ENHANCED STRATEGIC PLAN TOWARDS CLEAN AIR IN MUMBAI METROPOLITAN REGION

INDUSTRIAL POLLUTION

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Contents

List of graphs

List of maps

List of tables

Abbreviations

APCD	Air pollution control device
BEE	Bureau of Energy Efficiency
CEA	Central Electricity Authority
CEMS	Continuous Emissions Monitoring System
CEPI	Comprehensive Environment Pollution Index
CIDCO	City and Industrial Development Corporation
CPA	Critically polluted area
CPCB	Central Pollution Control Board
CSE	Centre for Science and Environment
DG	Diesel generator
FGD	Flue gas desulphurization
FO	Furnace oil
HSD	High-speed diesel
KDMC	Kalyan-Dombivli Municipal Corporation
LDO	Light diesel oil
MGCL	Mahanagar Gas Company Limited
MIDC	Maharashtra Industrial Development Corporation
MMR	Mumbai Metropolitan Region
MPCB	Maharashtra Pollution Control Board
MSMEs	Micro, small and medium enterprises
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NCAP	National Clean Air Action Plan
NO_x	Oxides of nitrogen
PM_{10}	Particulate matter of size less than 10 micron
$PM_{2.5}$	Particulate matter of size less than 2.5 micron
PNG	Piped natural gas
SO_2	Sulphur dioxide
SPA	Severely polluted area
SPCB	State Pollution Control Board
ULB	Urban local body
VOC	Volatile organic compound

Overview

The National Clean Air Action Plan (NCAP) was formulated in 2019 to create time-bound strategies to reduce concentration of particulate matter (PM_{10} and $PM_{2.5}$) by 20–30 per cent by 2024 (from the 2017 baseline). The overarching goal of NCAP is to create comprehensive mitigation strategies towards abatement of poor air quality and to augment monitoring of key pollutants. The fifteenth Finance Commission has provided direct grants to urban local bodies (ULBs) for the year 2020–21 for air pollution mitigation and to reduce PM pollution by at least 5 per cent each year. To achieve these clean air targets enhanced action plans at the city and regional levels are necessary.

NCAP has identified 122 non-attainment cities (102 initially; 20 were added later), on the basis of data obtained between 2011–15, with higher than prescribed levels of PM_{10}. New cities were added based on screened $PM_{2.5}$ levels. All these cities have been directed to devise Clean Air Action Plans in consultation with state Pollution Control Boards (SPCBs) and the Central Pollution Control Board (CPCB).

There are 18 non-attainment cities in Maharashtra (17 of them identified initially and Thane added in 2019). There are also a number of industrial areas in the Mumbai Metropolitan Region (MMR) region. Industrial pollution is a significant sector of intervention apart from vehicular emissions, road dust and re-suspension of dust, air pollution from biomass burning, C&D waste and DG sets. MMR has five non-attainment cities (Mumbai, Navi Mumbai, Thane, Badlapur and Ulhasnagar). All these cities have framed individual city action plans and they have been approved by CPCB. These base plans identify key sectors of interventions and top-line interventions in each sector. This creates an opportunity to enrich the planning process for effective implementation of air quality improvement measures over time.

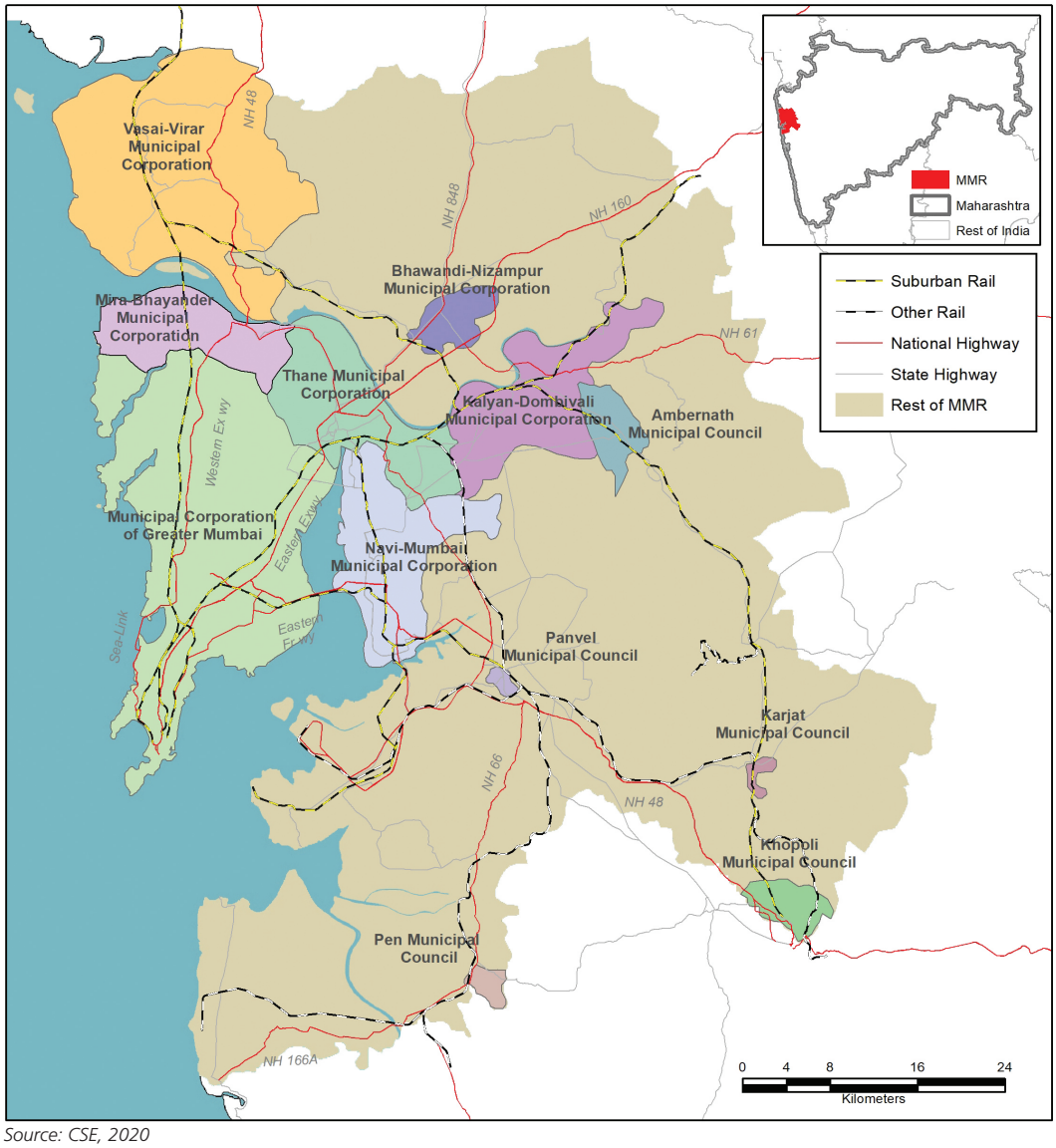
It is in this context that Centre for Science and Environment (CSE) has performed a baseline assessment of the industrial pollution challenge in MMR as well as the baseline action against industrial pollution. This assessment is not a quantitative analysis of potential impact of the action plan but a qualitative assessment of the design of the action plan to guide action on the ground. This review has been done based on a few overarching governing principles that can further strengthen the action planning process in the future.

