.01	501	162.18
	Karave	0.462	0.119	0.334	63.69	237	203.17
	Killegaonthan	0.772	0.208	0.792	34.17	190	109.68
	Agroli	0.407	0.071	0.236	87.21	384	175.10
Digha	Khokad	1.281	0.390	0.457	44.54	414	229.85
Ghansoli	Rabada	2.279	0.612	1.167	72.15	423	339.65
	Gumali	2.533	0.368	0.348	149.42	392	200.15
	Talvali	1.076	0.269	0.409	146.18	299	185.12
	Gothivali	0.523	0.209	0.232	54.90	201	107.71
Nerul	Nerul Sector 20	1.312	0.199	0.414	42.70	420	159.32
	Shirvane	2.585	0.275	0.364	72.95	1144	317.18
Turbhe	Turbhegaon	1.670	0.100	0.252	37.76	583	251.53
	Sanpada	0.357	0.193	0.267	70.10	252	219.03
Vashi	Vashigaon	2.955	0.190	0.920	38.50	1165	500.14
	Juhugaon	0.759	0.103	1.633	76.77	235	160.03
Koparkhairne	Koparkhairne	1.085	0.381	1.199	68.64	358	177.64
	Khairne	0.722	0.225	0.300	160.43	167	67.82
	Savaligaon(Koparl)	2.267	0.156	0.318	133.60	450	166.62
	Bonkode	2.956	0.124	0.459	63.88	485	188.38
	Mahapegaon	0.849	0.173	0.511	187.98	511	251.32

Source: Environmental Laboratory, NMMC

Creek

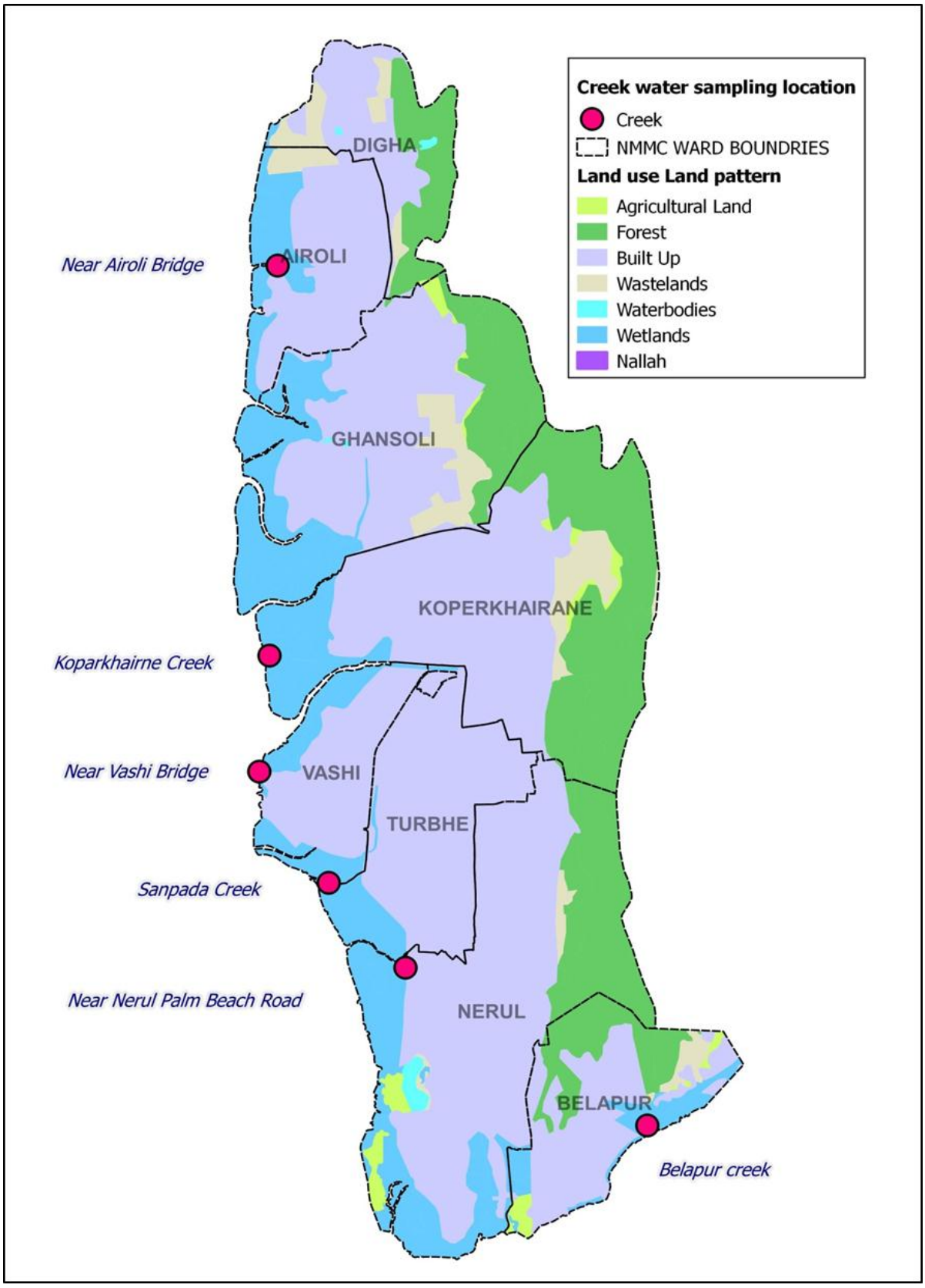
Monitoring of water samples from creeks is carried out at 6 locations by NMMC (Map No. 3). The annual average water quality of creek in NMMC area is tabulated below in Table No. 20. The annual average values for the water quality tests indicate that the creek water has high Chloride levels. All the readings from creek have violated the limits for Chloride (<600 mg/l) by more than 10 times. This has led to decrease in oxygen levels in the creek ecosystem which is clearly reflected from the low DO (Dissolved Oxygen) levels in the water samples at Turbhe (3.5 mg/l) and Airoli (1.7 mg/l). Creek near Vashi shows the reading for BOD to be almost double (218 mg/l) the limit (<100 mg/l). Thus the creek water is in a polluted state in Navi Mumbai.

Table No. 20: Annual average water quality of creek water samples in NMMC area

Location	Parameters							
	pH	SS (mg/l)	DO (mg/l)	BOD (mg/l)	TKN (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	Chloride (mg/l)
Limits	**5.5-9.0**	**<100**	**4.0-7.0**	**<100**	**<5**		**<45**	**<600**
Belapur	7.1	1517	4.4	71	21.976	3.329	1.046	9507.03
Near Nerul Palm Beach Road	7.3	948	4.0	27	13.261	3.258	0.908	9039.51
Near Vashi Bridge	7.3	1363	4.1	218	13.781	4.602	1.126	15188.38
Sanpada	7.5	968	3.5	81	14.902	4.225	1.782	9094.99
Koparkhairne	7.4	793	6.5	81	25.104	3.207	2.840	5788.63
Near Airoli Bridge	7.2	897	1.7	58	21.325	2.626	4.066	6060.18

Source: Environmental Laboratory, NMMC

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



Source: Environment Laboratory, NMMC

Ground Water

The NMMC region hardly depends on ground water for its activities due to established systematic water supply. The analysis of samples from well water is regularly carried out for the parameters of pH, DO, BOD, residual chlorine, alkalinity, and faecal coliform. In the year 2015-16, NMMC conducted water quality test for around 24 wells in NMMC area (Table No. 21). All the parameters were detected to be within limits but the samples revealed presence of E-coli and faecal coliform in all the water samples. Water quality was also identified for the borewell present at the Landfill site at Turbhe (Table No. 22). It readings indicate all the parameters are well between the limits but detects the presence of coliforms.

Table No. 21: Well water quality recorded in NMMC area in 2015-16

Sr. No.	Location	PARAMETERS											
		pH	Turbidity	Residual Chlorine	DO	BOD	COD	Chloride	Hardness	Sulphate	MPN Count /100 ml	E.Coli	F.Coli
			NTU	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)			
1	Agroligaon, Sector 29	7.1	0.00	Nil	3.7	1.0	20	38.92	529	663.81	23	+ve	+ve
2	Shahabazgaon, Sector 19	7.3	0.06	Nil	3.8	0.7	40	38.92	257	70.29	23	+ve	+ve
3	Shiravane, Sector 1, Nerul	7.4	18.96	Nil	2.9	0.6	50	71.36	257	36.95	23	+ve	+ve
4	Sarsole, Sector 6, Nerul	7.4	0.00	Nil	3.5	0.8	10	45.41	172	93.90	23	+ve	+ve
5	Karavegaon, Near Lake, Nerul	7.5	0.00	Nil	3.4	2.0	40	97.31	143	61.52	23	+ve	+ve
6	Daravegaon, Sector 23, Nerul	7.4	0.00	Nil	3.2	0.7	30	116.77	172	62.10	23	+ve	+ve
7	Turbhegaon, Sector 21	7.4	9.79	Nil	1.0	1.0	30	77.85	315	74.29	23	+ve	+ve
8	Ganpatipada, Turbhe	7.4	0.00	Nil	0.7	2.0	60	188.13	458	127.43	23	+ve	+ve
9	Indiranagar, Turbhe	7.3	68.40	Nil	3.1	1.0	40	110.28	300	109.33	23	+ve	+ve
10	Turbhe Stores	7.3	0.00	Nil	3.0	0.9	20	90.82	272	80.00	23	+ve	+ve
11	Tin Taki, Sector 18,Koparkhairne	7.8	0.00	Nil	2.7	0.4	10	38.92	129	22.10	23	+ve	+ve
12	Infront of P.C.Patil's House, Sector 19, Koparkhairne	7.7	0.00	Nil	2.8	0.5	10	64.87	186	30.29	23	+ve	+ve
13	Near Keshav Uncle's House, Sector 19, Koparkhairne	7.6	0.00	Nil	3.0	0.5	10	77.85	243	69.71	23	+ve	+ve
14	Anant Patil, Chinchali, Ghansoli	7.4	0.00	Nil	3.6	0.2	2	90.82	400	170.48	23	+ve	+ve
15	Old Video Center. Talvalinaka, Ghansoli	7.4	0.00	Nil	5.2	0.5	1	103.80	358	124.76	23	+ve	+ve
16	Rabadagaon behind GSR/ESR, Rabada	7.7	20.60	Nil	3.5	0.2	2	38.92	143	81.33	23	+ve	+ve
17	Near Vitthal Mandir, Divagaon, Airoli	7.7	0.00	Nil	3.8	0.3	4	38.92	129	61.90	23	+ve	+ve
18	Vitbhatti, Airoligaon, Airoli	7.6	0.00	Nil	6.4	0.3	4	38.92	215	179.05	23	+ve	+ve
19	Near Hanuman Mandir, Chinchpada, Airoli	7.4	77.70	Nil	1.8	3.0	12	84.34	315	140.38	23	+ve	+ve
20	Ilathanpada, Digha	7.5	0.00	Nil	6.5	1.0	7	71.36	257	92.38	23	+ve	+ve

21	Subhashnagar, Digha	7.7	0.00	Nil	3.9	0.4	2	45.41	243	93.52	23	+ve	+ve
22	Sanjay Gandhi Nagar, Digha	7.6	18.33	Nil	3.1	0.9	2	71.36	272	155.24	23	+ve	+ve
23	Juhugaon, Sector 11, Vashi	7.6	45.10	Nil	2.3	4.0	79	84.34	315	27.62	23	+ve	+ve
24	Vashigaon, Sector 6, Vashi	7.5	36.10	Nil	1.1	2.0	60	58.39	629	1104.76	23	+ve	+ve

Source: Environmental Laboratory, NMMC

Table No. 22: Water Quality of Turbhe bore well

Location of Well (Turbhe)	**pH**	**Turbidity**	**Residual Chlorine**	**DO**	**BOD**	**COD**	**Chloride**	**Hardness**	**Sulphate**	**MPN Count/ 100 ml**	**E.Coli**	**F.Coli**
		NTU	**(mg/l)**	**(mg/l)**	**(mg/l)**	**(mg/l)**	**(mg/l)**	**(mg/l)**	**(mg/l)**	**(mg/l)**		
Turbhe Landfill site Bore well	7.5	8.3	Nil	6.87	0.74	8	89.82	277.2	-	23	+ve	+ve
	7.1	10.2	Nil	5.12	4.6	31.36	81.1	840	-	23	+ve	-ve
	7.4	8.7	Nil	5.59	6.5	50.96	85.36	170	-	23	+ve	+ve
	7.4	2.7	Nil	4.28	0.14	20	67.07	246.4	-	23	+ve	+ve
	6.63	1	Nil	4.6	8	18	48.21	165	123.62	23	+ve	+ve
	6.5	2	Nil	6.85	3.44	46	66.29	271.7	135.62	23	+ve	+ve
	7.14	0	Nil	7.01	0.5	18	60.27	300	170.1	23	+ve	+ve
	7.33	0	Nil	6.67	3	60	168.67	386	167.81	23	+ve	+ve
	7.02	0	Nil	6.21	0.9	20	103.8	334	95.05	23	+ve	+ve
Average	**7.11**	**3.656**	**Nil**	**5.91**	**3.09**	**30.26**	**85.62111**	**332.3**	**138.44**	**23**	**+ve**	**+ve**

Source: Environmental Laboratory, NMMC

Water Resource Management

Water supply (Network)

This year on an average (average supply across all months), NMMC supplied around 389 MLD of treated water to Navi Mumbai city from the Bhokarpada treatment plant. Upon deducing the water losses, which account to about 19% of the water supply, it is estimated that around 315 MLD (Table No. 23) water was supplied by NMMC out of which 291 MLD was supplied to domestic sector and the remaining 25 MLD to the commercial sector. The supply of water to about 1,22,994 connections was through the well-developed distribution network of 972 km long facilitated by 132 booster pumps. The number and size of pipes used for water supply connection is provided below in Table No. 24. The NMMC provides max. 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.

