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Chandrapur City Air Pollution Control Action Plan

ACTION PLAN FOR CONTROL OF AIR POLLUTION IN NON-ATTAINMENT CITIES OF MAHARASHTRA

CHANDRAPUR

MAHARASHTRA POLLUTION CONTROL BOARD

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Action Plan for Control of Air Pollution at Chandrapur

1.1 Preamble

Chandrapur, the headquarters of the district to which it gives its name, is the largest city in the district and is situated 761 feet above sea level in 19° 57' north latitude and 79° 22' east longitude. The city is located on the confluence of rivers "Erai" and "Zarpat". The northern portion of the city is at high elevation and southern at low as per topographical map i.e. 56m. The old city is surrounded by walls. These walls were called as "Parkots". These walls have four gates to enter and leave the city namely Jatpura gate, Pathanpura gate, Bimba gate and Anchaleshwar gate. Also the hane four windows to enter and leave the old city namely ChorKhidki, Vithobakhidki, Hanuman khidki and Bagadkhidki. The Gaontideo Nala is originating from the upland of CSTPS. The Macchinala is originating from upland of Ranger college. This Nalah is merge in the tank "RamalaTalao" located in the heart of city. The north south length of Chandrapur city is about 10 Km and East West is 7 Km. In the north of city, there is a dam made on river Erai, having the capacity of 20 million cubic meters. Foundation stone of the city was laid down by Khandkya Ballalshah (Veer Shah), a Gond king.

1.2 Climate

The climate of the district can be classified as tropical hot climate with range of temperature through out of year. Primarily there are two prominent seasons in the district- the very hot summer and moderate winter. The summer months are very hot and prolonged while winter is short and mild. The monsoon season starts immediately after summer till late September. The southwest monsoon brings lots of rainfall during rainy season and there is no draught prone area in the district.

The temperature starts decreasing from the month of October. December is the coldest month Mean maximum temperatures during December is 28.2°C and mean minimum is 11.6° C. The southern part is comparatively warmer than the north. This ranges between 29.6° to 14.6° C. The lowest recorded temperature is in the north is 3° C and 8° C in the south. The daily mean temperature starts rising from the month of February and may is the peak summer month when maximum temperature goes upto 43° C and minimum temperature is 28° to 29° C. In severe heat condition temperature raises up to 47° C. However temperature starts blackening after may due to onset of monsoon, which last from June to September when it is hot and humid.

The prominent wind direction is from south to north. In summer the wind direction is from east to south and monsoon from south to east. During winter, the wind direction changes from north to east frequently is characterized by blowing of wild and violent winds heralding the approach of hot season which last till middle of June. The district receives rainfall from the south west monsoon from June to September. The average rainfall is about 1200 mm. The rainfall generally increases as one goes from the west to the east.

1.3 Population

As per provincial reports of Census of India, population of Chandrapur city in 2011 was 3,20,379 of which males and females numbers were 1,64,085 and 1,56,294 respectively **(Table 1.1 and 1.2)**.

Table 1.1 Demographics of Chandrapur city

Chandrapur City	Total	Male	Female
Population	3,20,379	1,64,085	1,56,294

Table 1.2 Annual population growth rate for Chandrapur city

S.No.	Year	Population	Decadal Variation	Percentage variation	Annual growth rate (%)
1.	1951	42795	--	--	--
2.	1961	58146	15351	35.87	3.587
3.	1971	84424	26278	45.19	4.519
4.	1981	146754	62330	73.83	7.383
5.	1991	226105	79351	54.07	5.407
6.	2001	289450	71507	31.62	3.162
7.	2011	320379	31586	10.91	1.091

1.4 Road Transport

Public transport in Chandrapur is carried by bus system and personal vehicles. Chandrapur is connected to many cities in Maharashtra by MSRTC buses. The buses ply to Nagpur, Gondia, Amrawati, Akola, Shirdi, Aurangabad, Nanded, Pune and Hyderabad. Chandrapur is located on main New Delhi - Chennai and New Delhi - Hyderabad - Bangalore railway line of the Indian Railways. It comes under Nagpur division of the Central Railway. Total number of registered motor vehicles till 2011 is 281764 as per RTP statistic data. It is increasing at the rate of 10.7% annually. **Table 1.3** presents the annual growth of vehicles of Chandrapur.