CSE has taken a regional—as opposed to a city-based—approach, keeping in view that polluted air transcends city boundaries and does not respect municipal jurisdictions. The impact of overtly localized or city-based action is limited. NCAP has created nationwide opportunities to deepen mitigation action across states. More recent deliberations and communiqué on NCAP from the Ministry of Environment and Forests and Climate Change (MoEF&CC) have taken the principle of regional approach on-board. Now is the time to operationalize this approach on the ground while working towards a legal

framework that will enable this kind of intervention to enable cooperation between multiple jurisdictions within air-sheds.

Currently, there is no established official scientific method for delineating an air-shed. Therefore, to demonstrate planning within a regional approach, the administrative boundary of the Mumbai Metropolitan Region (MMR) has been considered. This encompasses an area of 4,355 sq km and consists of eight municipal corporations, viz. Greater Mumbai, Thane, Kalyan–Dombivali, Navi Mumbai, Ulhasnagar, Bhiwandi–Nizampur, Vasai–Virar and Mira–Bhayandar; and nine municipal councils, viz. Ambernath, Kulgaon–Badalapur, Matheran, Karjat, Panvel, Khopoli, Pen, Uran, and Alibaug, along with more than 1,000 villages in Thane and Raigad districts.[1] The area is one of the most densely populated urban regions in the world. Four non-attainment cities (Mumbai, Navi Mumbai, Ulhasnagar and Badlapur) fall within it.

Map 1: Mumbai Metropolitan Region



Source: CSE, 2020

This assessment acknowledges that emissions inventory and source apportionment or exposure apportionment are not available for the larger region or for the key urban centres within it. There is also no official method to monitor and assess regional influence of industrial pollution. While the science for such methods needs to be strengthened quickly to support air quality management, it is possible to design action, processes, systems, and capacity based on certain guiding principles, best practice approaches and cost-effective best technology strategies for effective interventions and improvement.

Keeping this in mind, CSE's assessment has identified the guiding principles and taken stock of baseline action in the industrial sector in the region to identify gaps, and grasp the direction of change needed to inform the enhancement of action at a regional scale. To support this exercise, CSE conducted field-level assessments in the industrial pollution sector in the MMR region, carried out discussions with diverse groups of stakeholders including Maharashtra Industrial Development Corporation (MIDC), Maharashtra Pollution Control Board and industry associations. CSE's team also met Taloja Manufacturing Association, Vasai Industrial Association, Regional offices of Maharashtra Pollution Control Board, and consultants working in the field of environment.

This has provided us insight into the systemic issues and concerns regarding pollution in the industrial sector. We have made use of data from government sources, peer-reviewed scientific literature and personal interviews.

Based on this baseline review of air quality and sectoral challenge, enhancement of action is suggested as the next step with targets and indicators for tracking progress in the industrial sector in the region. Steps towards improved compliance, verification and reporting mechanism have also been suggested.

Guiding principles

A set of guiding principles and criteria are needed to ensure that the action plan is effectively designed for sustained air quality gains and to deliver on public health goals. This assessment recognizes the fact that action planning is at the early stages in India and faces the challenges of deficit in data and information, inadequate scientific tools and systemic gaps.

It is, therefore, necessary that action planning be guided by no regret and best practices approaches based on the leapfrog principles. Action plans need to be designed to meet the National Ambient Air Quality Standards (NAAQS) that have been notified under the Air (Prevention and Control of Pollution) Act, 1981.

This enhanced planning process has taken on board the following guiding principles to define the scope of interventions in the industrial sector:

- A robust science-based air quality monitoring and reporting system, rigorous air pollution source and exposure assessment, and tools to inform air quality management strategies for measurable improvements.

- Air quality plans need to afford adequate protection to sensitive population groups, including children and the poor. Mapping of exposure of vulnerable groups is essential.
- Action plan against industrial pollution requires sector-wise emissions reduction targets, guiding principles, assessment of baseline action, and detailed qualitative and quantitative indicators to define the scope of interventions.
- Cohesive and coordinated action and convergence of existing schemes, policies and budget lines in different sectors need to be ensured to deliver on clean air goals.
- Measurable outcomes based on quantitative indicators and qualitative service-level benchmarks are needed, along with measurable air quality improvements over time to track process outcomes in different sectors for strengthening of the systems and institutional processes.
- Focus on equitable, affordable, innovative and leapfrog solutions. Draw upon global good practices to inform action.
- Adopt air-shed approach to reduce regional influence on air quality.
- Adopt polluter pays principles to design fiscal strategies. Adopt cost–benefit analysis to support ambitious targets.
- Adopt demand management strategies.
- Action should avoid trade-offs to prevent leakages and lock-in of more pollution in systems and infrastructure. Evaluate strategies to prevent unintended consequences.
- Strong compliance and monitoring mechanism with incentive and deterrence need to be established at the national and state level.

Adoption of these guiding principles for framing of the enhanced action plan is important for effective interventions to achieve improvements in air quality.

This review is divided into two parts. Part I analyses the baseline challenge and status of action in the industrial sector to identify the way forward. Part II provides the detail action plan in tabular format highlighting action points along with detailed indicators. It also captures institutional arrangement needed for coordination, monitoring, compliance and reporting.

PART I

Sectoral challenge and action

Industrial air pollution and baseline policy action

An assessment of the challenges and status of baseline action in the industrial sector is vital to chart an enhanced action plan. Efforts have been made to piece together information available in the public domain and from stakeholders in the respective sectors to assess the level of progress and also the gaps. This helps to identify the direction of change needed for enhanced and effective action.

Industrial pollution challenge

A regional plan for industrial pollution control needs granular mapping of the nature and structure of industry in the entire region. Mapping of industrial pollution is a challenge in MMR, spread over 4,355 sq km and consisting of eight municipal corporations, and including more than 1,000 villages of Thane and Raigad districts.[2]