Table No. 23: Highlights of the water supply network at a glance

Head	Details
Total Average water supply in 15-16	389 MLD
Processing and Distribution losses	~19%
Net Water Supply to Navi Mumbai (NMMC limits)	315 MLD
Length of distribution network	972.28 Km
Number of booster pumps	132
Water supply breakup	Metered: 302 MLD Unmetered: 20 MLD
Water supply sectoral break up	Domestic: 291 MLD Commercial: 25 MLD Gaothan& Slums: 6 MLD

Table No. 24: Number and size of pipes for water supply connections in NMMC area

Type	Connection size								Total
	15	20	25	40	50	80	100	150	
Domestic	110181	1369	1295	1011	561	133	20	08	114578
Commercial	6815	486	663	251	167	18	08	08	8416
Total									**122994**

Source: Environmental Laboratory, NMMC

The Ministry of Urban Development, Government of India, is nodal Ministry in charge of various aspects of Urban Development including Urban Water Supply and Sanitation in the country. The service level benchmarks set by Ministry of Urban Development, Government of India is 100%. From the Figure No. 34 it is observed that the coverage of water supply in NMMC area is 100% which meets the standard.On other hand, the Municipal Corporations of Thane, Mira-Bhayander and Ulhasnagar have around 94% coverage while Vasai Virar and Kalyan Dombivali municipal corporations have around 52 and 43% coverage only.

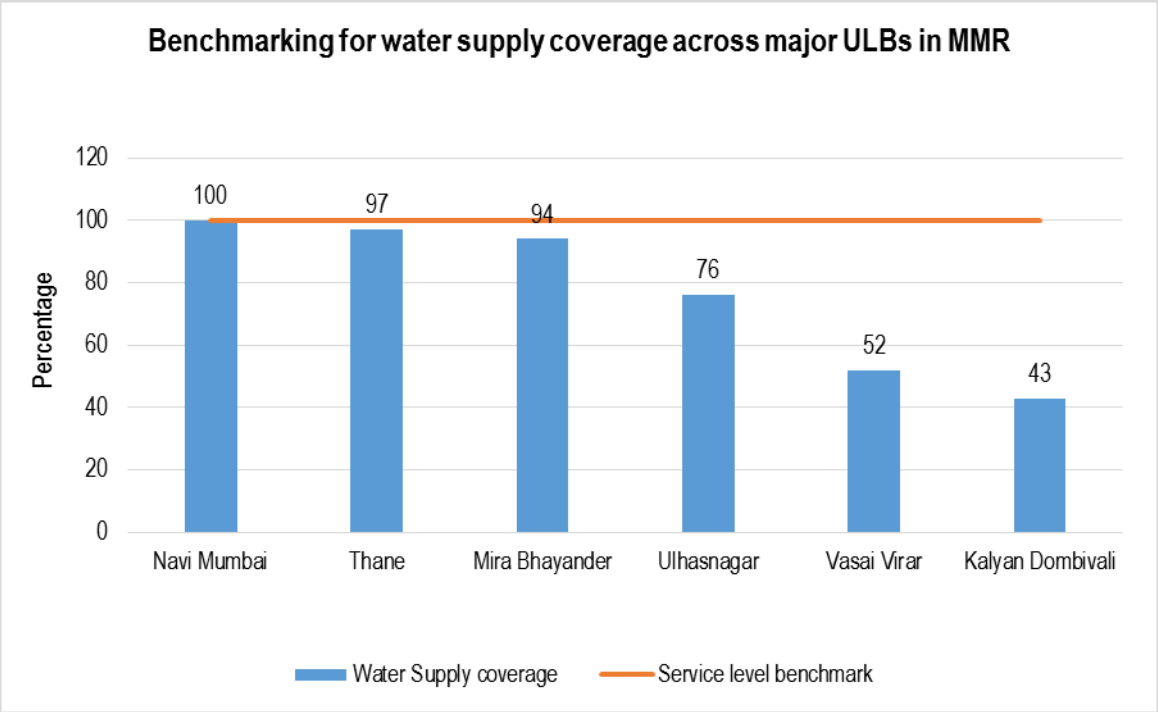


Figure No. 34: Benchmarking for water supply connections across major ULBs in MMR

Source: Performance assessment system[26]

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

Per capita water consumption

The per capita water supplied 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. It is expressed in LPCD -Litres Per Capita per Day.

According to CPHEEO (Central Public Health and Environmental Engineering Organization), Ministry of Urban Development, Government of India[27], the benchmark water supply is 135 LPCD including losses. It is estimated that net water supply in NMMC area is about 197 LPCD this year which is higher than the designated benchmark. The NMMC supplies the highest LPCD water supply as against the other ULB's in Mumbai MR (**Figure No. 35**).

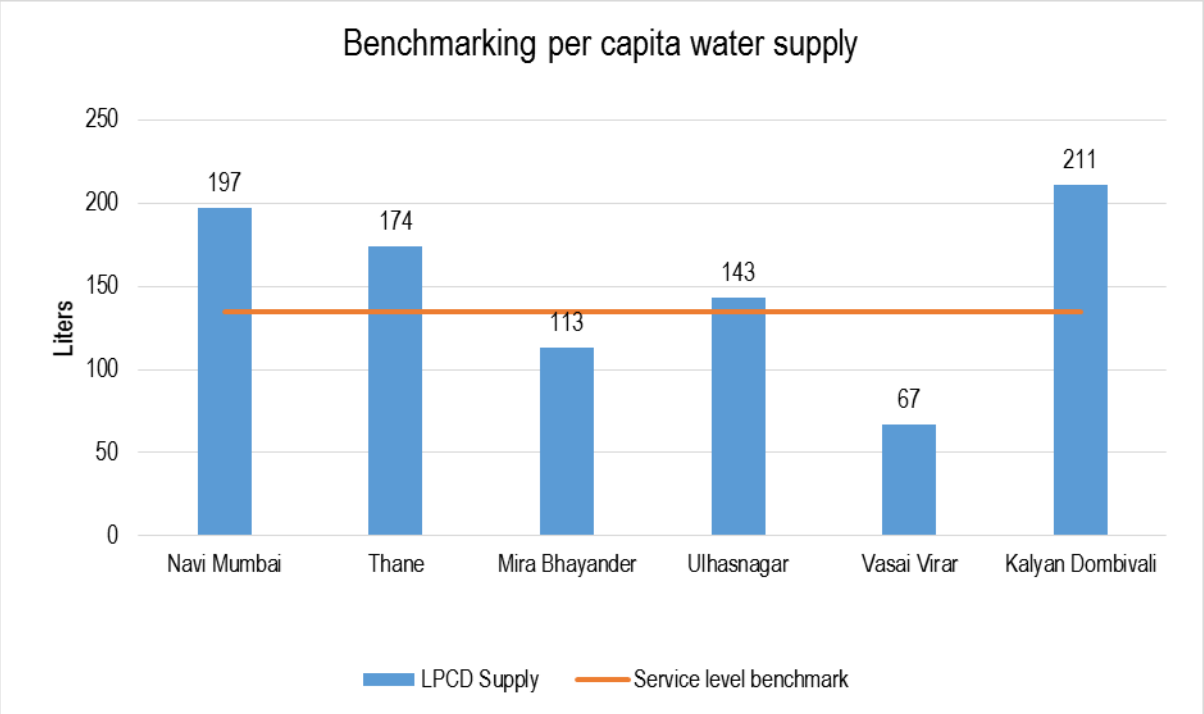


Figure No. 35: Benchmarking for per capita water supply for major ULBs in MMR

Source: Performance assessment system [28]

[27]http://saiindia.gov.in/english/home/Public_Folder/Professional_Practices_Group/State_Local_Manual/PUDUCHERRY_MANUAL/Wad%20Manual/Water%20Supply.pdf
[28]http://www.pas.org.in/

Drinking water quality at tap end

Regular monitoring of drinking water samples at various points across the city is carried out by NMMC to analyse the water quality for its potability. Consumption of contaminated water may lead to severe diseases in individuals which can result in epidemic, if not treated. All necessary quality controls are taken by NMMC in order to supply potable water to citizens. If any contamination is detected, corrective measures are taken. In the year 2015-16, total 20214 samples were analysed out of which 2.96% (579) samples were detected to be non- potable (Figure No. 36).

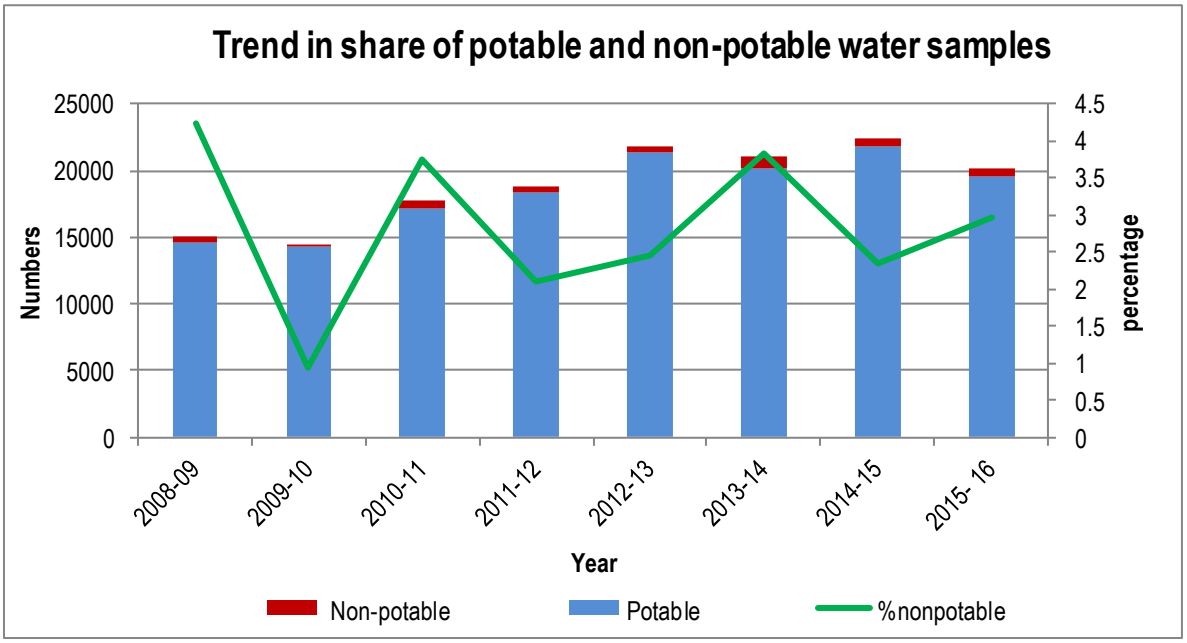


Figure No. 36: Trend in share of potable and non-potable water samples in NMMC area

Source: Environmental Laboratory, NMMC

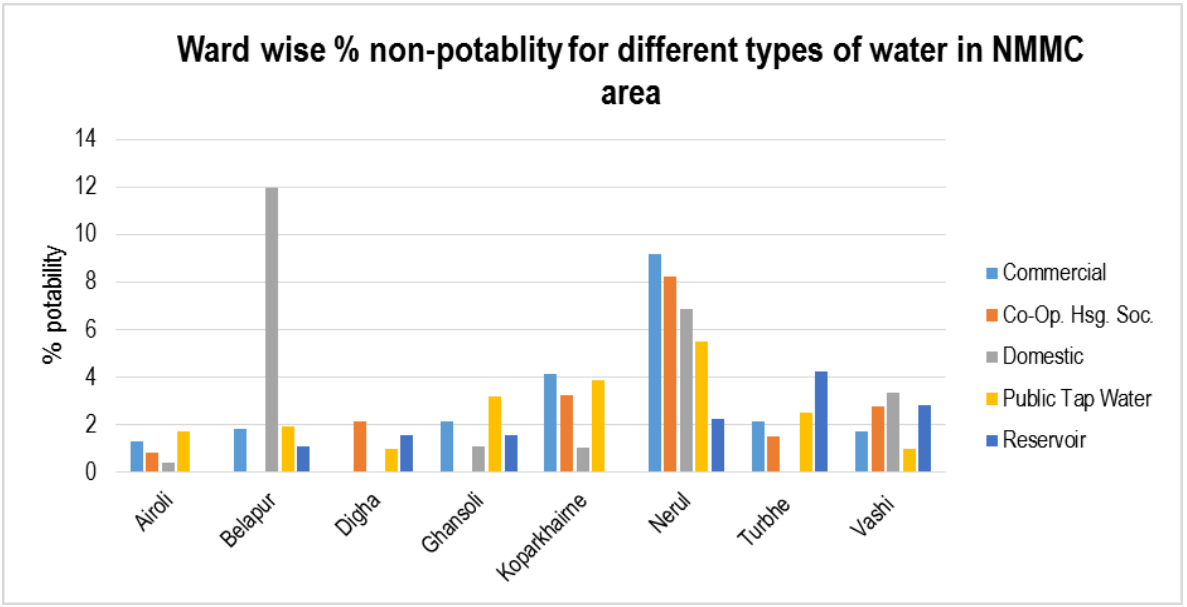


Figure No. 37: Ward wise % non-potablity for different types of water in NMMC area

Source: Environmental Laboratory, NMMC

From Figure No. 37, it is observed that Nerul zone registered non potability samples for domestic as well as commercial water samples with around 5–8% of the samples. Simialrly Belapur node recorded non potability for about 12% of the domestic samples collected in 2015-16. Other nodes recorded non-potable sample for less than 4% of the observations.

Sewage treatment and public toilets

NMMC has a well-planned underground sewage network which has coverage of about f99% in NMMC area and caters to about 2,28,923 connections. The total length of sewer lines is 448.37 km which caters 100% of the population. Also, there are about 446 public toilets with equal distribution for men and women.