Table 1.4 Annual growth rate of registered vehicles in Chandrapur City

Code	Name of Regional office	2006	2007	2008	2009	2010	2011	% increase or decrease over year
34	Chandrapur	177225	195954	214619	232787	254524	281764	10.7

Source: Transport Commissioners Office, Report on Vehicle Growth and other Statistics of Maharashtra

1.5 Development and Infrastructure

Chandrapur is stated as an industrial center since 1981 when MAHAGENCO established Chandrapur Super Thermal Power Station at Durgapur. Till 1970s the town had major industries like Ballarpur Paper Mill, ACC cement factory and Maharashtra Elektrosmelt Limited (MEL). There were four five underground mines which were administered by WCL.

With the start of open cast coal-mines (WCL) many small scale enterprises, especially hotel and transport emerged. Manikgarh Cement and L&T cement were set up during the same period. The town, infact the district witnessed industrialization in the second phase during 1990s with the expansion of CSTPS. Many more WCL open cast mines, Maratha Ambuja Cement, Murali Agro (Cement) industries, Ultra Tech and number of iron plants came up in the district.

There is a 'Co-operative Industrial Estate' along Mul road, which comes in the extended limit of the town. The gross area of this estate is 21.04 Ha and it provides total 101 plots for Industrial units, out of 54 plots are in function. The Maharashtra Industrial Development Corporation has also established industrial estate along Ghugus road, outside the Municipal limits. It has 172 plots out of which 42 plots are in function.

In addition, there are multiple service sector activities such as domestic work, auto-rickshaw driving, street-vending, scavenging, running small grocery shops, selling vegetables and other agricultural products road side, working as porter in the railway stations as well as in the collieries and other industries which requires loading and unloading of heavy materials to be done.

Thus transition of Chandrapur district from a background district to an industrial district has completely determined the economic profile of the town. Chandrapur district is further set to become a major investment destination in future. 38 industrial houses in the country have signed Industrial Entrepreneurs Memorandum with Government of India. These industries include various power generation industries, coal-mines, cement industries etc. Some industries are also for the extraction of other less exploited minerals such as fero-mangenese, copper and limestone. The total estimate divestment in the district by these industrial setups is to the tune of 44,771 crore. The district is set to become a major power hub in the future with expansion plans of CSTPS and other newly commencing power stations.

Chandrapur is developing rapidly towards wide spectrum of sector as Power plants, roads, industries, etc. Thus it can be observed that due to this rapid industrial, vehicular and infrastructural growth, city is facing a great air pollution problem which in turn is increasing the stress on available environmental resources.

2.0 Data Analysis and Emission Inventory

2.1 Monitoring Air Quality

Monitoring of air quality in the region has been going on for a considerable period.Many of the stations have been collecting data through manual system and some industries also monitor the ambient air through their manual/automatic stations.

2.1.1 Past Air Quality Monitoring NAMP Data Analysis

The trend analysis of ambient air quality of Chandrapur at NAMP and SAMP stations were done. There are 18 NAMP station from Maharashtra, and 6 from Chandrapur. SO_2, NOx and RSPM and SPM have been identified for regular monitoring at all the locations. The monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year. Air quality monitoring NAMP database of Chandrapur over the 10-year period i.e., from 2004 to 2013, was taken from MPCB website. Analysis on NAMP database was carried for assessing air quality trends by annual and monthly means for past 10 years.

2.1.2 Land based point Measurements by IIT Bombay and NEERI

$PM_{2.5}$ and PM_{10} samples were collected for monsoon and winter seasons at NAMP station (SRO Nagarparishad Office Building) in Chandrapur. Standard operating procedures (SOP's) for acid digestion of Teflon and Quartz membrane filter paper handling from USEPA (1999) was referred and adopted for the present work. (Source: CPCB 2010; USEPA., 1999). Weighing was performed on an electro-microbalance with 1µg sensitivity. Unexposed and exposed Teflon and Quartz membrane filters were kept in desiccators for a minimum of 24 hours prior to weighing. The weighing was performed in a temperature and humidity controlled room (25 °C ± 2 °C and 40 % ± 5% RH).