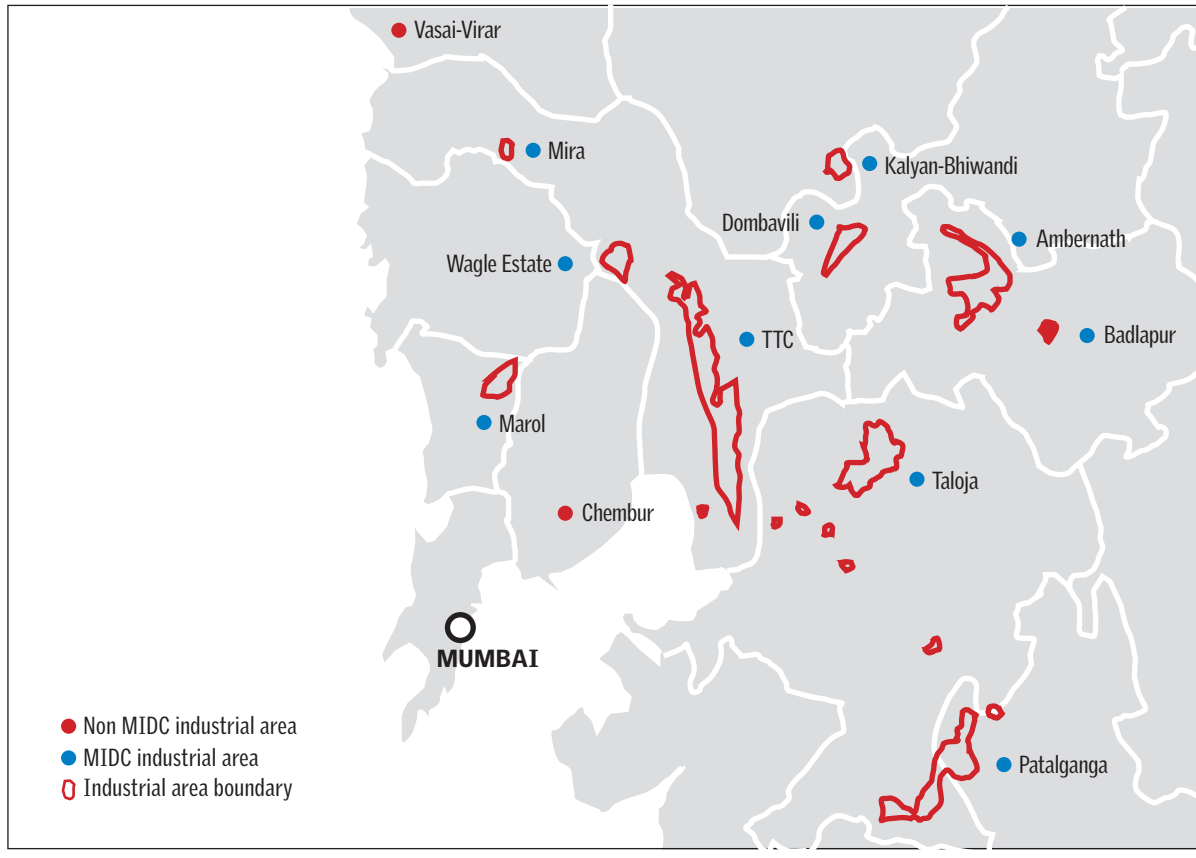
The Mumbai–Pune industrial belt is an important one for India. As per the land use pattern of MMR, only about 2 per cent (88 sq km) of the area is under industrial use. Major industrial areas lie in the Mumbai suburbs of Panvel, Thane and Bhiwandi, primarily hosting include chemical and engineering sectors. There are 13 major industrial areas (excluding an IT Park) located in the MMR region, namely Ambernath, Badlapur, Chembur, Dombivali, Kalyan–Bhiwandi, Mira-Bhayandar, Marol, Patalganga, TTC, Taloja, Vasai Virar and Wagle estate. Most of these (nine) are located in the Thane district. Thane district has a total area of about 4,000 sq km. Mumbai, Raigad and Palgarh districts have one industrial area each. With a population of about 1.11 crore, the region has a population density of about 1,915 per sq km.[3]

Most industrial areas in Maharashtra are planned and developed by MIDC. By 2017, MIDC had built 289 industrial areas over 66,274 hectares of land (see *Map 2: Industrial areas in MMR* and *Table 1: Industrial areas in MMR*).

Three areas of MMR—Chembur, Dombivali and Navi Mumbai—have been identified as critically polluted areas (CPAs) by Comprehensive Environment Pollution Index (CEPI) assessments since 2019. The most polluted sites have been recorded in Dombivali region, which is home to as many as 1,400 chemical companies. These areas form a major share of red and orange category industries in the region, including chemical, dye and pharmaceutical manufacturing units. Some of the industrial areas in the Navi Mumbai region are Taloja, Patalganga and TTC industrial area.

CPAs are different from non-attainment cities, as CPAs are identified using CEPI scores in which air, water and land are considered as parameter of assessment, whereas non-attainment cities are those which do not meet NAAQS.

Map 2: Industrial areas in MMR



Source: Compiled from MIDC GIS information

Table 1: Industrial areas in MMR

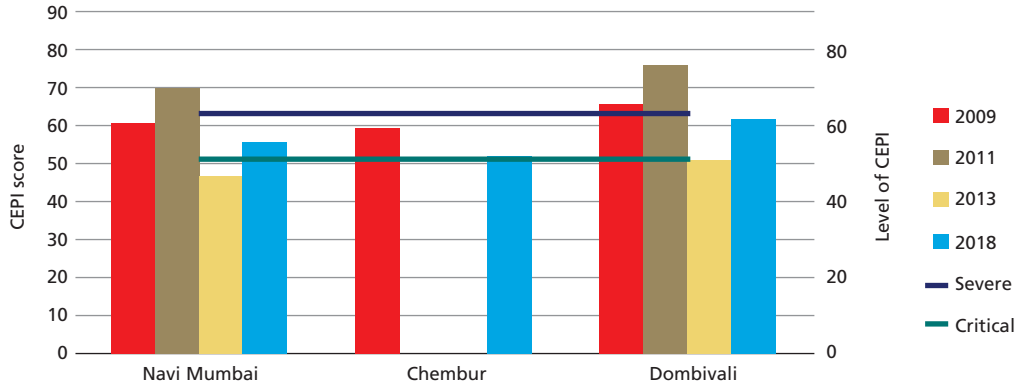
S. no	Industrial area	District administration	Area (in hectare)	Number of industries (approximate)	Major sectors
1	**Ambernath**	**Thane**	**786**	**400**	**Chemical and engineering**
2	Badlapur	Thane	104	370	Chemical, engineering and textile dyeing
3	**Dombivali**	**Thane**	**347**	**500**	**Chemical, engineering and textile dyeing**
4	Kalyan-Bhiwandi	Thane	86	100	Textile
5	Mira-Bhayandar	Thane	7	46	Engineering
7	**TTC**	**Thane**	**2,333**	**900**	**Engineering and chemical**
8	**Taloja**	**Thane**	**900**	**900**	**Food**
9	Wagle estate	Thane	255	30	Industries have started moving out of this area
10	Patalganga	Raigarh	NA	40	Textile and chemical
11	Marol	Mumbai		-	Majority of industries have moved out of this area
12	Chembur	Mumbai		5	Oil, power and fertilizer plant
13	Vasai-Virar	Palgarh	NA	2,400	MSME, engineering, rubber and plastic moulds

Source: CSE, 2019–20 (compiled from MIDC website, industry sources, stakeholder interactions and MPCB data)

CEPI air trend for areas in MMR are available. The areas were termed as CPAs and severely polluted areas (SPAs) based on the aggregate score of 70 and between 60–70 respectively, based on the sub-index score (score of individual environmental component like air and water) as follows:

- Score more than 63: A critical level of pollution in the respective environmental component
- Score between 51–63: Severe–critical level of pollution (see *Table 2: Overall CEPI score for areas in MMR* and *Graph 1: Trends in CEPI air score for areas in MMR*).

Graph 1: Trends in CEPI air score for areas in MMR



Source: CSE, 2019-20 (based on compilation of CEPI scores for mentioned years)

Table 2: Overall CEPI score for areas in MMR

CEPI	2009	2011	2013	2018
Navi Mumbai	73.7	78.5	72.87	66.32
Chembur	69	NA	NA	55
Dombivali	78	85	72	70

Source: CSE, 2019-20

The CEPI air score of Navi Mumbai and Dombivali has improved between 2013 and 2018. However, the reason for this improvement in score is not clear. As per the 2018 CEPI assessment, Dombivali continues to be a CPA whereas Chembur and Navi Mumbai have improved to the level of SPAs. MPCB has prepared action plans for CPAs in the region.