Sewage Treatment Facilities

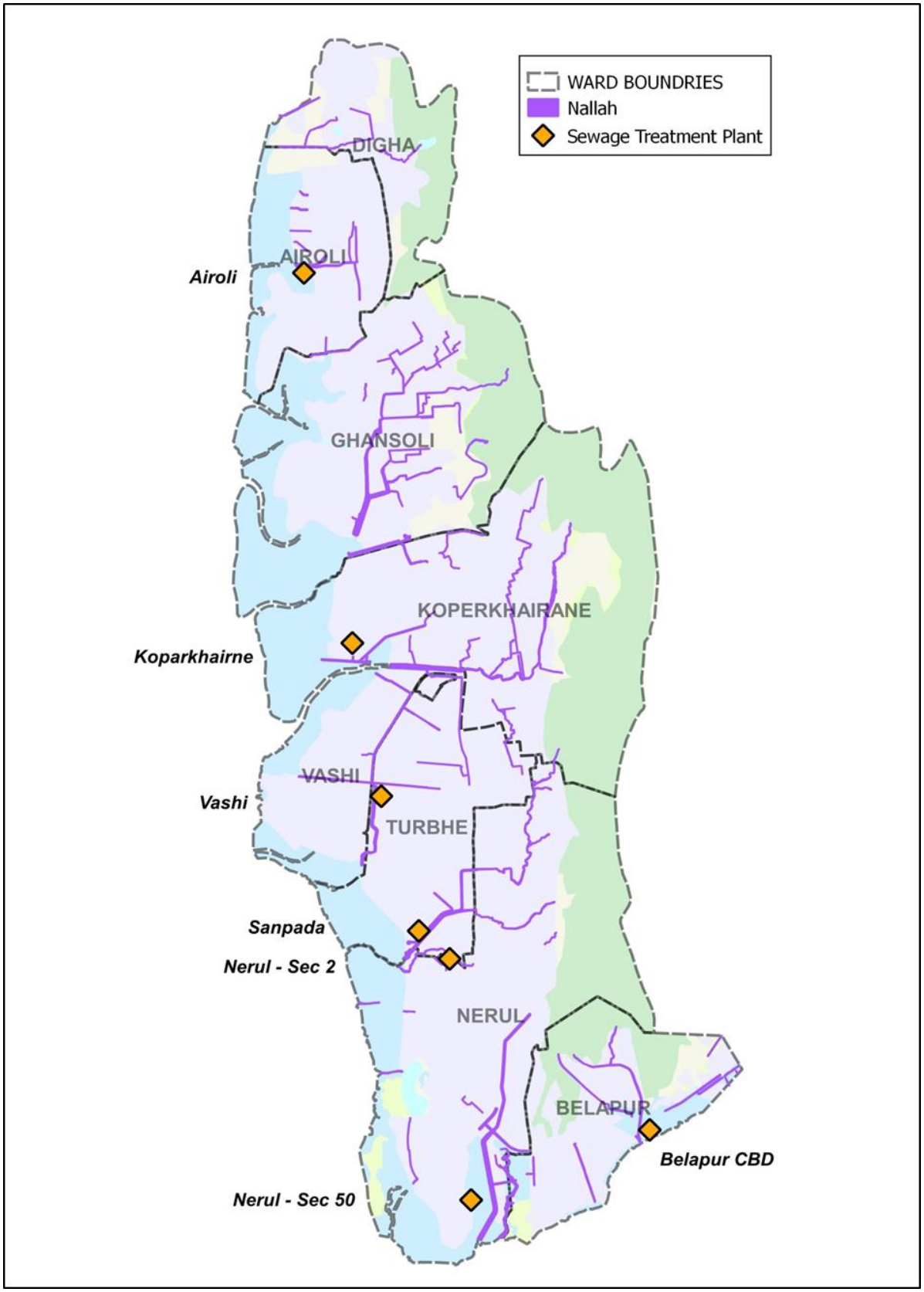
The sewage generated in NMMC area is treated at 6 sewage treatment plants and one aerated lagoon (Map No. 4). The total capacity of STPs accounts for 424 MLD. The total sewage generated in NMMC area is 180- 200 MLD and 100% of the sewage gets treated. The STP's possess Primary as well as Secondary treatment system which works on the of Cyclic Activated Sludge Treatment technology using advanced Sequencing Batch Reactor (SBR) process. The system operates in a batch reactor mode which eliminates all the inefficiencies of the continuous processes. The complete process takes place in a single reactor, within which all biological treatment steps take place sequentially.

Special suction units are installed 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 collect and dispose of the sewage to the treatment plants. A brief detail of the STP's in Navi Mumbai under NMMC is provided in Table No. 25.

Table No. 25: List of functional Sewage Treatment Plants in NMMC area (2015-16)

Sr. No.	Node & Sector	Design Capacity (MLD)	Treatment technology
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
Total		**424**	

Source: Environmental Laboratory, NMMC



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

Performance of Sewage Treatment plant

Regular monitoring of water quality from STPs is done by NMMC before the water is released into the creek. This also helps to monitor the efficiency of treatment plants. The data for the inlet and outlet is presented in Table No. 26. It is noted that, except for Suspended solids (S.S) all water samples from 7 STPs are well within the standard for all parameters. All the readings for effluent water from all the STPs are violating the standard of 100 mg/l.

Table No. 26: Average performance and efficiency of STPs in NMMC area

Name of STP	PH		D.O		B.O.D		C.O.D		S.S	
			(mg/l)		(mg/l)		(mg/l)		(mg/l)	
	6.5-8.5		4.0-7.0		<100		<250		100	
	In	Eff	In	Eff	In	Eff	In	Eff	In	Eff
Belapur CBD	7.13	7.5	0.68	4.28	110	4.1	250	35	158	7
Nerul	7.12	7.23	0.64	5.23	128	*3.8*	234	32	179	7.5
Sanpada	6.6	7.2	1	4.2	142	3.5	303	36	172	7.2
Vashi	6.75	7.26	0.62	4.29	119	4.42	360	40	190	9
Koperkhairane	6.61	7.12	0.9	4.9	120	2.9	230	26	160	6.2
Airoli	6.99	7.5	0.6	4.6	138	4.3	300	36	138	8.9

Source: Environmental Laboratory, NMMC

Storm water Management

Navi Mumbai has storm water drain networks of total 550 km (Table No. 29) in length. The ratio of length of storm water drains to total length of major roads in NMMC area is 84% and covers almost the entire city except for the MIDC area where the ratio is about 50% (Table No. 29).

The main features of the storm water drains are the Nallahs and the unique holding ponds of the city which prevent flooding of water in the city. NMMC regularly monitors the water quality in the Nallahs as well as the holding ponds.

Nallahs

There are 10 major nallahs which collect and discharge storm water in creek area (Map No. 5). These nallahs originate in MIDC area and carries industrial effluent to the creek. These carry mixed wastewater during dry season. The list of nallahs is tabulated in Table No. 27 and the water quality is determined in Table No. 28.

Table No. 27: 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: Environmental Laboratory, NMMC

Table No. 28: Annual Average water quality of water samples collected from nallahs

ZONE	NAME OF NALLAH	PARAMETERS								
		pH	D.O	B.O.D	C.O.D	S.S.	Nitrate	Nitrite	Sulphide	Chloride
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
	LIMITS	**5.5-9.0**	**-**	**<350**	**-**	**<600**	**<45**	**-**	**-**	**<1000**
Belapur	Belapur Sector 12	7.3	3.7	22	119	165	1.516	0.468	7.63	233.33
	Belapur Sector 15A	7.6	2.4	31	137	278	1.029	0.332	10.10	415.58
Vashi	Vashi Sector 18 (Khairne Nallah)	7.6	2.3	33	141	442	3.354	0.202	12.44	3998.97
Turbhe	Turbhe Mafco Nallah	7.5	1.7	28	664	327	4.054	0.209	10.61	3515.83
	Pavane MIDC Nallah	7.9	Nil	47	224	170	0.942	0.042	12.31	338.43
	Turbhe Sector 19	7.4	Nil	26	218	157	1.419	0.162	12.81	666.64
	Turbhe Sector 24	7.6	Nil	120	667	1159	1.065	0.040	6.45	9649.14
	Juinagar Herdillia Nallah	7.5	0.7	76	379	211	1.117	0.260	12.53	210.34
Koparkhairne	Koparkhairne Sector 11	7.6	Nil	45	288	191	0.981	0.045	21.57	395.57
	Mahape Bridge Nallah	7.5	2.8	20	348	250	1.261	0.262	12.28	570.71
Airoli	Airoli Bharat Bijali Nallah	7.2	Nil	12	171	183	1.394	0.269	12.44	315.59
Ghansoli	Nocil Nallah	7.5	Nil	42	355	300	2.092	0.173	15.37	397.52
Nerul	Nerul Palm Beach Road	7.4	Nil	43	565	566	3.330	0.285	11.51	3886.56

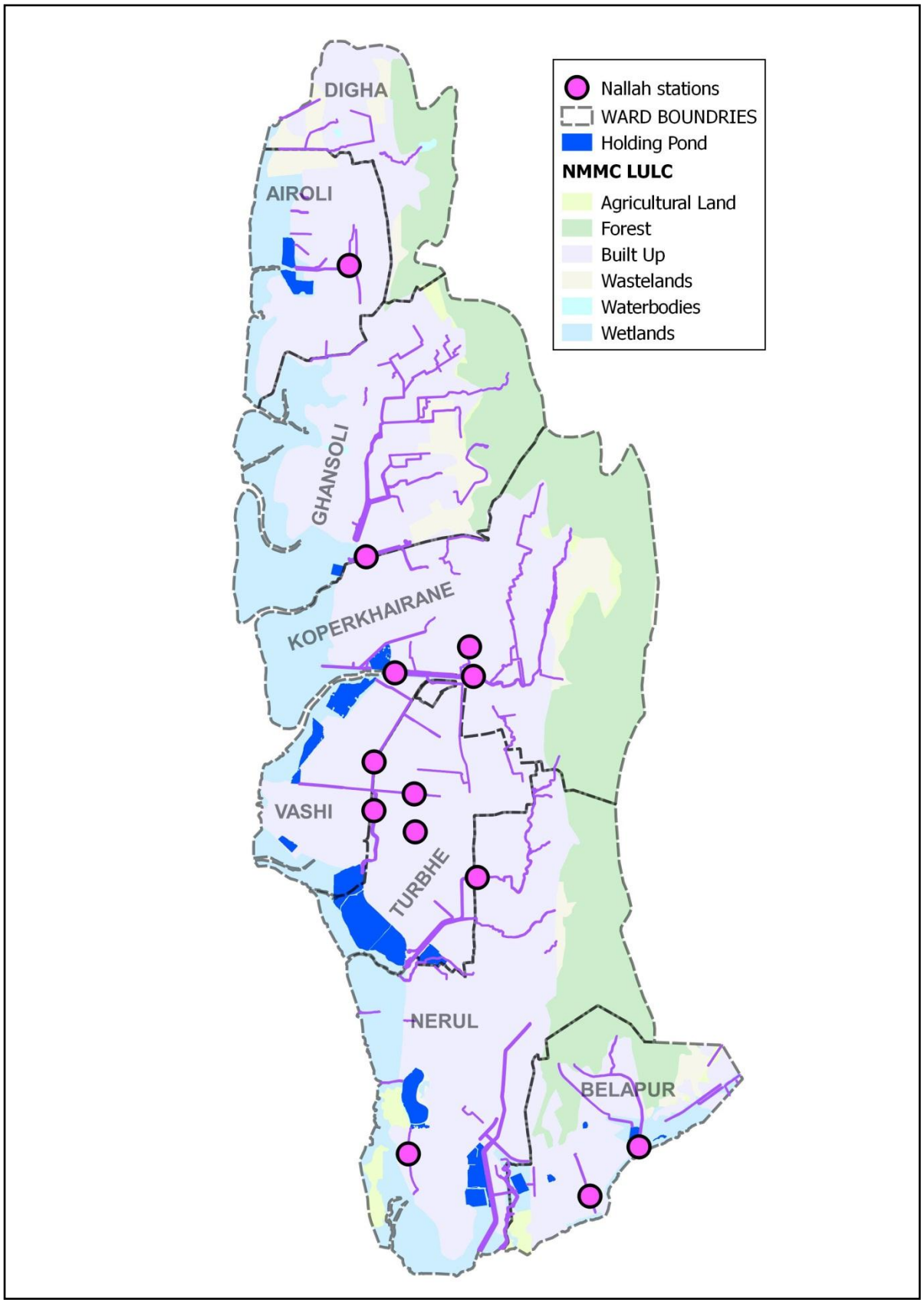
Source: Environmental Laboratory, NMMC

The water samples of nallahs (Table No. 28) from Turbhe node shows highest suspended solid pollution 1159 mg/l which is 2 times higher than the standard (600mg/l) prescribed by CPCB. Turbhe sector 24 area has recorded the highest pollution (9649mg/l) for chloride which almost 9 times higher than the prescribed standard of 1000 mg/l. The second highest area recording pollution is in Vashi (Vashi Sector 18) with chloride pollution almost 4 times (3998.97mg/l) the standards followed by other areas such as Nerul (3886.56mg/l) and Turbhe (Turbhe Mafco Nallah) (3515.83mg/l).

Table No. 29: 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: Environmental Laboratory, NMMC



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

Holding Ponds

CIDCO use the Dutch technology for flood control to optimise the reclamation levels of the city as Navi Mumbai is located below the High tide level. This method involves construction of bunds rising above the Highest Waterline to block entry of tidewater in the area proposed to be reclaimed. 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 (Figure No. 38 and Picture No. 5)

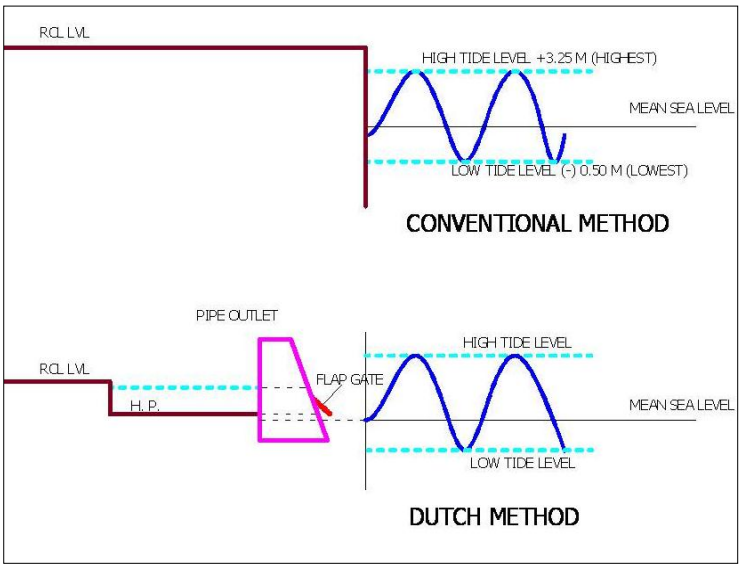


Figure No. 38: Schematic of the Dutch dyke used for land reclamation in Navi Mumbai

Picture No. 5: Dutch dyke (Holding ponds) with flap gates

For disposal of rainwater, total 11 holding ponds have been constructed in Belapur, Vashi Turbhe, Koparkhairane and Airoli nodes under NMMC. Bunds have been constructed around these ponds and control mechanism for release of water during low tides has been installed (Table No. 30).