Airmetrics (ARM) MiniVol™ portable air samplers were used in this study to sample $PM_{2.5}$ and PM_{10}. The sampler can operate on battery for 24 hours continuously and has electronic panel for programming the sample durations. The samplers are impactor based and operate at an air flow rate of 5.0 lpm. The mass of samples collected over specified duration (8 hour) includes the main considerations like adequate mass collection for gravimetric analyses and prevention of overloading of the filter that could lead to excessive pressure drop across the filter. Standard laboratory procedures were followed while handling the filter papers. The flow rate of 5.0 lpm was found to be suitable as it would collect about 2.4 m^3 of air in 8 hours, and the total mass of sample would be in the range of 240 to 360 µg (Goyal, 2008). The instruments were calibrated for flow rates and mass collection of PM before the sampling.

2.2 Emission Inventory

All sectors emission inventories have been prepared with a view to prepare source data in terms of loads, areas (gridwise) and any variation for the area. These data sets are useful for air pollution modeling and forecasting purposes.

2.2.1 Mining and Industrial sectors

Emission inventory estimates are determined based on considering available industrial activity information, emission factors and scientific judgment. For the current study, Industrial and Mining Google documents were prepared with all the required information for emission inventory development for Chandrapur. The Google documents were sent to all the industries and mining sectors present in the Chandrapur. Overall 25 mining industries and 15 commercial industries emission inventory information were received through the Google document for calculating emission loads of each industrial sectors. Simultaneously emission inventory information for industries also collected from the industries' environmental status reports and documents those are laid in MPCB Chandrapur.

In Chandrapur there are three main categories of industries. Power plants, Cement industries and Sponge iron industries. Other than those are coal mines thus coal as a fuel is majorly used in industries, Paper, Textiles, Food and Feeds and Multi organics.

Sr. No.	Industrila Unit in Area	Fuel	Unit	Consumption	PM(T/year)	CO (T/yesr)	SO2 (T/year)	Nox (T/year)
1	CTPS Unit 3-7	Coal	MT/day	36000	21024	3942	256887	72270
2	CTPSUnit 3-7	FO	kL/day	70	38	15	481	169
3	CTPSUnit 8-9	Coal	MT/day	12630	7376	1383	90125	25355
4	CTPSUnit 8-9	LDO	kL/day	12.5	7	3	86	30
5	Indian Explossives	Coal	Mt/day	80	47	9	571	161

2.2.2 Line source /Vehicular emissions

A vehicular emission inventory was prepared for the city of Chandrapur. The purpose of this emission inventory was to calculate the amounts of particulate matter (PM), carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides (NOx) emanating from vehicular sources. The following sections provide a detailed description of the methodology that was adopted for preparation of this emission inventory and the results that were obtained.

2.2.2.1 Methodology

The methodology for calculating vehicular emissions included the following steps:

a) Selection of important junctions within Chandrapur
b) Division of Chandrapur city into 1 km x 1 km grids
c) Selection of vehicle categories for conducting traffic counts
d) Implementation of traffic counts at selected junctions
e) Extrapolation of traffic count data to understand vehicular movement during the entire day
f) Calculation of road lengths in each grid
g) Calculation of emission loads (grid-wise and overall) by use of emission factors

The following sections will details each of the above steps.

2.2.2.2 Selection of appropriate junctions for conducting traffic counts

Selection of appropriate locations for conducting traffic counts is a crucial step in development of a vehicular emission inventory. Locations were selected based on the following criteria:

a) Junctions formed by state highways within Chandrapur city limits
b) Junctions formed by major arterial roads within Chandrapur city limits
c) Locations within the city which are known to have high vehicular movement

In all, eleven (11) junctions were selected for conducting the traffic counts **(Table 2.1)**. **Figure 2.1** below shows the locations of these eleven junctions.

Table 2.1 : Junction Numbers and their Respective Names

Serial number	Junction number	Junction name
1	1	MSETCL Square*
2	2	PadoliChowk
3	3	Warora Naka
4	4	SP College Square*
5	5	Mingaon Junction*

6	6	Bengali Camp
7	7	Jatpura Gate
8	8	City Police Station Square*
9	9	Anchaleshwar Gate
10	10	Pathanpura Gate
11	11	GEC Junction*
12	12	Near Carnival Cinemas
13	13	Chandrapur Durgapur Road
14	14	DOC Road & DRC Road (Near Ayyapa Mandir)
15	15	Devada Datala Road
16	16	Entry point of MSH 6
17	17	On Nagpur Road (Near Tristar Hotel)
18	18	Wadgaon Road & Akashwani Road
19	19	Post Office Circle
20	20	MSH 6 & Ramnagar Road

* May not be the actual names. These were the names used by us for reference as it is normally known in the area.