CSE carried out its own survey of the industrial areas. The survey found that Kalyan and Dombivali were the most polluted, in terms of visible emissions from industrial stacks. Both areas have chemical, fabrication, intermediate dye, pharmaceuticals and textile units. The chemical sector is a source of VOC emissions. Since this study has been done based on fuel consumption data available for different industries and mainly focused on particulate matter (PM), sulphur dioxide (SO_2) and nitrogen oxide (NO_x) as pollutants for estimation of pollution loading, CSE has not considered VOCs in it.

Chembur has industrial units of large and organized sectors like power, oil refining and fertilizer. Emissions from these units are controlled as the norms for these sectors are quite stringent compared to medium and small sector units (MSMEs). CSE conducted ambient monitoring in the industrial areas using an AEROCET-make portable PM monitor. $PM_{2.5}$ and PM_{10} are the major pollutants in the ambient air. Industrial emissions and heavy traffic have strong bearing on local exposure. This monitoring was designed to capture local exposure and cannot be directly compared with regulatory monitoring of ambient concentration and NAAQS. CSE's indicative monitoring in Chembur, Taloja and TTC industrial areas put average levels of $PM_{2.5}$ at 73 $\mu g/m^3$, 62 $\mu g/m^3$ and 64 $\mu g/m^3$ respectively. The average PM_{10} values ranged between 200–900 $\mu g/m^3$. Patalganga industrial area in Navi Mumbai (near Panvel) has the lowest exposure, whereas Dombivali has the highest exposure. The latter comes under the Kalyan-Dombivali Municipal Corporation (KDMC), district Thane. Since Dombivali is one of the most densely populated area in MMR, its air quality impacts a larger population than other areas (see *Table 3: Details of exposure monitoring conducted by CSE in industrial areas of MMR*).

Mira-Bhayandar industrial area, in district Thane, is one of the smallest industrial area in MMR. Unpaved roads, a lone ready-mix concrete plant and construction in the vicinity are the main reasons for elevated levels of particulates. Road infrastructure needs to be developed in Dombivali, TTC, Kalyan-Bhiwandi and Mira-Bhayandar industrial area to control dust.

Table 3: Details of exposure monitoring conducted by CSE in industrial areas of MMR

Industrial area	Date of monitoring	Time of monitoring (15-minute average)	PM_{10} ($\mu g/m^3$)			$PM_{2.5}$ ($\mu g/m^3$)		
			Maximum	Minimum	Average	Maximum	Minimum	Average
Ambernath	18 February 2020	11:50–12:05 hours	2,652	206	**704**	86	39	**54**
Chembur	12 February 2020	14:00–14:15 hours	676	141	**248**	97	67	**73**
Dombivali	14 February 2020	15:20–15:35 hours	3,395	122	**904**	119	35	**58**
Kalyan-Bhiwandi	14 February 2020	10:20–10:50 hours	2,213	108	**367**	105	39	**47**
Mira Road	15 February 2020	15:00–15:15 hours	1135	182	**822**	98	39	**57**
Patalganga	16 February 2020	11:55–12:35 hours	633	117	**200**	65	44	**48**
Taloja	13 February 2020	17:20–17:35 hours	462	157	**237**	79	50	**62**
TTC industrial area	19 February 2020	11:20–12:20 hours	2,422	144	**742**	130	38	**64**
Vasai-Virar	15 February 2020	12:35–12:50 hours	893	164	**427**	78	36	**50**

Source: Aerocet™ air monitoring data, Centre for Science and Environment, 2019

Ambernath industrial area: Ambernath industrial area includes Ambernath MIDC area and Additional Ambernath, which together cover about 800 hectares of land. There are approximately 350 air polluting industrial units in Ambernath MlDC. The major industrial sectors in the area include active pharmaceutical ingredient (API) or bulk drugs, dye intermediates and engineering.

During the survey of the industrial area, CSE found significant visible emissions from industrial stacks in the Additional Ambernath industrial area as compared to Ambernath industrial area. Internal roads are not paved in the Additional Ambernath area. Moreoevr, Ambernath industrial area doesn't have access to piped natural gas but Ambernath area has.

Ambernath area: Decent roads

Ambernath area: Stack emissions in Additional Ambernath

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Stack emissions in Additional Ambernath

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Badlapur industrial area: Stack emissions

Badlapur industrial area: Industrial waste dumped on the roadside

Badlapur MIDC area: Badlapur town is located in Thane district on the banks of the Ulhas river. Badlapur industrial area is spread over 104 hectares. The nearest municipal corporation is Ulhasnagar. Piped Natural Gas (PNG) is accessible in the Badlapur industrial area. However, the number of industries that may have switched over to PNG is not available. Badlapur industrial area has textile processing and printing, chemical, pharmaceutical, engineering, glass and plastic industries. It employs approximately 10,000–15,000 people in 370 industrial units. Waste management in the area is not satisfactory and industrial waste can be seen dumped along the roadside at a few locations. Stack emissions were visible at some industrial units and roads have been paved but fugitive emissions due to movement of traffic is still prevalent.

Chembur industrial area: Chembur is a prominent industrial area situated in the south-central part of Mumbai. It has several large-scale red category industrial units including Rashtriya Chemical Fertilizers (RCF), Hindustan Petroleum Corporation Limited (HPCL), Indian Oil Corporation Limited (IOCL) bottling plant, Bharat Petroleum Corporation Limited (BPCL), and Tata Power and Bhabha Atomic Research Centre (BARC). There is heavy movement of materials and trucks. Road conditions are comparatively better. No visible stack emissions were found during the survey. Since roads in the industrial area are well maintained, dust emissions are low (see *Table 4: Details of major industrial units in Chembur*).

Table 4: Details of major industrial units in Chembur

Industrial unit	Product	Capacity	Fuel usage
Tata Power	Electricity	Unit 5: 500 MW Unit 8: 250 MW	Only units 5 and 8 are operational. They use coal as fuel
RCF Trombay	Fertilizer	3.3 LMT	Process: Natural gas Captive power plant: Coal
BPCL	Petroleum refinery	12 MMT	Natural gas
HPCL	Petroleum refinery	7.5 MMTPA	Natural gas

Source: CSE, 2019–20

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Chembur industrial area: Road condition

Chembur industrial area: Industrial stacks with no visible emissions

Dombivali industrial area: Dombivali industrial area is located in the Thane district with an area of 347 hectare. The nearest municipal corporation and council are Kalyan-Dombivali and Ambernath respectively. Dombivali industrial area is divided into Phase I and Phase II. There are around 200 air polluting industrial units in the area. The three main industrial sectors in this area are chemical, engineering and textile. Pharmaceutical, food processing, footwear and other industrial units are also part of the area.

Dombivali is one of the most polluting industrial areas in MMR, along with Kalyan-Bhiwandi. Use of coal as the major fuel is the main culprit. Significant stack emissions are visible from many industrial units in the area. Even though PNG is available, most industrial units in the area have not made the shift from conventional fuel.