Table No. 30: 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: Environmental Laboratory, NMMC

Table No. 31: Annual average quality of water samples collected from holding ponds

ZONE	Holding Ponds	PARAMETERS							
		pH	S.S	D.O	B.O.D	C.O.D	Nitrate	Nitrite	Phosphate
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		5.5-9.0		4.0-7.0	<100	<250	<45		<5
Belapur	Belapur Sector 12	7.5	758	3.8	48	977	4.353	0.324	1.410
	Belapur Sector 15A	7.3	1136	9.0	71	1102	4.700	0.332	0.864
Vashi	Vashi Sector 8	7.6	479	1.7	28	516	3.535	0.201	2.456
	Vashi Sector 10A	7.1	1418	6.9	138	1527	4.522	0.275	1.553
	Vashi Sector 11 & 12	7.4	690	2.9	85	878	4.451	0.302	2.414
	Vashi Sector 30	7.3	737	3.1	102	923	3.652	0.316	2.335
Koparkhairne	Koparkhairne Sector 14	7.5	608	1.8	105	649	2.617	0.259	3.678
	Koparkhairne Sector 19	7.1	534	7.3	30	508	2.490	0.120	0.308
Airoli	Airoli Sector 18	7.1	903	2.2	39	1199	3.834	0.482	4.287
	Airoli Sector 19	7.1	988	5.8	17	1369	4.160	0.466	1.604
Turbhe	Sanpada Sector 18, 19 & 20	7.4	934	3.0	73	1196	4.281	0.493	1.753

Source: Environmental Laboratory, NMMC

Table No. 31 depicts the water quality monitored at the holding ponds in the year 2015- 16. It reveals that the levels of COD were found to be violating by 2-3 times higher the standards of 250mg/l at all the locations. Whereas, the BOD levels are seen to violate the standards (100 mg/l) at 3 locations viz Vashi Sector 10A (138mg/l), Koparkhairane Sector 14 (105mg/l) and Vashi Sector 30 (102mg/l). Higher DO levels (9mg/l) were found only at Belapur Sector 15A. Rest all the parameters like pH, nitrite, nitrate and phosphates were well in the limits.

Pressure and Impacts

Various pressures exist on water as resource. These pressures are in form of increase in water demand, water pollution (industries and domestic) and water losses due to theft and leakage. The pressures on water resource in Navi Mumbai city are presented in this section.

Owing to rapid urbanization in NMMC area there has been increase in demand for water. The demand for water supply is increased about 55% from 272 MLD to 401 MLD for last six years. The Figure No. 39 shows increase in water supply in all nodes of Navi Mumbai. It could be clearly observed that, irrespective of the increasing water demand across nodes, the water supply had been reduced due to the lack of water for the year 2015- 16 for various nodes. It is estimated that the water requirement for NMMC would increase to about 500MLD by the year 2042.

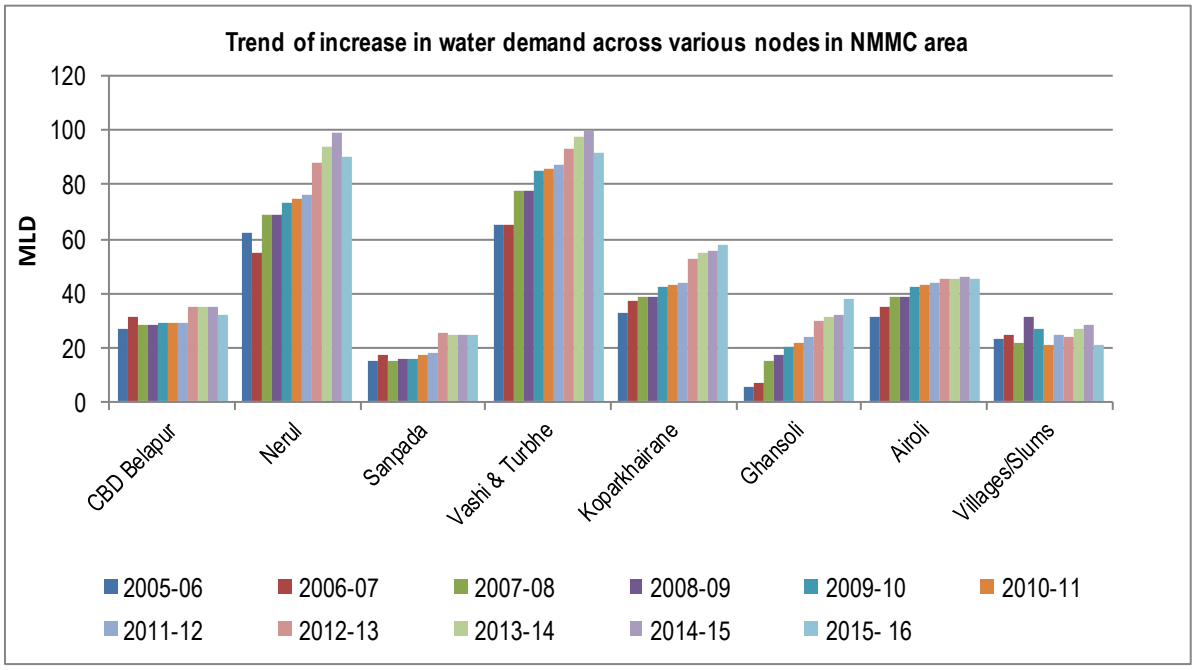


Figure No. 39: Trend of increase in water requirements in NMMC

Electricity consumption of STP's in NMMC

The losses incurred due to distribution losses and leakages induce pressure on the water supply system. They not only cause losses in terms of absolute water requirements and financial losses but also losses in terms of energy requirements at the pumping stations, booster pumps treatment consumables and so on. The electricity consumed by the STP's is provided below in Table No. 32.

Table No. 32: Consumption of electricity by the STP's in NMMC

Sr. No	Electricity Consumption parameters	Units	Node					
			CBD-12	Nerul-50	Vashi-18	Koparkhairne - 14	Airoli-18	Sanpada-20
1	Total Capacity	MLD	19	100	100	87.5	80	37.5
2	Total Load	MLD	8-10	35- 40	35- 40	32- 35	35- 40	10- 12
3	Total Pumps	Nos.	0	8	8	7	6	6
4	Total capacity of pumps	HP	0	1400	1400	1225	1050	480
5	Total units consumed	Kwh	1291968	3011320	3156308	3251205	3104560	1352450

Distribution losses and Leakages

From Figure No. 40, it is noted that the losses have increased by almost 1% i.e. from 19% to 19.70% compared to the previous year. The supply of water this year has also been reduced to 401 MLD with almost 20 MLD depreciation compared to last year. An increase in the losses by 7% is observed from 2006-07 to 2015-16. Irrespective of the distribution of water, the losses have been observed to be almost equivalent for the last 2 years.

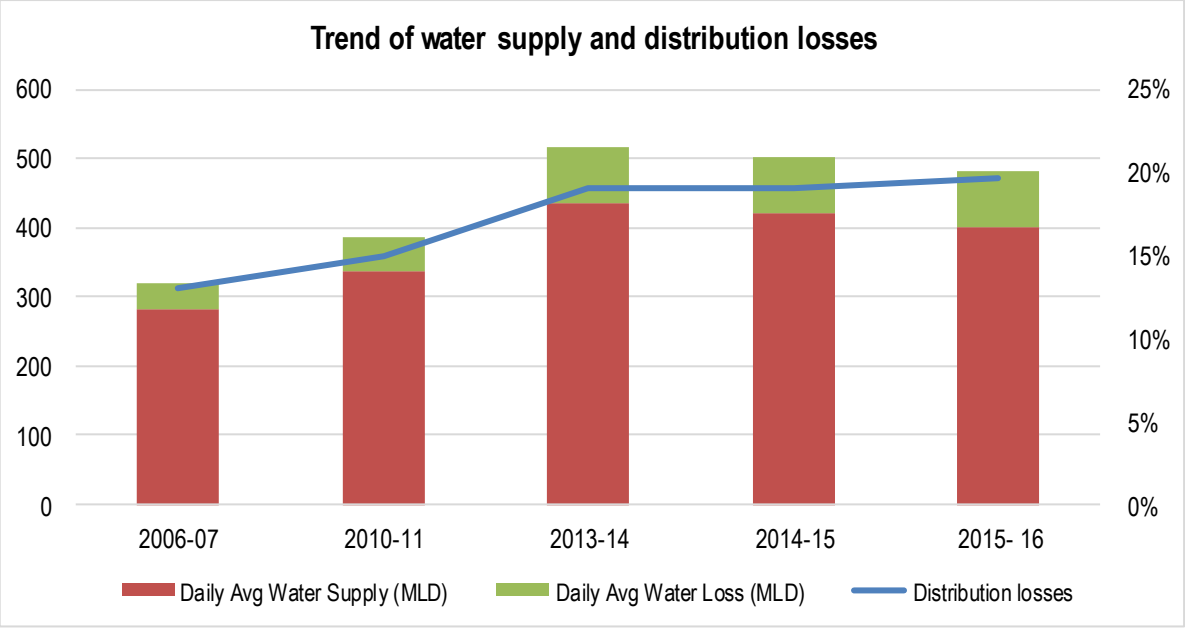


Figure No. 40: Trend of water supply and distribution losses in NMMC

Response

- Around 5840 complaints were received for water supply and all were addressed by the corporation.
- Similarly, 384 complaints were reported for major pipe breaks and leakages and all were addressed.
- NMMC conducts regular water audit for water supply schemes.

Release of Sewage and industrial effluents

As per CPHEEO, about 70-80% of total water supplied for domestic use gets generated as wastewater[29]. The waste water from industries and domestic activities accounts for major source of water pollution. Navi Mumbai being coastal region, any release of polluted water can lead to water pollution affecting the marine and coastal ecosystem. With rapid expansion of city from last few years and increase in water supply, the quantity of wastewater generated has increased in the same proportion. It is observed that the sewage generated this year has been drastically reduced by almost 76 MLD compared to last year. This is the lowest sewage generated in the past 7 years. The water supplied for the year 2015-16 is 389 MLD which is cut off by 32 MLD as compared to 2014-15 (421 MLD). The total sewage generated for the year 2015-16 accounts for 200 MLD.

Response

NMMC has taken the initiative of selling the recycled sewerage water to MIDC which helps in the reuse of water reducing the stress on the industrial water demand.

Scanty rainfall

The year 2015-16 was a draught year and NMMC area received mere ~1600 mm of rainfall roughly around 60% of the annual average rainfall received in the region. This lead to acute shortage of water in the city and water cuts were imposed starting from the months of November. The water cut was increased gradually and in the month of March it reached about 30% cut from the normal supply of 435 MLD as compared to last year. The Figure No. 41 represents the average monthly supply of water provided by NMMC and its respective reduction to achieve the water cut imposed in the city.

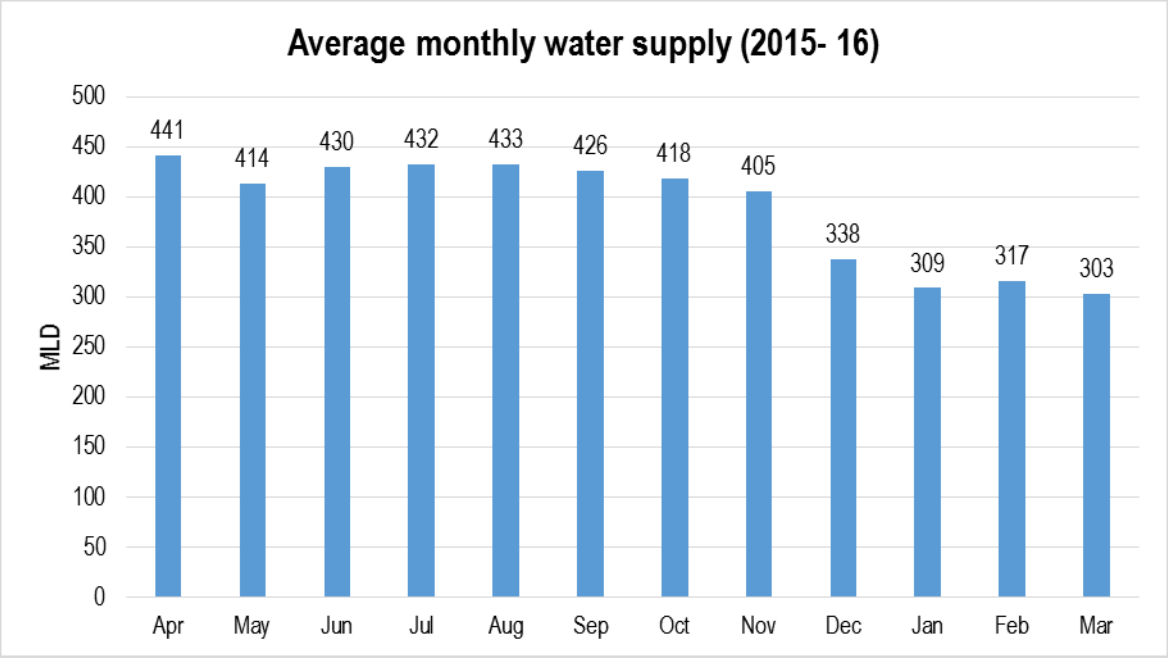


Figure No. 41: Average Monthly supply of water in Navi Mumbai in 2015-16

[29]R Kaur, SP Wani, AK Singh and K La, Wastewater production, treatment and use in India,

Illegal dumping of debris and other waste in water bodies

Dumping of solid waste like plastics, demolition and construction wastes, garbage (animal and vegetable wastes), rubbish, yard debris, ashes, wood waste and so on leads to water pollution. Many religious offerings are also dumped into the holding ponds and lakes adding to water pollution. In order to prevent such pollution for lakes and ponds, NMMC has undertaken Lake Vision project in 2009-10 which has the following objectives:

- Decorative lights, flowerpots, cobal stone path way, stamp concrete for Ghat.
- Periodic dewatering and de-silting of lakes to increase the water holding capacity
- RCC Nirmalyakund, Washing area & idol immersion partition to the lake in order to control the entry of pollutants.
- Aeration system and central fountain in the lakes to improve water quality.
- Construction of Gabion retaining wall along periphery & partition wall for Idol Immersion tank
- 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.
- Beautification of lake surroundings by ultra-modern infrastructure

Picture No. 6: Gabion wall partition for restricting idols immersion in Lake of Navi Mumbai

Silting of holding ponds

Holding ponds lies between the creek and the land where there is movement of water in and out of the holding pond owing to the tidal currents. The tidal currents cause effective transportation of mangrove propagules in the holding ponds which have increased the growth of mangrove in the holding ponds. The growth of mangroves in the holding ponds causes silting which further reduces their capacity to hold water. Due to this reason holding ponds are not serving the purpose of their construction. The silting of holding ponds may lead to flooding during rains and high tides in the city.

Response:

NMMC filed a petition on 18th December 2005 to carry out repair work of holding ponds. In 2006, the high court granted permission to carry out regular work which included:

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

In 2010, it was decided that NMMC should apply for the requisite permissions of de-siltation to MCZMA before applying to High court. Accordingly NMMC has applied to MCZMA of Govt. of Maharashtra on 30th August 2012 which was passed on 4th March 2013 to develop action plan. A detailed action plan has been submitted on 5th August 2013 by NMMC proposing treated silt to be used for quarry slope refill. The addition of artificial soil in steep quarry slopes needs to be carried out using specialized technologies. 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. 7: Growth of mangroves at holding pond in Koparkhairne

Initiatives for Conservation of water

Realizing the current need to conserve water, NMMC has adopted a method of "Back flushing" of water at the Bhokarpada water treatment plant (Picture No. 8). Around 10- 12 MLD of water is back treated and the water is used for various purposes. Initially the treated water was released in the natural stream but now the water is stored in a newly developed water storage tank. The work of installing of the water storage tank and other equipment was completed by April 2015. The stored water can now fulfill the need of around 50,000 people in the city. This initiative has also resulted into a saving of INR 1,08,000 per day which shall help compensate the cost of installation of tank and other equipment in the next 2 years.

Picture No. 8: Back flushing of water at Bhokarpada water treatment plant

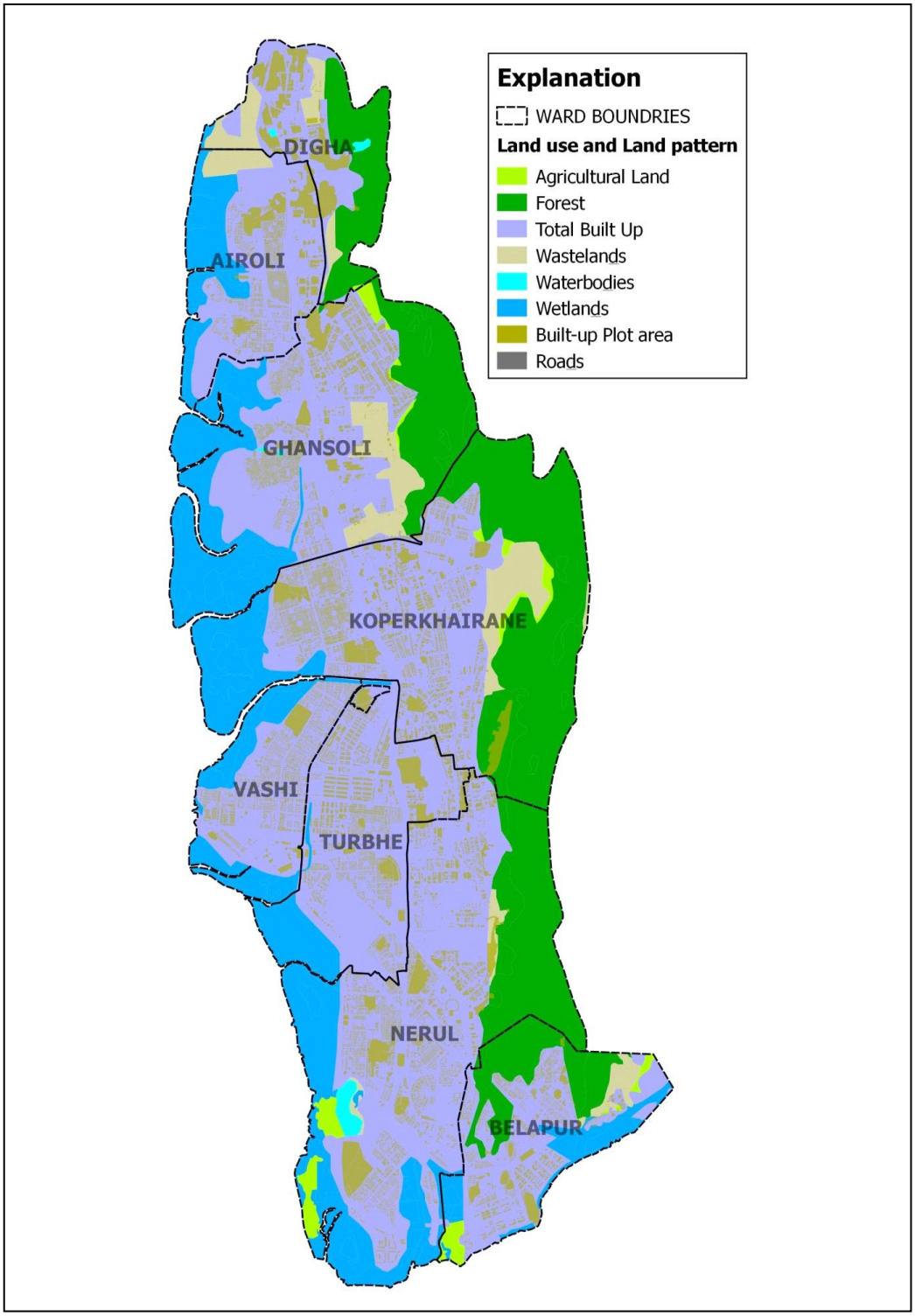
Source: City Engineering department, NMMC

Other Key Initiatives

Realizing the importance of conservation and preservation of water resources in the city, NMMC has taken several initiatives which not only help in reducing the pressure on water resources in the city but also help in conservation of energy.

- NMMC has planned 24x7 water supply in the city while also keeping up to the standard of 150 LPCD as prescribed by Ministry of Urban Development Government of India.
- 24x7 water supply with the help of gravity helps save a lot of electrical energy as all the Elevated Service Reservoirs (ESRs) & Ground Service Reservoir (GSRs) could be bypassed.
- A direct pipeline is proposed to be installed from the Sewage Treatment Plant (STP) to the industries to directly transfer the recycled sewage water reducing the cost of transportation. This pipeline would be installed under the AMRUT scheme.

Land Resource



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

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, 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.

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 data recorded 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's jurisdiction is spread across 108.63 sq. km (Table No. 33). Majority of the area (56.16%) is built up area which is spread across 61 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, mangroves, wetlands, creeks, mudflats and manmade water bodies.

Table No. 33: 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

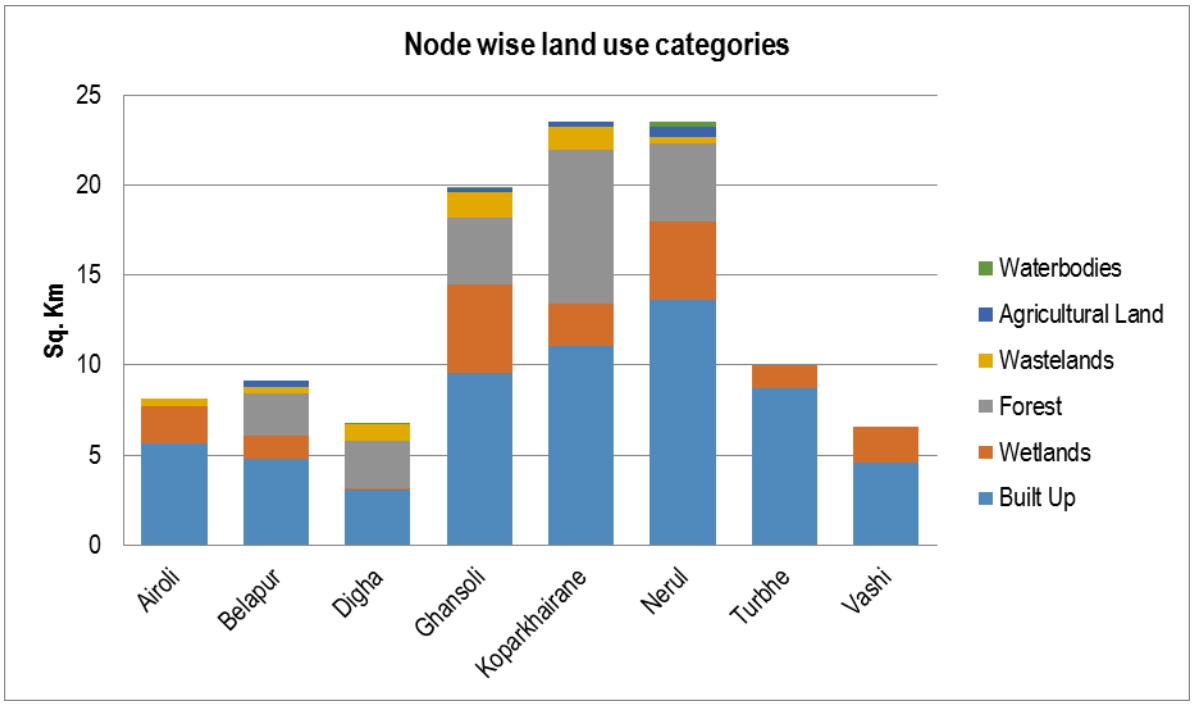


Figure No. 42: Ward wise land use categories in NMMC

Source: MRSAC

It can be clearly observed from **Figure No. 42** 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 60% 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[30]. 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, marshlands & 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[31]. They are distributed in the inter-tidal region between the sea and land (**Picture No. 9**)[32]. 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[33] but only few areas are under the jurisdiction of Municipal Corporation. The dominant mangrove species recorded in the area included *Avicennia marina* and a mangrove weed, *Acanthus ilicifolius* and *Sonnertia alba.* Research studies of NMMC area documents species of true mangroves representing approximately 3 genera and 3 families while 10 species of mangrove associates belonging to 8 genera under 6 families and 1 species of non-mangrove halophytes have been recorded[34]. 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.

[30] Ramsar Convention
31 http://cmsdata.iucn.org/downloads/managing_mangroves_for_resilience_to_climate_change.pdf
32 http://www.marineclimatechange.com/marineclimatechange/bluecarbon_2_files/Girietal2011.pdf
33http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue40/news/toi_mangroves_cidco.pdf
34 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. 9: Dense mangroves cover along Thane creek

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 concentration of greenhouse gases[35]. Studies have found that mangroves have the potential to store more carbon in their biomass compared to tropical and temperate forests[36]. It is found that mangroves sequester approximately 1.5 metric tons/hectare/year of carbon[37]. 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.

[35] http://www.mangrovesforfiji.com/mangroves/carbon-sequestration

[36] http://www.wetlands.org/News/tabid/66/ID/3503/Not-all-mangroves-are-identical-new-study-reveals-hotspots-for-mangrove-biomass.aspx

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

Habitats in the city

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. 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". 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.

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. 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. 24. 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 environment 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. Gardens further play a significant role in enhancing the physical, emotional and spiritual well-being necessary to build healthy and socially sustainable communities. 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.

Other than garden NMMC is also undertaking initiative such as tree plantations on the other open spaces/areas present in the city such as the circles, Road dividers and T belts (**Table No. 34**).

Table No. 34: Ward wise open spaces along with their area in NMMC

Sr. No	Area	Garden		Open spaces		Road dividers		Circle		T belt	
		No. of Garden	Area (sq. m)	No. of Open spaces	Area (sq. m)	No. of Road dividers	Area (sq. m)	Circle	Area (sq. m)	T belt	Area (sq. m)
1	CBD Belapur	31	154857	19	31036	52	26761	2	3200	1	7027
2	Nerul	34	280805	7	6196	9	8100	1	780	2	7473
3	Sanpada and Turbhe	12	62408	2	2611	1	1000	-	-	-	-
4	Vashi	31	148678	13	36976	4	11500	-	-	1	8278
5	Koparkhairane	15	50108	11	26858	3	10113	1	437	-	-
6	Ghansoli	3	4372	6	14620	-	-	-	-	-	-
7	Airoli	37	115127	10	14288	6	8805	-	-	-	-
8	Digha	1	5100	-	-	-	-	-	-	-	-
9	Palm beach road	-	-	8	78916	2	45254	-	-	-	-
10	Thane Belapur Road	-	-	2	60412	10	22754	1	267	-	-
11	MIDC	3	10500	2	8523	1	1658	-	-	-	-
Total		**167**	**831955**	**80**	**280436**	**88**	**135945**	**5**	**4684**	**4**	**22778**

Source: Garden Department, NMMC

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. 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. Navi Mumbai is currently home to 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 of 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. 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 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. Migratory and threatened birds such as Lesser Flamingos visit Navi Mumbai in large numbers. Flocks of flamingos can be observed from Belapur to Airoli in high numbers along the mangrove patches from November to May. Ornithologists have also observed a substantial rise in their population and attribute the reason for this to availability of sufficient food and conducive habitat (**Picture No. 10**).

Picture No. 10: Lesser flamingos 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. 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.

Pressure & Impact

Mining and Quarrying

Mining and stone quarrying is a major 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 (0.96 sqkm). 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. 35: Mining in and around Navi Mumbai

Sr No	Name of village	Number of sites	Area (m^2)	Area (km^2)
1	Bonsari	17	244592	0.244592
2	Kukshet	10	105300	0.1053
3	Pavane	8	95175	0.095175
4	Sirvane	10	103125	0.103125
5	Turbhe	23	275796	0.275796
	Total		**823988**	**0.823988**

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 flamingos 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. 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. 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. Important flamingo 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.

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. 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 UHI 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. 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, 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.

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 fulfil 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 TERI (The Energy and Resources Institute). 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. The building has received LEED's Gold rating from IGBC (**Picture No. 11**) owing to the following green features implemented and integrated in the building design.

- 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. 11: New NMMC Headquarters- A green building

Addition of Open Spaces

As open spaces in the city helps in reducing the impacts of UHI, NMMC and CIDCO plan to increase the area by adding various open spaces in future. 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.

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. 12**).

Picture No. 12: Biodiversity lecterns at Nisarga Udyan, Koparkhairane

- The forest department and the CIDCO are undertaking a joint survey of mangroves in the area with the plan of creating a mangrove wetland centre for Navi Mumbai. 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 (Picture No. 13).

Picture No. 13: Tree plantation belt at Turbhe, Navi Mumbai

- NMMC has carried out tree plantations in every block as can be seen in **Table No. 36**. 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.