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Dombivali industrial area: Coal is used extensively

Dombivali industrial area: Stack emissions easily visible in the area

Kalyan-Bhiwandi industrial area: Kalyan-Bhiwandi industrial area is located in the Thane district and is spread over 48 hectares. Additional Kalyan-Bhiwandi industrial area is spread across 38 hectares. The nearest municipal corporation and council are Kalyan, Dombivali and Ambernath respectively. The area has around 100 industrial units, largely in the textile sector, i.e., bleaching and dyeing. Intermittent black emissions are visible in several stacks. As per field observations, most industrial units use coal, followed by fuel oil. This industrial area does not have access to PNG. Internal roads are not paved and are responsible for huge dust suspension.

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Kalyan-Bhiwandi industrial area: Visible emissions from stack and shop floor

Mira-Bhayandar industrial area: Mira industrial area in district Thane has about 40–50 small- or medium-scale industrial units. The area is dominated by engineering works. No significant visible emissions were noticed during the field survey. Construction of a paved road was in progress. Waste management and collection is good in the industrial area as bins have been placed at the entrance of every industrial unit. The area does not have access to PNG.

Patalganga industrial area: Patalganga industrial area is small and developing. It falls under Raigad Municipal Corporation, Navi Mumbai. Major industrial units in the area include Reliance Textiles, Bombay Dyeing, Castrol, Cipla and Indoamines. Very few stacks emit visible fumes. Roads and drainage system in the area are satisfactory. Additional Patalganga industrial area is still in the development phase and the existing industries are mainly in the engineering sector and mostly non-polluting in nature.

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Well-maintained roads in the industrial area

Stacks with visible emissions were few in number

Taloja industrial area: Taloja industrial area is located in the Thane district and is one of the major industrial areas of MMR. The total area of Taloja MIDC is 900 hectares, with about 1,000 industrial units in operation. There are around 150 large-scale and 200 medium-scale industrial units; with the rest being small-scale. Light diesel oil (LDO) and coal are the major fuel for the units. Around 30 units use PNG. As per data provided by MPCB, the area has around 300 air polluting industrial units.

As per Taloja Manufacturing Association (TMA), at present most of the industrial units use LDO. Industries are willing to shift to PNG as the price of PNG is similar to LDO and its use will reduce pollution. As PNG has higher calorific value, it will reduce energy costs as well. Each unit has to invest about

Rs 8-10 lakh for switching over to PNG. Industries are awaiting gas supply from Mahanagar Gas Company Limited (MGCL). However, there are some safety concerns regarding PNG at the MSME units. Due to the MGCL criterion of having open spaces around a unit, many MSME units have been unable to get 'no objection certificates'. It is understood that large- and medium-scale units do not have any problem with switching over.

Through continuous vigilance, non-compliance can be reduced significantly. A unique strategy has been devised by the officials of MPCB. They make use

Taloja industrial area: Well-built roads

Green belt around a plant boundary

Taloja industrial area: Stack emissions are visible in a few industrial units

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of cross-regional concept to inspect the units, whereby officers of a different region come and inspect the units. It helps in improving enforcement. Industrial units in the region are fined heavily due to poor CEPI and this has been a factor catalyzing improvements in CEPI. However, TMA claims that the amount paid in fines could have been utilized in improving the technologies to reduce pollution from the industrial units. TMA vice-president alerted us to the increasing proximity of residential areas to the industrial area, so the units in the area may have to move. Looking at the scenario, there are two possibilities: Either the zonal or master plan is not being followed by the development agency or there is no master plan in the first place. This could not be confirmed during our survey.

Taloja industrial area has well-maintained roads and the industrial units maintain green belts on their premises. Stack emissions are not continuous but are visible in a few units. Chemical sector is the major industry in the area.

TTC industrial area: TTC industrial area is located in the Thane district and is one of the oldest and largest industrial areas in India. It is spread across 2,333 hectare having around 600–800 industrial units. It is difficult to provide the exact number of operational industrial units in the TTC area because during the last decade, a large number of units has been shifted or closed down. This is largely because commercial property rates have grown rapidly and residential areas have come up in close proximity of the industrial area. The area falls under Navi Mumbai Municipal Corporation. PNG gas is available in the area. About 10–20 per cent of the industrial units have shifted to PNG. As per MPCB data, there are around 550 air polluting industrial units in the area. Internal roads have not been constructed in the industrial area, resulting in fugitive dust emissions during traffic movement.

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TTC industrial area: Cemented main road vs bumpy internal roads

Vasai-Virar: Good practice of solid waste bins at the door of each industrial unit

Vasai-Virar: Roads are in good condition in the area

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Vasai-Virar: The area is dominated by the engineering industry (rubber and plastic moulds). A typical industrial unit in the area has equipment like lathe machines and power press). There are around 2,400 industrial units in the area, located in about 10–15 industrial estates. All these units fall under the MSME sector. About 70–80 per cent of the units are micro-scale, whereas the share of small- and medium-sector is 20–30 per cent.

The area comes under Vasai-Virar Mahanagar Palika. Infrastructure in the industrial area includes roads and drains. No significant emissions were observed. However, with regard to waste management, good practices were observed during the survey.

Wagle (Thane) industrial area: Wagle industrial area is one of the oldest in India. It is located in Thane over 254 hectares of land. The nearest municipal corporation and councils are Thane and Panvel respectively. PNG gas is available in the area. There is no sewerage line. However, since land rates are quite high, many units have shifted to other industrial areas.

Pollution load in major industrial areas of MMR

For an indicative assessment, pollution load of PM, SO_2 and NO_x from industrial sources have been estimated. Process emissions have not been considered. CSE could not get the emissions data of the industries. CSE got data on fuel type and quantity used directly from the MPCB. Information on operational hours for each industry was assumed based on the sector review. Fuel in industry is used mainly in boilers for steam generation, in furnaces for heating and melting, in thermal fluid heaters for heating purposes or for process applications, and in diesel generators for power back up. The major

fuels used include coal, wood, liquid fuel (high-speed diesel, furnace oil and low-sulphur diesel), agro-waste and PNG. Based on the daily fuel consumption by different combustion equipment, annual consumption in tonnes per year has been estimated, assuming that the industrial units operate 330 days in a year.

Pollution load has been calculated considering different segments of industry in the region, pollution control equipment installed and types of fuel used in each industry. It has been assumed that all industries are operating in compliance with the norms and have proper air pollution control devices (APCDs) installed.

CPCB emissions standards for the three pollutants for various combustion equipment have been taken to estimate the controlled pollution load of PM, SO_2 and NO_x. Along with this, the theoretical requirement of air for combustion was also taken from the Bureau of Energy Efficiency (BEE) handbook to calculate the controlled pollution load.

Out of the 13 industrial areas in MMR, pollution load analysis has been done for Ambernath (includes Additional Ambernath), Dombivali, Taloja and TTC as 70–75 per cent all industrial units within MMR operate in these areas and they are expected to have a major share in industrial pollution load of the region (see *Table 5: Number of units in prominent industrial areas of MMR*).