Table No. 36: Tree plantation data for 5 years in NMMC

Sr. No	Node	2011-12	2012-13	2013-14	2014-15	2015- 16	Total
1	CBD Belapur	3000	0	3100	250	0	**27035**
2	Nerul	0	0	800	120	0	**18853**
3	Juinagar	0	0	0	0	0	**2632**
4	Sanpada	0	0	0	0	0	**3898**
5	Vashi	1500	0	0	0	0	**13850**
6	Koparkhairane/Ghansoli	1500	67500	65000	4650	300	**155754**
7	Airoli	1000	0	0	2400	0	**19290**
	TOTAL	**7000**	**67500**	**68900**	**7420**	**300**	**241312**

Source: Garden Department, NMMC

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.

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. 14**). This initiative will also allow citizens to connect with nature.

Picture No. 14: Proposed watch tower at mangroves area for Bird watching

- 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. 37.

Table No. 37: Gardens proposed for Navi Mumbai

Sr. No	Name of the garden	Node
1	Scientific Park	Airoli
2	Botanical Garden	Belapur
3	Navras	Koparkhairane
4	Amusement Park	Vashi

Source: Garden Department, NMMC

Solid Waste Management

NMMC is responsible for the collection, transportation as well as disposal of solid waste generated in NMMC area. Solid waste collection is carried out in 81 zones through private contractors. 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. NMMC collects and disposes the solid waste at the Turbhe scientific landfill site after appropriate segregation and processing of the leachate collected.

Source and Composition

The daily average of solid waste generated and collected by the NMMC in the year 2015-16 was about 695 Metric Tonnes (MT). The main source of solid waste is from the residential areas comprising of household waste, accounting to more than 89% (623 MT) of the total waste generated and collected in NMMC area. Also considering the breakup of the amount of waste generated from the residential sector (**Table No. 38**), highest amount of waste is generated and collected from Koparkhairane ward (98.86 MT/day) while lowest amount of waste is generated from Digha ward (23.63 MT/day). The presence of APMC right within the city is also a major source of solid waste, and accounts to about 9.5% (66.58 MT) of the total solid waste generated in the city. NMMC is also responsible for collecting and disposing the non-hazardous waste generated by the industries in the MIDC area.

As seen in **Figure No.** 43, the solid waste in NMMC mainly consists of biodegradable waste from the residential and commercial areas followed by plastic, paper and so on. Metal waste possess the lowest share in total composition of solid waste.

Table No. 38: Quantity of daily average MSW generated from NMMC in 2015 -16

Sr. No	Node	Ward	Total MSW (Metric tons)
1	Belapur	A	92.54
2	Nerul	B	97.98
3	Vashi	C	88.8
4	Turbhe	D	97.99
5	Koparkhairane	E	98.86
6	Ghansoli	F	53.87
7	Airoli	G	69.32
8	Digha	H	23.63
Subtotal			**622.99**
9	APMC		66.58
10	Others		5.85
Total			**695.42**

Source: Environment Laboratory, NMMC

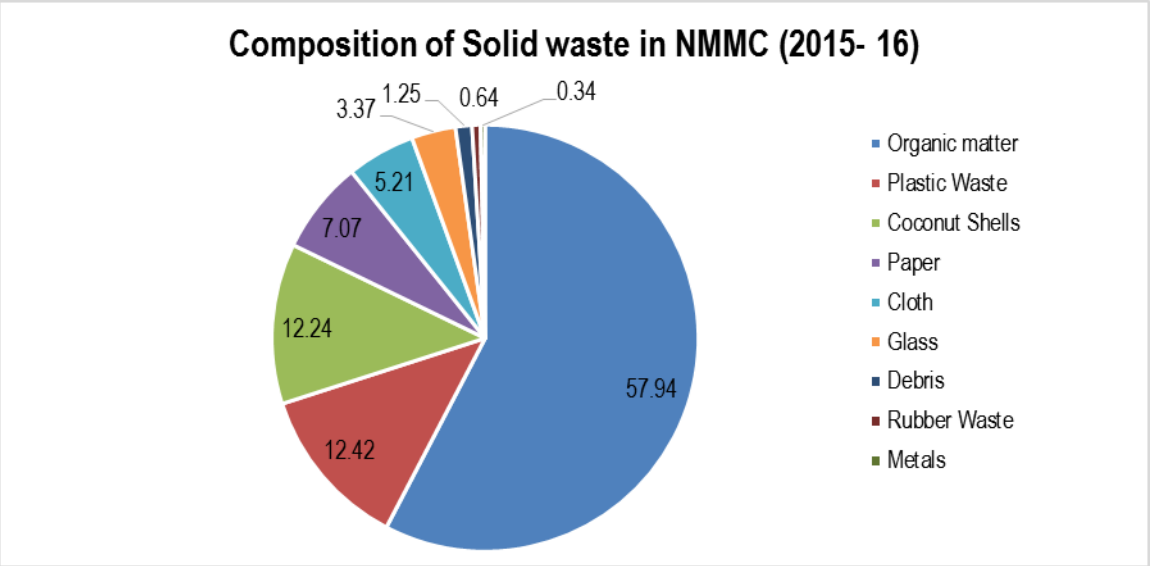


Figure No. 43: Composition of solid waste in NMMC

Source: Environment Laboratory, NMMC

Collection

About 108.63 sq. km of area is covered for the collection of solid waste. Out of the total area covered by NMMC, housing societies constitutes of 6343 units; Industry 3977 units and commercial 800 units. The total number of households covered for collection is around 2,99,363 through door to door collection (bell ringing) which accounts to almost 100% coverage for the door to door collection of solid waste. Domestic solid waste from houses is mechanically collected and loaded in refuse transportation vehicles by transportation contractors. The transportation vehicles used for the collection and transportation of solid waste is provided below in Table No. 39.

Table No. 39: List of vehicles used for collection and transportation of solid waste

Sr. No	Type of vehicle	Total no. of vehicles
1.	16 TGVW Compactor	45
2.	10- 11 TGVW Compactor	24
3.	15 GVW Mini Truck	50
4.	Green waste vehicle	8
5.	Inspection vehicle	5
6.	Washing Jet hyper spray vehicle	2

Source: Solid Waste Department, NMMC

Community bins are provided at market places. There are total 12489 bins present in the city with varying capacities (**Table No. 40**) mainly of closed type. The green bins are used to collect the wet waste while the blue for dry waste.

Table No. 40: Number of bins across NMMC area to collect solid waste

Capacity of the bins	80L	120L	240L	340L	1.1 m^3
No of bins	---	5742 (Green: 3068/ Blue: 2674)	6149 (Green: 2884/ Blue: 3265)	---	598

Source: Solid Waste Department, 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 by the government run hospitals in NMMC, this year was around 13,839 Kg (**Table No. 41**). 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. 41: Composition of biomedical waste generated by NMMC hospitals

Categories (% evalution)	**Disposal Method**	**Vashi Hospital, Vashi**	**Mata Bal Hospital, Nerul**	**Mata Bal Hospital, Turbhe**	**Mata Bal Hospital, Koparkhairane**	**Mata Bal Hospital, Airoli**	**Total**
Needle, Lancet, Scalpel Veinflor, Discarded Glass wares- Tube, Pipettes, Syringes, Slides, Coverslips, Disposal Waste- IV Sets, Disposal syringes, Injection Vials, Amp. Glass, Bio Catheters, Plastic Bottles	Autoclaving & Shredding	8385.44	235.6	204.1	198	179.81	**9202.95**
Microbial Waste, Highly Infectious Waste, Isolate, Discarded Medicines, Solid Waste, Liquid Waste	Incineration	4079.87	184.25	137.5	131.71	103.62	**4636.95**
Total		**12465.31**	**419.85**	**341.6**	**329.71**	**283.43**	**13839.9**

Source: Health Department, NMMC

Sweeping

NMMC undertakes daily sweeping of roads to clear of the waste on the roads. The total length of road swept accounts to 1317.19 km and 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 2646, mainly on a contract basis. Sweeping is conducted daily for about 8 hours starting in the morning. The equipment provided to the sweepers are provided below in **Table No. 42**.

Table No. 42: List of equipment provided to the sweepers

Sr. No	Name of Equipment	Total no. of machines
1.	Fiber bins	1856
2.	Hand containers	148
3.	Grass cutting machines	89
4.	Flippers	408

Processing & Scientific Disposal

NMMC is collecting domestic solid waste (wet & dry) from all the nodes 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 695 MT waste is received daily for processing. The expected life expectancy of the landfill site is for around 68 more years. The waste is processed daily using the Wind Rows composting & Refused Derived Fuel technology. Recyclable waste is separated and recycled (**Figure No. 25**). 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.

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 direct emissions of "Green House" effect. Air Quality Monitoring Station present at this site helps to monitor air pollution from this integrated solid waste disposal facility at Turbhe. The landfill site is responsible for generation of a lot of leachate due to the degradation of solid waste. The Leachate treatment plant was commissioned in 2011-12 and the water thus recycled is used to maintain the temperature of the windrows. This helps is preventing seepage polluted water as well as helps save on water making it a significant environmental achievement. The leachate water is regularly sampled and the quality of water is tested each year (**Table No. 43**). This year proximate and chemical analysis of the solid waste samples has been conducted (Annex – IV).

Table No. 43: 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						
Influent	7.7	0.9	449	2290	1157.08	1078	560.06
Effluent	7.7	6.7	24	378	605.16	688	406.93

Note: All Values are in mg/l except pH

Source: Environment Laboratory, NMMC

Picture No. 15: RDF plant and windrow composting facility at Turbhe landfill site

Picture No. 16: Nisarg *Udyan* developed by scientific closure of open dumping site

Initiatives

Segregation at Source

NMMC has initiated the segregation of solid waste at the source of the same. The domestic waste which comprises of the dry and wet waste is collected differently at the door which further helps reducing the extra work of segregating the waste at the dumping ground.

Scientific Closure of Old Wild Dumping Ground at Koparkhairne

Scientific closure of an old wild dumping ground at Koparkhairne, having an area of 17 hectare containing 20 lakhs M.T garbage was completed by NMMC. A network of wells to collect trapped landfill gas (LFG) 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. 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 into lush green garden. 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. 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

- Decentralized biogas plants of 10-30 MT capacity to be installed at the ward level in order to generate energy which could be used for area lighting at the ward level.
- Under the banner of Swacch Bharat Mission, NMMC has planned to install a Waste to Energy plant in the module of 600 TPD which shall help convert the Refuse derived fuel (RDF) to Energy.
- NMMC is planning to set up a construction and demolition waste debris recycling plant realizing the need for conservation of environment.
- Setting up of an E-waste recycling plant has been proposed by NMMC.
- NMMC also plans to setup up a waste to energy plant based of biomass gasifier technology to process coconut shell waste and generate electricity. A pilot plant of 20kWe is proposed at the Turbhe land fill site and the power thus generated would be used for area lighting.

Health

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 (World Health Organization) has estimated that 24% of the global burden of disease, healthy life years lost, (Annex-V), and 23% of all deaths (premature mortality) were due to modifiable environmental factors (for example, pollution, occupational risks, land use practices and lack of sanitation)[38]. As per a research by WHO, environmental factors are responsible for spreading more than 80% of the diseases. Globally, nearly one quarter of all deaths and of the total disease burden can be attributed to the environment[39]. Diseases with the largest absolute burden from environmental exposure included diarrhoea, lower respiratory infections, Dengue and Malaria.

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. The following section presents the status of various diseases recorded in NMMC in the year 2015-16 and the actions taken in the sensitive wards/ UHPs (Urban Health Posts) in NMMC area.

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 instruments and specialist doctors. Given below is the list of current health care facilities of Navi Mumbai in comparison with the previous years and as evident in Table No. 44, since last year there is an increase in the health related facilities in NMMC area 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[40]. As seen in Figure No. 44 Navi Mumbai (3.3)[41] has better density of hospital beds as compared to national (0.7) as well as the global average (2.7) per 1000 population.

[38] http://www.who.int/quantifying_ehimpacts/publications/preventingdisease.pdf?ua=1
[39] http://www.who.int/quantifying_ehimpacts/publications/preventingdisease/en/
[40] WHO Guidelines
[41] This involves private as well as government hospital beds

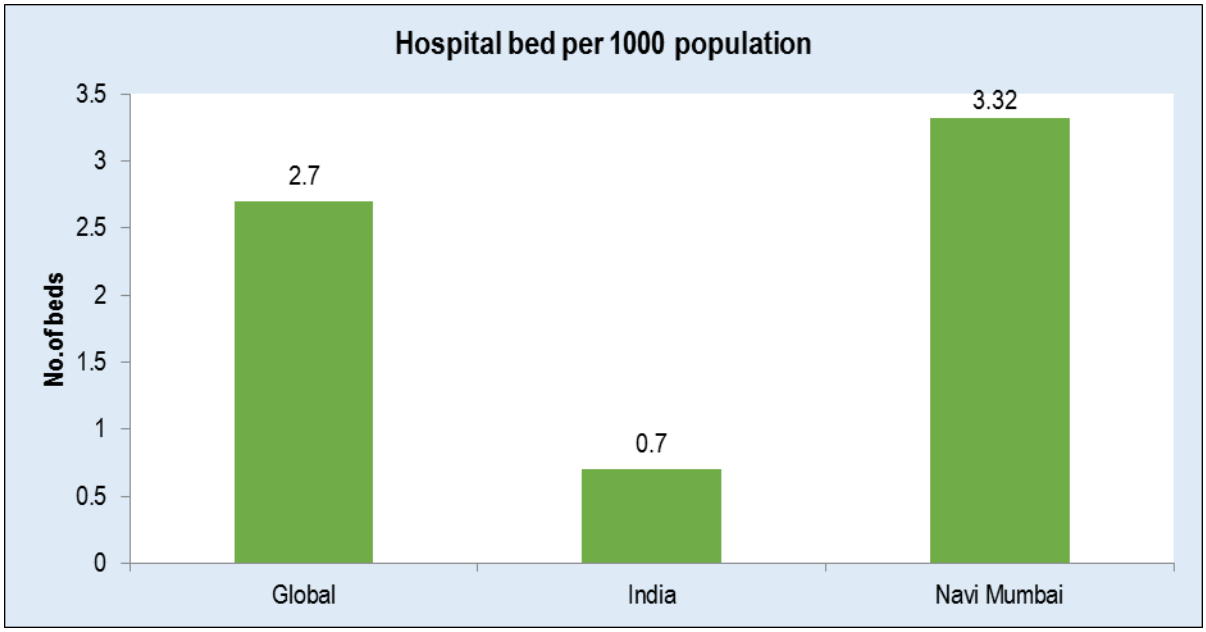


Figure No. 44: Benchmarking of hospital bed density per 1000 persons for Navi Mumbai

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

Table No. 44: Health care facilities in NMMC

	2012-2013	2013-2014	2014-15	2015-16
No. of Private Hospitals	184	184	188	197
Registered With NMMC	180	181	186	197
Dispensaries	158	184	191	184
Ayurvedic Clinics	351	377	386	377
Homeopathy Clinics	144	152	158	152
Bachelor of Dental Surgery	54	80	85	80
Pediatricians	75	75	75	75
Gynecologists	83	83	83	83
NMMC Hospitals	5	5	5	6
NMMC Dispensaries	20	21	21	21
NMMC Mobile Dispensaries	2	2	2	2
Private Dispensaries	797	865	920	920
Private Nursing Homes	76	81	81	81

Source: Health Department, NMMC

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 total number of patients affected by the water borne diseases are provided below in **Table No. 45**. It could be clearly observed that the number of patients has increased this year if compared with the past 3 years.