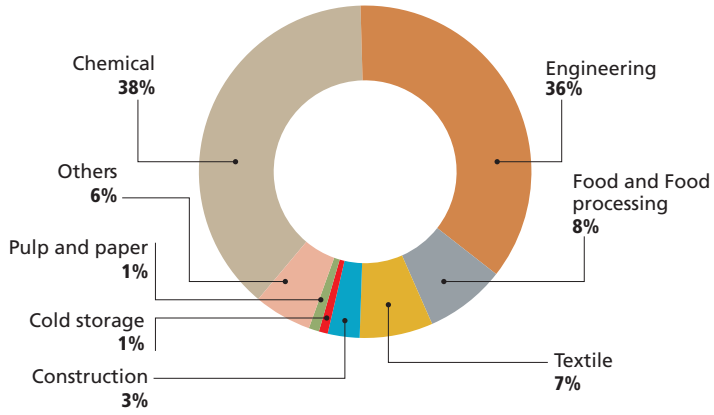
Table 5: Number of units in prominent industrial areas of MMR

Industrial sector	Ambernath	Dombivali	Taloja	TTC	Total
Chemical	162	75	137	160	534
Engineering	111	38	104	247	500
Food and food processing	40	7	25	37	109
Textile	12	68	1	18	99
Construction	12	4	6	21	43
Pulp and paper	5	3	1	3	12
Cold storage			10	4	14
Other	8	6	7	57	78
Grand total	**350**	**201**	**291**	**547**	**1,389**

Source: CSE, 2019–20 (analysis based on data provided by MPCB)

There are around 1,400 medium- and small-scale operational units in these four industrial areas. Chemical, engineering and food processing (8 per cent) are the major industries in Ambernath, Taloja and TTC. In Dombivali, chemical (38 per cent) and engineering (37 per cent) are the major industrial sectors (see *Graph 2: Industrial sectors in MMR*). Coal is used in a significant number of the units. As per available data, only 88 industrial units out of 1,389 use PNG. Moreover, 196 units use agro-based residue.

Graph 2: Industrial sectors in MMR



Source: CSE, 2019–20 (based on data provided by MPCB)

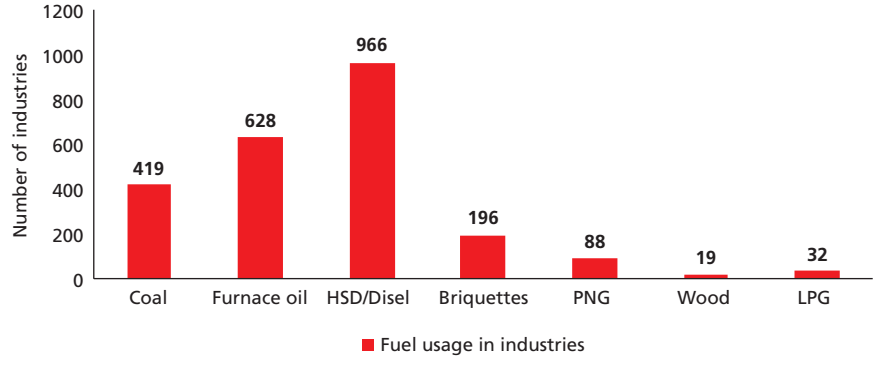
Table 6: Number of industrial units using each fuel

Industrial area	Coal	Furnace oil	HSD or diesel	Agro-residue	PNG	Wood	LPG
Ambernath	188	72	234	164	26	7	10
Dombivali	73	42	115	3	2	3	5
Taloja	71	64	200	19	28	4	6
TTC	87	450	417	10	32	5	11
Total	**419**	**628**	**966**	**196**	**88**	**19**	**32**

Many industries use more than one fuel
Source: CSE, 2019–20 (analysis based on data provided by MPCB and environmental statements of the industries)

It is clear that a large of number of units use liquid fuel (high-speed diesel or HSD, diesel and furnace oil). Having said that, fuel usage in the industries is highly diversified and many industries use more than one fuel (liquid, solid and gaseous) in their processes or for utility purpose (see *Table 6: Number of industrial units using each fuel* and *Graph 3: Major fuels consumed by industrial units in MMR*).

Graph 3: Major fuels consumed by industrial units in MMR



Source: CSE 2019–20

Liquid fuel (HSD or fuel oil) is used in a large number of industrial units. But in terms of quantity, coal consumption is the highest. The annual average coal consumption is about 2 million tonnes. The consumption of liquid fuel, i.e., HSD, LDO or diesel, and furnace oil (FO) is about 1.2 million tonnes and 0.2 million tonnes respectively.

TTC industrial area has the highest consumption of coal- and agro-based fuel; whereas Taloja has the highest consumption of PNG among the four industrial areas. Ambernath industrial area has highest liquid fuel consumption. TTC and Taloja industrial areas have significant consumption of coal, this signifies that there is scope for industries to switch over to cleaner fuels from conventional fuels in these industrial areas. Industries in Taloja are shifting to PNG. Industries in TTC are using significant quantity of agro-waste or briquettes. The area consumes nearly 70 per cent of the total agro-residue consumed in MMR (see *Table 7: Industrial area-wise fuel consumption* and *Table 8: Sector-wise fuel consumption*).

Table 7: Industrial area-wise fuel consumption

Industrial area	Fuel consumption (in tonnes per year)						
	Coal	HSD or LDO	FO	PNG	Agro-waste	Wood	LPG
Ambernath	201,323	521,556	53,752	40,116	57,437	968	3,295
Dombivali	235,277	24,473	10,740	991	2,805	1,089	1,572
Taloja	418,189	359,563	59,324	218,511	91,446	198	31,502
TTC	1,163,427	292,670	69,931	75,803	376,728	1,084	2,293
Total	2,018,216	1,198,262	193,747	335,422	528,415	3,340	38,663
Total (in million tonnes)	2.02	1.2	0.19	0.34	0.53	0.003	0.04

Source: CSE, 2019–20 (analysis based on data provided by MPCB)

Table 8: Sector-wise fuel consumption

Sector	Fuel consumption (in tonnes per year)							
	Coal	HSD or LDO	FO	PNG	Agro-waste	LPG	Wood	Total
Chemical	1,433,817	808,691	155,903	293,317	458,477	1,538	1,231	**3,152,975**
Engineering	250,296	148,893	28,810	26,200	58,131	3,175	145	**515,649**
Food and food processing	15,795	13,419	1,790	7,570	6,973	33,748	83	**79,378**
Textile	243,332	13,978	2,376	3,798	3,977	195	891	**268,547**
Construction	6,600	195,296	462	3,633	0	0	0	**205,990**
Pulp and paper	67,716	58	0	0	0	0	990	**68,764**
Others	660	16,098	4,406	903	858	7	0	**22,932**

Source: CSE, 2019-20 (analysis based on data provided by MPCB)

The chemical sector is the most fuel-intensive. Total usage of all types of fuel in the sector is about 3.1 million tonnes per annum. Total fuel consumption in engineering, textile and construction sectors is about 0.2–0.5 million tonne per annum, next only to the chemical sector. The construction sector (which includes hot-mix and ready cement plants and stone crushers) uses liquid fuel.

Chemical and engineering sectors consume all type of fuels. During the stakeholder survey, members of one of the industry associations mentioned that most of the industries use liquid fuels in MMR, which is correct information, but on the basis of fuel consumption and as per CSE's own analysis (based on the data provided by MPCB), coal turns out to be the fuel consumed the most.