Table No. 45: Persons affected by Water borne diseases in NMMC

Area	Patients Per node						
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
CBD Belapur	14	21	10	8	5	8	12
Karave	21	27	7	6	1	4	8
Nerul	23	20	4	8	6	5	12
Nerul II	21	32	15	5	7	4	16
Shiravane	23	29	17	5	51	42	33
Sanpada	8	24	15	7	6	10	21
Indranagar	48	37	35	26	29	32	36
Turbhe	81	40	63	6	25	30	55
Vashi	22	19	16	22	18	12	14
Juhugaon	20	12	28	33	1	1	26
Khairne	81	38	23	28	52	48	41
Mahape	56	16	63	37	24	26	28
Pawane	8	15	7	28	18	12	18
Ghansoli	18	32	38	21	18	16	34
Rabade	3	4	6	8	13	11	12
Katkaripada	21	20	2	2	0	5	19
Airoli	29	22	86	40	25	25	34
Chichpada	50	11	8	3	3	2	12
Digha	11	14	13	9	10	8	21
Nagaon	0	-	-	-	2	0	0
Ialthanpada	0	16	16	5	4	1	16
NOCIL Naka	0	0	0	0	4	0	8
Total	**558**	**449**	**472**	**307**	**318**	**302**	**476**

As seen in **Figure No. 45**, the number of cases for gastro intestine diseases have increased drastically if compared with the past 2 years. There is almost an increase of 38% (351 cases) in the no. of cases if compared with the cases of last year (217 cases). Norovirus, is known to cause gastroenteritis and commonly occurs due to consumption of contaminated food and water. It is also contagious and may be caused upon being in contact with an infected person. A significant increase could also be recorded by almost triple in the cases of dysentery. The number of cases have increased from 22 cases in 2014- 15 to 65 cases in 2015-16. No significant activity is observed in the cases for Hepatitis B and Typhoid, a decreasing trend could be seen for both the diseases.

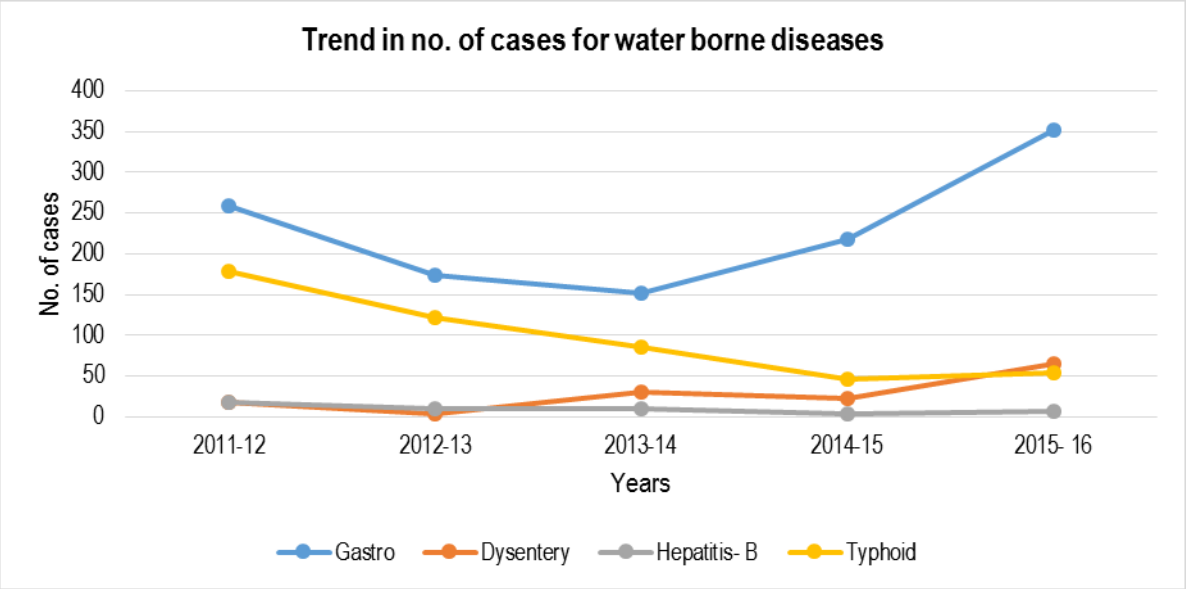


Figure No. 45: Trend in cases of water borne diseases reported in NMMC area

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 a challenge. According to WHO, vector-borne diseases account for 17% of the estimated global burden of all infectious diseases, with dengue and malaria at the top of the list.

Malaria

Malaria, a parasitic infectious disease, is transmitted by mosquitos 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 wise total number of malaria cases reported by NMMC's health department in the last 5 years. As seen in the table, a decreasing trend could be observed for the reported malaria cases from the past 2 years. The no. of cases have decreased from 396 in 2013- 14 to 301 in 2015- 16.

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

Nodes/Year	2011-12	2012-13	2013-14	2014-15	2015- 16
CBD Belapur	53	14	18	20	30
Karave	36	14	33	34	31
Nerul	30	13	19	18	12
Nerul II	87	17	39	27	19
Shiravane	40	12	23	26	17
Sanpada	61	13	24	20	14
Turbhe	47	16	13	26	20
Pawane	55	7	27	24	24
Indiranagar	56	22	54	39	27
Juhugaon	7	0	2	3	3
Vashigaon	19	2	5	5	4
KoperKhairne	76	17	21	20	19
Mahape	39	6	8	6	6
Ghansoli	39	10	21	16	17
Rabade	18	5	8	6	5
Katkaripada	12	9	12	14	9
Airoli	28	4	10	8	10
Chinchpada	23	4	10	9	7
Digha	27	14	20	16	7
Ilthanpada	22	8	12	13	11
NOCIL naka	0	0	0	6	9
Total	**775**	**207**	**396**	**356**	**301**

Source: Health Department, NMMC

Dengue

Dengue fever, also known as breakbone fever, is a tropical disease caused by the dengue virus. The *Aedes* sp. of mosquito acts as the vector for transmission of dengue infection. Symptoms of Dengue include fever, headache, muscle and joint pains, and a characteristic skin rash that is similar to measles. Dengue and dengue hemorrhagic fevers could be prevented by following good practices like managing water containers and avoiding accumulation and stagnation of freshwater in and around houses.

As shown in the Figure No. 46, the number of cases for Dengue fever are highest (76) this year compared to the last 10 years. The cases have grown by almost 38 times than the cases recorded last year. The cases of dengue have displayed a drastic rise this year irrespective of a declining trend in the no. of cases.

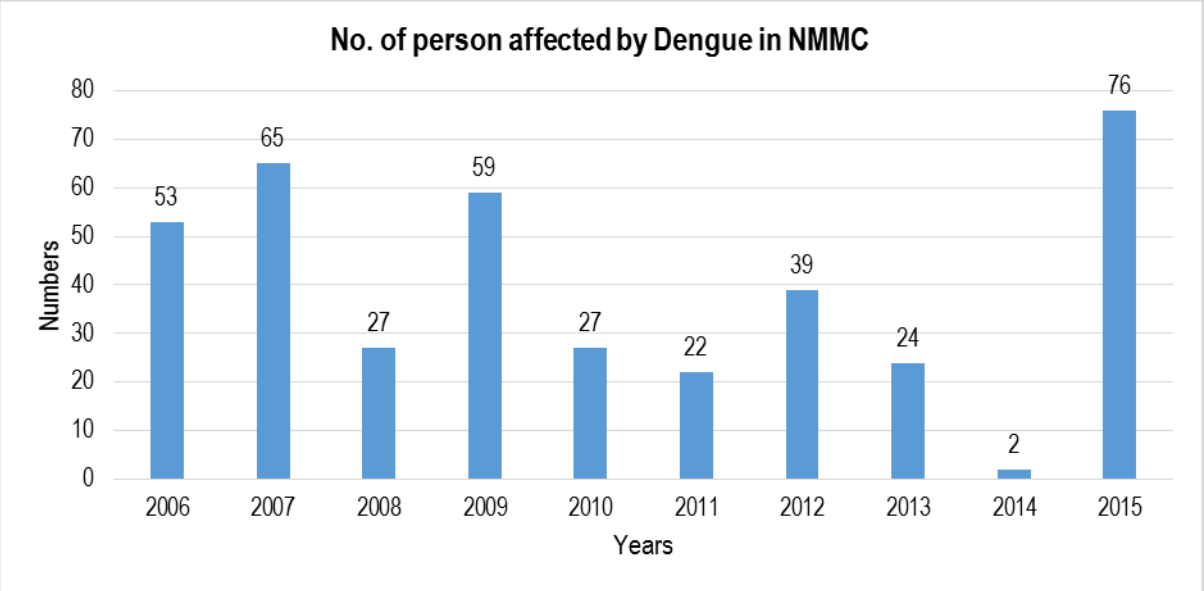


Figure No. 46: Total number of Dengue cases reported in Navi Mumbai

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[42]. 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 mosquitos.

Air Borne Disease - Tuberculosis

Airborne diseases are caused by pathogens and transmitted through air as the medium. 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. TB is caused by bacteria (*Mycobacterium tuberculosis*) that affects the lungs and the condition is 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. It could be observed from **Figure No. 47** that the number of cases recorded for tuberculosis are showing an increasing trend for the past 5 years. The total no. new and re treatment cases have increased by 1.11% from the year 2013 (1608) to 2015 (1795).

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 well equipped to treat TB patients.

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

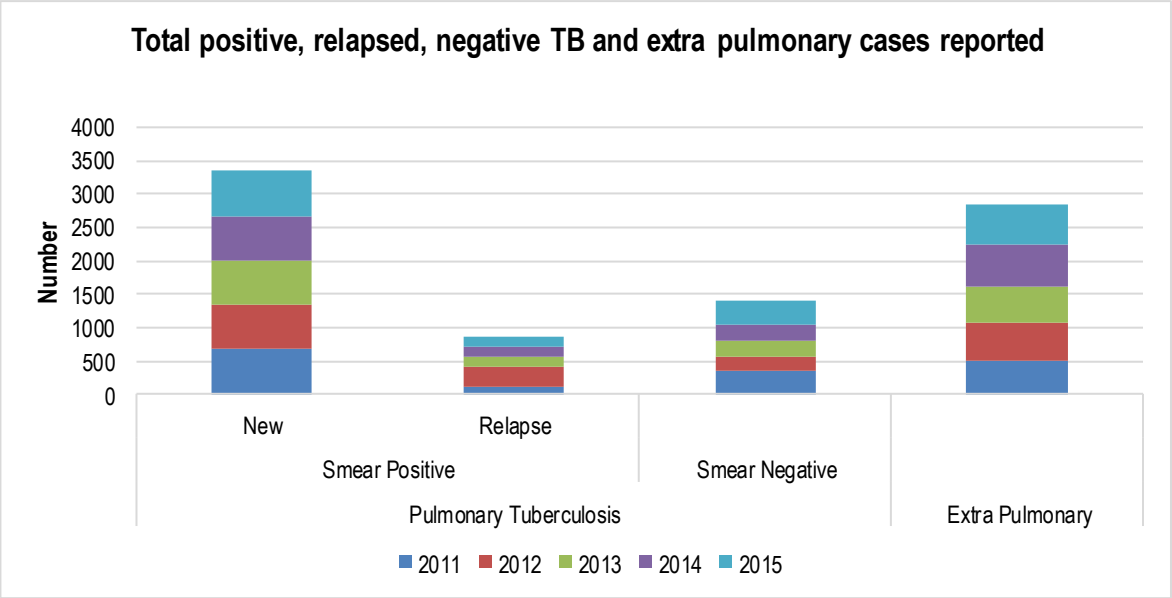


Figure No. 47: Total number of cases and deaths reported due to TB in the past five years

Source: Health Department, NMMC

Health services and facilities by NMMC

NMMC has the following health care facilities 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

Table No. 47: List of actions by NMMC for health

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	Free Medical check-up & health card for slum dwellers	Under Implementation

Health Department, NMMC

Annex–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:

Environmental Quality Index (EQI);

Urban Infrastructure Index (UII); and

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. 48: Assignment of importance units and PEQ scale for parameters selected for computing EQIPEQ 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 71.38%.The detailed parameters for EQI is tabulated in Table No. 3**Error! Reference source not found.**.

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. 3

It has been found out that present UII in NMMC area is 79.65 %.

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 75.52% (Table No. 3).