TTC, being the largest industrial area (in terms of number of industrial units) of the MMR, contributes the most to the overall loading of PM, SO_2 and NO_x among the industrial areas in MMR (see *Table 9: Pollution load in major industrial areas in MMR*).

Table 9: Pollution load in major industrial areas in MMR

Industrial area	PM	SO_2	NO_X
	Tonnes per year		
Ambernath	3,000	6,300	3,200
Dombivali	1,800	1,200	605
Taloja	4,200	5,800	3,382
TTC	10,000	8,800	4,582

The table represents the maximum emissions from the industrial areas if all industrial units are in compliance with applicable emissions norms

Source: CSE, 2019–20 (analysis based on fuel usage provided by MPCB)

TTC contributes about 44 per cent to the total industrial pollution load of the four areas. Pollution load of Ambernath and Taloja industrial areas is about 24 and 26 per cent respectively. TTC and Taloja have the highest contribution in the total pollution load (together contributing about 70 per cent). Controlling PM emissions in these two areas can provide significant benefit in terms of reduction in air pollution and improving the overall quality of ambient air in the region. Similar trends have been observed in the case of SO_2 and NO_x loading.

Sector-wise industrial pollution load

Annual consumption of fuel by each industrial sector has been calculated from data obtained from MPCB. Accordingly, pollution loads of various industrial categories were calculated and tabulated—primarily of the chemical, engineering and textile industries (see *Table 10: Pollution load of major industrial sectors in MMR*).

Chemical sector has the highest contribution in the pollution load (nearly 72 per cent). This is largely due to huge overall high consumption of fuels in the sector.

Table 10: Pollution load of major industrial sectors in MMR

Industrial sector	PM	SO_2	NO_x	Per cent share in overall load
	Tonnes per year			
Chemical	13,000	15,000	8,500	72.3
Engineering	2,300	2,700	1,400	12.6
Food and food processing	169	225	128	1
Textile	1,800	1,000	500	6.3
Construction	400	1,900	600	5.5
Pulp and paper	497	252	124	1.7
Other	50	200	90	0.7

Source: CSE, 2019–20 (analysis based on data provided by MPCB)

Limitations of the assessment

While this estimation provides crucial indications about the nature and magnitude of the problem, there are limitations in terms of assumptions in the absence of data on some critical parameters.

- VOC and fugitive emissions from the industrial sector have not been considered in calculating the pollution load. The major focus of the study was on PM, SO_2 and NO_x emissions from industrial stacks.
- Since actual fuel analysis reports are not available for the industrial units, fuel specifications from BEE's 2015 handbook were used to calculate the pollution load.
- It has been assumed that the units operate for 330 days in a year and between 8–24 hours a day, depending on the industrial category. Diesel generator (DG) sets have been assumed to operate for three hours every day.
- Pollution load is estimated by assuming that all operating industrial units are in compliance with applicable emission norms with proper APCDs installed in all of them.

PART II

Comprehensive Clean Air Action Plan and Graded Response Action Plan (Industrial Pollution)

Against the backdrop of the challenges outlined for the industrial sector, this comprehensive action plan has been developed for the Mumbai Metropolitan Region (MMR).

Sector-level interventions with detailed indicators have been included to guide implementation. Process indicators have been included for each action point as they are important to guide and inform the scope of action needed to make a difference and to track progress.

Special care has been taken to ensure that sufficient indicators are included in the plan itself to indicate the nature and scope of action needed. Budgetary resources have been earmarked for investment, or investments from other private or bilateral sources are expected. If these investments are better informed and aligned with Clean Air Action planning process and objectives, significant changes at-scale are possible. This plan builds on baseline action in the industrial sector and integrates ongoing action and action plans of the state government. The action plan has also included elements from good practices and follows appropriate guiding principles.

The plan also opens up the opportunity for developing fiscal strategies based on polluter pays principle to generate additional resources for funding of the plan. In areas where the action depends on private sector participation and investments, detailed guidelines under this plan can guide such investment. The plan has identified the agencies responsible for implementation of each action point and has also indicated the timeline for implementation. This can be monitored for reporting and compliance.

For proper implementation and oversight, the high-powered committee will coordinate with the city-level and regional-level authorities in MMR for direction, compliance monitoring and reporting. Each concerned department across MMR will appoint a high level officer as the nodal authority for coordination, implementation and periodic reporting.

Comprehensive Action Plan (CAP): Short-, medium- and long-term measures against industrial pollution

Source-wise clean air action plan and compliance strategy for MMR to meet clean air standards. The following table indicates the short-, medium- and long-term action needed along with agencies responsible

Action point	Indicators of action for implementation and reporting	Baseline action	Agencies responsible and timeline for action	Status of action and progress against indicators for action points (to be supported by data/ documents etc)
1. Fuel usage and fuel shift for pollution abatement				
Expedite the fuel shift in industries from conventional polluting fuel (coal, furnace oil, etc.) to cleaner and non-polluting fuel (PNG, electricity etc.)	A number of industries have shifted to PNG Possibility of electricity for small units	MPCB to provide mapping of available infrastructure	Mahanagar Gas Co., Industry Associations with support from state government and MPCB if required Timeline: 12 months	A policy push for shift to PNG is required
Provision of incentives towards clean fuel usage during the initial couple of years after the industry switch over. This will help industry in coping with the investment cost of PNG	Introduction of policy to incentivize the industries for using cleaner fuel		State or Central government along with MPCB	
Natural gas to be made more competitive so that it can meet industrial requirements. Cleaner fuel needs to be less expensive	Removal of VAT (13.5 per cent in Maharashtra) on natural gas and inclusion of natural gas under GST	Explore all possibilities to subsidize the gas to replace conventional fuels	State government and MPCB	
In areas where the switchover to PNG is not possible due to its non-availability or cost, and industries are using liquid fuels, it is recommended that industries should not use high sulphur fuel oil (FO)	Reduction in SO_2 load without switching to PNG, just by replacing FO with other liquid fuel with lesser sulphur content	Policy draft shall be prepared by MPCB and sent to the state government to issue a notification Awareness creation among industries	State government, MPCB and industrial associations Timeline: Two–three months	

Action point	Indicators of action for implementation and reporting	Baseline action	Agencies responsible and timeline for action	Status of action and progress against indicators for action points (to be supported by data/ documents etc)
The fuel policy of Maharashtra mentions the APCD requirements for the industries using fuel oil. However, APCD requirement in industries using fuel other than FO is not mentioned in detail and is required to be included	Revised rules for installation of appropriate APCD with respect to fuel consumed in industries, considering fuel type and usage	Necessary revision in fuel policy	MPCB and state government (under Section 19 of the Air Act) Timeline: Immediate	Requirement of APCD for industries using fuel other than fuel oil
Use of agriculture-based biomass should be promoted in industries	Increased used of agro-residue in industries along with appropriate APCD		MPCB Timeline: Two–three months	Use of agro-residue in MMR industrial areas is only about six per cent of the total fuel consumption and only 14 per cent of the industries are using agro-based fuel. An increase in these numbers signifies increase in biomass consumption as fuel. Explore the availability of agriculture biomass
In Taloja, Mahanagar Gas company to conduct a safety audit and should try to resolve the issues related to safety, logistics, boiler technology and provide the PNG connection to small-scale units as well	Safety audit in industries Number of PNG connections in small units	Explore the options of better technologies to provide gas connections to 500 units	MGCL, experts and concerned authorities together to look for the feasible options to provide PNG connection to small industries, and resolve their safety concerns	
2. Chemical industry-sector specific actions				
Chemical industry is a major sector in MMR. In general, the major emissions from the sector include VOC compounds from the process. Monitoring of VOCs in the ambient air is a must in the industrial areas where chemical industries are predominant	Continuous VOC monitors for ambient air at relevant locations in industrial areas	Identification of the industrial areas where chemical industries are dominant	MPCB Timeline: Six months	