Table No. 48: 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. 49: Estimation of Environmental Quality Index

Sr. No.	Parameter	Environmental Quality Index, %				
		Max	Average 2014-15	Average 2015-16	Variat -ion	Remarks
A.	Ambient Air Quality					
A.1	Air Quality Index-Residential Area (RSPM)	10	7.35	7.11	-0.24	Due to quarry operations in NMMC area
A.2	Air Quality Index-Traffic Junctions (RSPM)	5	3.11	2.95	-0.16	Due to construction activities of ROB in Thane Belapur Road by MMRDA & construction activities of roads in MIDC area.
B.	Ambient Noise Levels					
B.1	Noise Level: Residential Area	10	4.32	4.18	-0.14	Increase in Population of the city and change of life style attributed to increase in noise levels.
B.2	Noise Level: Traffic Junctions	5	1.60	1.59	-0.01	Due to rapid increase in vehicular population in the city.
C.	Ambient (Surface/Ground) Water Quality					
C.1	Surface (Drains) Water Quality, BOD mg/l	3	1.92	2.20	0.28	Due to decrease in BOD level in some Nallahs.
C.2	Surface (Lake) Water Quality, BOD mg/l	3	1.58	2.21	0.63	Construction of Gabian wall has significantly reduced the pollution of lakes.
C.3	Ground (Well) Water Quality, BOD mg/l	3	2.40	2.55	0.15	Major wells are enclosed with net providing no access to external pollution along with regular de-siltation.
C.4	Efficiency of Sewage Treatment Plants	6	5.84	5.85	0.01	
D.	Solid Waste Management					
D.1	Solid Waste Collected, percentage	3	2.70	2.85	0.15	Micro planning in door to door garbage collection and change of compactor capacity to 5T, 8T & 10T.
D.2	Solid Waste Segregation at Household Level, percentage	2	1.40	0.20	-1.20	Segregation of wet and dry garbage needs to be done properly at household level.
D.3	Solid Waste Segregation at Disposal Site, percentage	2	1.84	1.70	-0.14	O&M problem at site.

Sr.	Parameter	Environmental Quality Index, %				
D.4	Solid Waste Recycle at Household Level, percentage	2	1.80	1.60	-0.20	Segregation of plastic waste is not being done properly at household level.
D.5	Solid Waste Recycle at Disposal Site, percentage	2	1.10	1.90	0.80	Segregation of Plastic is being done on large scale by rag pickers
D.6	Biomedical Waste Collected, percentage	2	1.40	2.00	0.60	
D.7	Road/Public Places Cleanliness	2	1.80	1.80	0.00	
E.	Protection of Ecosystem					
E.1	Protection of mangroves	10	8.00	8.00	0.00	
E.2	Protection of hills and quarry restoration	10	6.00	6.00	0.00	
F.	Public Health					
F.1	Drinking Water Quality, % samples fit for drinking	5	4.88	4.86	-0.02	Continuous monitoring and disinfection by chlorination needs to be followed regularly.
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	5	4.31	4.04	-0.27	More extensive monitoring program & chlorination needs to be executed.
F.3	No. of cases of malaria in node	5	4.19	4.29	0.10	Strengthening disinfectant spraying programme, improving hydraulic of the surface drains, specifically with regards to High tide/Low tide and preventing the ponding due to accumulation of solid waste, muck and plastic bags etc.
F.4	Cases of TB, percentage population affected	3	2.64	2.52	-0.12	Continuous monitoring program is required with special attention.
F.5	Control of Street Dogs	2	1.20	1.20	0.00	-
	Total	**100**	**71.38**	**71.59**	**0.21**	

Annex–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

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
State of Natural resources	Landuse	% of green area to the total city area	%		Town planning departmen t	38	10
		Green area per 1000 persons	Ha/p erson	To be calculated from total green area of the city and total population of the city.	Town planning departmen t	3.72	10
	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/ Annu m		Maharasht ra Energy Developm ent 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 departmen t	293	10
		% of households connected by	%			100	10

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		service connection					
		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	463.5	4
		Life of landfill site	Years			68	10
		% 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	%		Regional Transport Authority	60.0	4

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		public transport					
Initiatives for improving city environment	Environmental awareness and education	Are the training programmes 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 ModerateL for Low A for Absent		H	6
		To what extent are awareness programs on evironment launched during festivals or other times of the year?				M	4
		To what extent exhibitions / street plays etc organized to spread environmental awareness?				H	6
		To what extent does the city/town have any local Television channel running programs, advertisements related to environment				M	4

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		sponsored by the respective ULB?					
		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?				M	4
		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				M	4

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		the policy and regulations of the ULB?					
		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?				VH	8
		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				VH	8

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		managed by the ULB?					
		To what extent does the ULB have regulations on use of fuel like banning firewood and providing alternate fuel?				L	2
	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

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		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

Annex-III: Category wise No of Vehicles Registered in Navi Mumbai RTO

Sr. No	Category	Type	Financial Year						
			09-10	10-11	11-12	12-13	13-14	14-15	15-16
1	2-Wheelers	Motor Cycles	5235	16361	15188	17395	16525	17953	24354
2		Scooters	7547	271	81	-	0	0	0
3		Mopeds	0	0	0	-	0	0	0
4	4-Wheelers	Cars	10665	13042	13184	11808	8298	10841	10709
5		Jeeps	160	222	104	-	0	0	0
6		Station Wagons	0	0	0	-	0	0	0
7(A)	Taxi/ Autorickshaw	Taxi meter fitted	0	0	187	-	-	0	0
7(B)		Taxi Tourist Cabs	283	630	548	851	439	917	1966
8		Auto-Rickshaws	606	444	493	628	1663	3487	2445
9	Buses	Stage carriages	49	116	11	4	1	43	44
10		Contract carriages	209	314	251	-	35	248	334
11		School Buses	23	35	136	180	99	96	143
12		Private Service Vehicles	21	43	32	171	5	14	11
13		Ambulances	35	39	28	10	16	37	18
14		Arti.& Muli. Vehicles.	0	2	0	30	-	0	0
15	Other Heavy Vehicles	Trucks & Lorries	934	1717	1067	901	725	1655	2609
16		Tankers	257	168	220	249	155	226	267
17		Delivery Van (4 wheelers)	256	309	643	512	213	302	284
18		Delivery Van (3-wheelers)	1095	1237	1462	1565	1019	1602	1866
19		Tractors	0	0	0	-	0	0	0
20		Trailers	460	694	381	438	230	351	364
21		Others	10	20	57	7	15	25	9
		Total	**27845**	**35664**	**34073**	**34749**	**29438**	**42639**	**45423**

Source: RTO, Navi Mumbai

Annex-IV: Proximate and Chemical analysis

SGS

Test Report

Print Date : 24/04/2015

SAMPLE DRAWN BY SGS INDIA PVT. LTD.

Report No : CE15-001430.001

JOE No : CE15-001430

Report Control No : CER0000015759

Sample Described by Customer as : MUNICIPAL SOLID WASTE

Client Name	:	NAVI MUMBAI WASTE PROCESSING CO PVT LTD
Client Address	:	SURVEY NUMBER - 376-379, NMMC DUMPING GROUND,
	:	BEHIND LUBRIZOL FACTORY,
City	:	TURBHE, NAVI MUMBAI
Postal Code	:	400703
State	:	MAHARASHTRA
Country	:	INDIA
Sample Type	:	MUNICIPAL SOLID WASTE
Received	:	11/04/2015
Sample Qty. Recd.	:	2.5KG
Sampling Location	:	NMMC DUMPING GROUND
Sampling Date	:	30.03.15
Test Start/End Date	:	11/04/2015 - 23/04/2015

Analysis	Method	Result	Unit
Ash content (as dry basis)	IS 10158 : 1982	12.6	%
Volatile matter	IS 10158 : 1982	74.0	%
Sulphur as S (as dry basis)	ASTM D4239 - 12 (Method B)	0.24	%
Carbon as C (as dry basis)	ASTM D5373 - 08	45.77	%
Hydrogen as H (as dry basis)	ASTM D5373 - 08	6.40	%
Nitrogen as N (as dry basis)	ASTM D5373 - 08	1.86	%
Oxygen as O (as dry basis)	Balance	33.10	%
GCV (dry basis)	IS 10158 : 1982	4125	KCal/kg
Silica as SIO2	IS 13624 : 1993	4.838	% (w/w)
Arsenic and arsenic compounds as As	AOAC 990.08 : 2005	BDL(DL:10)	mg/kg
Cadmium and cadmium compounds as Cd	AOAC 990.08 : 2005	BDL(DL:10)	mg/kg
Total chromium compounds as Cr	AOAC 990.08 : 2005	37	mg/kg
Copper compounds as Cu	AOAC 990.08 : 2005	106	mg/kg
Lead and lead compounds as Pb	AOAC 990.08 : 2005	18	mg/kg
Nickel compounds as Ni	AOAC 990.08 : 2005	28	mg/kg
Zinc compounds as Zn	AOAC 990.08 : 2005	322	mg/kg

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SGS

Test Report

Print Date : 24/04/2015

SAMPLE DRAWN BY SGS INDIA PVT. LTD.

Report No : CE15-001430.001

JOE No : CE15-001430

Report Control No : CER0000015759

Analysis	Method	Result	Unit
Manganese-silicate as Mn	AOAC 990.08 : 2005	523	mg/kg
Mercury and mercury compounds as Hg	USEPA 200.8	BDL(DL:10)	mg/kg
Moisture content	IS 2720 (Part 02) : 1973	71.7	%
Fixed Carbon	ASTM D3172 - 07a	13.4	%
Chloride as Cl	USEPA 9212	781773.3	mg/kg
Fluoride as F	USEPA 9214	46.0	mg/kg
Sulphuric anhydride as SO3	IS 1727 : 1967	0.346	% (w/w)
Phosphorus as P2O3	USEPA 200.7/Conversion	23515	mg/kg
Strontium as SrO	USEPA 200.7/Conversion	339	mg/kg
Titanium as TiO2	USEPA 200.7/Conversion	2235	mg/kg
Aluminum as Al2O3	AOAC 990.08 : 2005/Conversion	21517	mg/kg
Iron as Fe2O3	AOAC 990.08 : 2005/Conversion	45235	mg/kg
Calcium as CaO	AOAC 990.08 : 2005/Conversion	124322	mg/kg
Magnesium as MgO	AOAC 990.08 : 2005/Conversion	30414	mg/kg
Sodium as Na2O	AOAC 990.08 : 2005/Conversion	41361	mg/kg
Potassium as K2O	AOAC 990.08 : 2005/Conversion	82066	mg/kg
Manganese as Mn3O4	AOAC 990.08 : 2005/Conversion	726	mg/kg
Copper as CuO	AOAC 990.08 : 2005/Conversion	133	mg/kg

Remark : BDL - Below Detection Limit, DL - Detection Limit.

Per pro SGS India Private Ltd

V_MUTHUKUMAR

Authorized Signatory

****End of Report****

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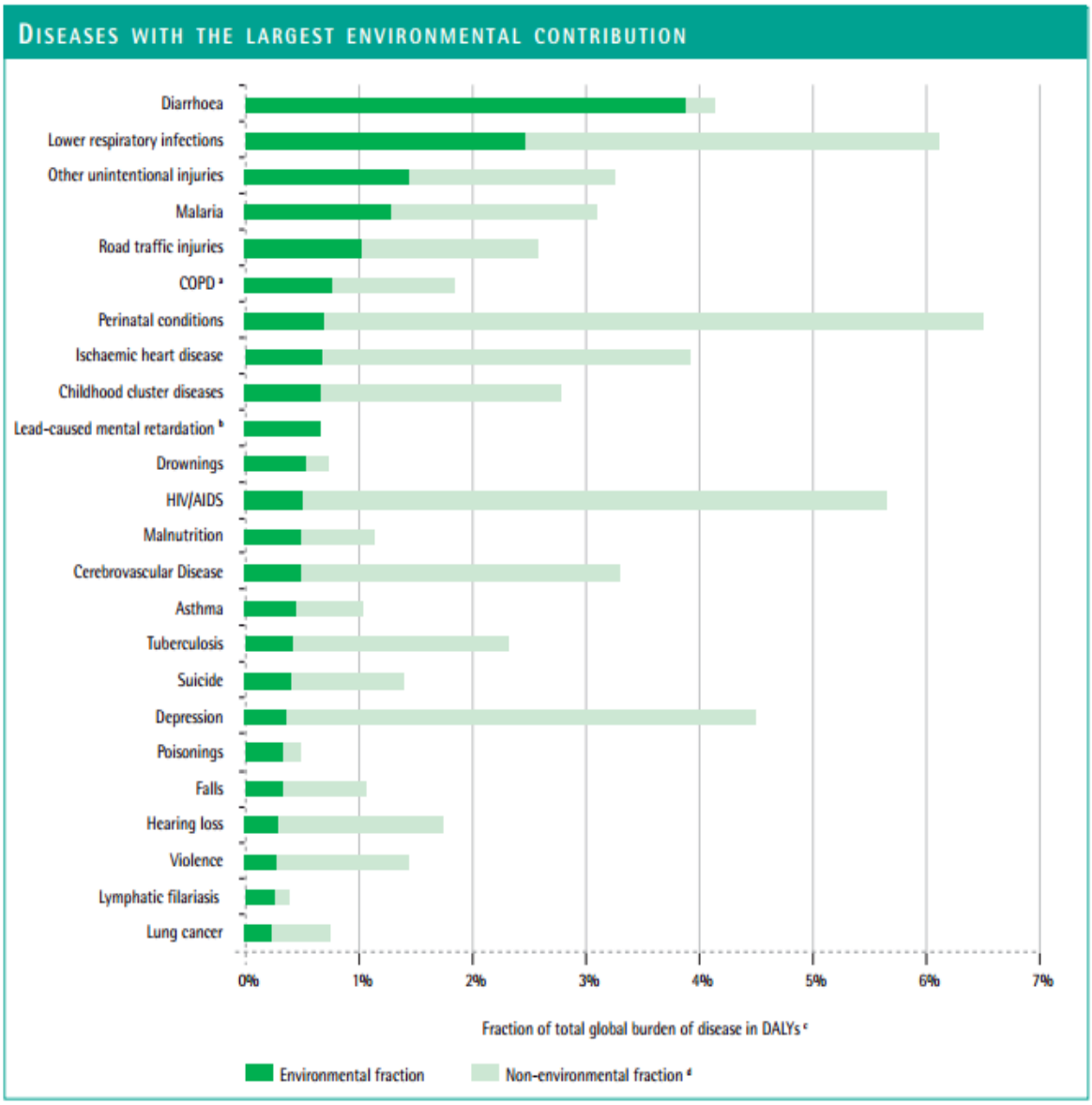
Annex -V: Diseases with largest environmental contribution



[a] Abbreviations: COPD = Chronic obstructive pulmonary disease.
[b] Lead-caused mental retardation is defined in the WHO list of diseases for 2002, accessed at: www.who.int/evidence.
[c] DALYs represents a weighted measure of death, illness and disability.
[d] For each disease the fraction attributable to environmental risks is shown in dark green. Light green plus dark green represents the total burden of disease.

Source: WHO Report: Preventing disease through healthy environments