Action point	Indicators of action for implementation and reporting	Baseline action	Agencies responsible and timeline for action	Status of action and progress against indicators for action points (to be supported by data/ documents etc)
Develop an air toxics emissions inventory and control plan for the MMR region. Identify and monitor toxics, as well as assess health risk through exposure modeling	Presence of toxics and proximity of the population to the source Whether exposure is possible: risk assessments	Identify problem areas	MIDC, MPCB and industry associations	
Sector-specific pollution assessment study for the chemicals industries for pollution abatement Presence and performance of appropriate APCDs to be assessed Possibility of a common solvent recovery plant	Identification of the opportunity to reduce the loading and preparation of sector-level findings for better environment management	Inventory of solvent consumption per month, specifying type of the solvent Emissions due to chemical processing (unit process or operations)	MPCB Timeline: Six months	
3. Regulatory action				
Surprise inspections to check compliance of the industries operating in Kalyan Bhiwandi and Dombivali area: Visible stack emissions were observed in many industries in both the industrial areas A unique strategy of cross-regional inspection as already devised and implemented by MPCB in Taloja industrial area to be replicated in other regions. Inspection of industries to be done by the MPCB officer of some other region	Lesser emissions from the industries will be observed and industries will adhere with emission norms It will help in better enforcement	An inspection protocol should be developed MPCB should prepare an action plan	MPCB Timeline: immediate	
Modify non-attainment criteria for cities where industries are located within the city limits. For example, in cities which have chemical industries in their vicinity, the non-attainment criteria should also consider the ambient VOC concentration and not only particulate matter	VOC standard for industrial area of the chemical sector	MPCB shall develop ambient VOC standard for industrial area of the chemical sector in consultation with CPCB	MPCB, CPCB Timeline: One year	Area specific ambient air quality standard for chemical sector
Assessment of health impact in cases of proximity of industries and community	Conduct a human health risk assessment study	Identify the areas where industrial and residential areas are in proximity. For example, Dombivali	MPCB Timeline: Six months	

Action point	Indicators of action for implementation and reporting	Baseline action	Agencies responsible and timeline for action	Status of action and progress against indicators for action points (to be supported by data/ documents etc)
Industrial associations should be identified and considered a major stakeholder in the air pollution action plans being prepared by MPCB and should be given the responsibility of environment management in the respective industrial areas	Industry associations taking more responsibility and developing action plans of their own to manage environment properly	Inventorization of industry associations area-wise and holding of stakeholder meeting with each of them	MPCB Timeline: Six months	
Provide subsidies for purchase of air pollution control devices (APCD), particularly for small- and medium-scale units	Increasing the number of APC devices installed		MPCB and Maharashtra state government	
4. Industry associations and other stakeholders				
Maintaining road infrastructure, drainage systems, waste collection and safe disposal facilities etc., in industrial areas	Maintain infrastructure and conduct need assessment for development of roads and drainage lines	Criteria should be developed to assess roads in consultation with Central Road Research Organization and PWD There should be installation of weigh-in-bridges to avoid overtonnage of trucks	MIDC and other agencies responsible in industrial areas Timeline: Immediate and continuous	
Policy level intervention in siting of upcoming industrial areas to ensure the presence of adequate buffer zones along the periphery of the industrial areas so as to clearly demarcate the boundaries of residential and industrial areas. An area management plan for all the industrial areas will ensure proper ambience of the area	Future planning for industrial area development with proper buffer zones and a proper land use planning should be done through dispersion modeling while making a master plan for upcoming industrial areas	MPCB has been entrusted under Section 17 of the Air Act to provide advice to state governments in locating the industrial areas SPCB, in tandem with the land acquisition department, should introduce green belts and buffer zones around industrial areas to discourage the growth of residential colonies	MIDC, CIDCO, municipal corporations and MPCB to make the criteria and advice the state government accordingly Timeline: One year	

Action point	Indicators of action for implementation and reporting	Baseline action	Agencies responsible and timeline for action	Status of action and progress against indicators for action points (to be supported by data/ documents etc)
5. Technological interventions				
Common steam generation units for industrial sectors	Feasibility study to explore the opportunity of replacing small boilers with centralized systems for steam generation		MIDC, City and Industrial Development Corporation (CIDCO), and industry associations Timeline: One year	
Installation, upkeep and regular use of air pollution control devices	Inventory of all polluting units along with the details of the installed device		MIDC, City and Industrial Development Corporation (CIDCO), Industry associations and industries Timeline: One year	
Provide financial incentives such as discount on electricity bills for MSMEs when air pollution control devices are being used	Drafting and notification of incentives			
Create a mechanism for penalty for medium and large enterprises for not installing and using air pollution control devices				

INSTITUTIONAL MECHANISM FOR IMPLEMENTATION

In order to implement and monitor the progress of the proposed actions, a regional level monitoring committee is proposed, which will also provide for the institutional mechanism for implementation. This monitoring committee will oversee the work done by the concerned responsible agency.

Proposed composition of the Regional Monitoring Committee

District collector or magistrate	Chairman
Sub-divisional magistrate of district headquarter	Member secretary
Chairman of local municipal corporation and sarpanch of villages	Member(s)
Regional officer of MPCB	Member
Representative of leading NGOs working on environment-related issues (nominated by the chairman)	Member
Regional officer of the transport department	Member
CEO, Maharashtra Industrial Development Corporation (MIDC)	Member
One academic from the field of environment (nominated by the chairman)	Member
Regional officer of MIDC	Member

Annexure

EMISSION STANDARDS FOR COMBUSTION EQUIPMENT[4]

There are multiple standards for combustion equipment with different capacities

S. no.	Capacity (TPH)	PM emission limit (mg/Nm^3)	SO_2 emission limit (mg/Nm^3)	NO_x emission limit (mg/Nm^3)
Small industrial boilers (coal or liquid fuel)[5&6]				
1	Less than 2	1200	400	300
2	2 to less than10	800	400	300
3	10 to less than 15	600	400	300
4	15 and above	150	400	300
5	Boilers using agriculture waste as fuel[7]	500		
Thermic fluid heater (TFH)	Varying	150, 500, 600, 800 or 1,200	400	
Furnace				
1	Cupola furnace			
A	< 3 TPH	450	300	400
B	> 3 TPH	150		400
2	Arc furnace	150		
3	Induction furnace	150		
4	Reheating furnace	150	300	1,000
DG set[8]	> 800 KW or 1000KVA	75 or 100 (based on fuel used)	< 2 per cent sulphur content	710–1,100 ppmv (based on date of commissioning)

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