Figure 2.1: Grid map and vehicle counting locations of Chandrapur city

Table 2.2: Details of tentative vehicle counting locations in Chandrapur city

Vehicle count location	Road names
V1	Entry point at Chandrapur-Nagpur road
V2	Entry point at MSH 6
V3	Near Chandrakhar Swami mandir
V4	On Nagpur Road near Tristar hotels
V5	Wadgaon road and Akashwani road
V6	MSH 6 and Ramnagar road
V7	Near carnival cinemas
V8	Bengali camp chowk
V9	Doc road and DRC road (near ayyappa mandir)
V10	Chandrapur Durgapur road
V11	Devada Datala road

2.2.2.3 Grid overlay

A 2 km x 2 km was overlaid over the map since the emission loads from vehicles were to be represented in a grid-format.

2.2.2.4 Selection of vehicle categories for traffic count

It was decided that the vehicles be classified into the following 6 categories:

- 2 wheelers
- 3 wheelers
- 4- Wheelers
- Buses/Trucks

2.2.2.4 Traffic counts at selected junctions

Timings

Traffic counts were conducted at the locations shown in **Figure 2.1 and Table 1**. It was decided that the counts be conducted in three (3) different shifts, representative of peak and non-peak times with regards to vehicular movement.

The traffic count at every location was carried out in three shifts, namely between 8 AM to 12 noon (representing morning peak hours), 1.00 PM to 4.0 PM (representing non-peak hours) and 5.0 PM to 7.0 PM (representing evening peak hours).

Traffic counting procedure

Traffic counts were conducted manually by using mechanical counters (**Table 2.2**). Three people were assigned one junction with each person counting two types of vehicles.

Counting was done on the roads forming the junction and only the vehicles approaching the junction from each of these roads were counted. In other words, only the vehicles on one side of the road were considered.

On each of the roads forming the junction, duration of the traffic count was 15 minutes. The data was recorded in the format shown below.

Junction Name: **Time period:**

Location: **Date :**

Table 2.2 : Format for Entering Vehicle Count Data, as Employed for Traffic Counts in Chandrapur

2-wheelers	3-wheelers	4-wheelers	Buses/Truck

2.2.2.5 Analysis of the collected data

The important steps in analysis of the collected data are:

- Extrapolation of vehicle numbers to understand average daily vehicular movement
- Compilation of data from different junctions to understand vehicular movement on both sides of a road
- Calculation of the road lengths in each grid
- Calculation of emission loads in every grid

2.2.2.6 Data extrapolation

Since the traffic count on each road forming a junction was conducted for a period of 15 minutes in each hour, it was necessary to extrapolate the data so as to represent vehicular movement occurring throughout the day.

The first step in this extrapolation was calculation of number of vehicles approaching the junction from each road in one hour. This was done by multiplying the traffic count on each road by a factor of 4 since the actual vehicle count duration was 15 minutes.

Hourly vehicle count for Road A = No. of vehicles counted in 15 minutes X 4 – (1)

The total duration of vehicle movement through the day was considered to be from 7.30 AM (0700 hours) to 10.30 PM (2230 hours), divided into 3 slots, each of 5 hour duration as shown below:

Morning peak hours: 8.00 AM to 12.00 PM

Afternoon non-peak hours: 1.0 PM to 4.0 PM

Evening peak hours: 5.00 PM to 7.00 PM

To calculate the number of vehicles travelling on one side of the road for a 5 hour slot, the average hourly count for that slot was multiplied by a factor of 5. Following the same procedure for the morning, afternoon and evening slots and summing up all of them, the total number of vehicles travelling on the side of a road approaching a junction in 15 hours was calculated.

Morning slot one side vehicle count for Road A = Hourly vehicle count for Road A during morning slot x 5 – (2)

Afternoon slot one side vehicle count for Road A = Hourly vehicle count for Road A during afternoon slot x 5 – (3)

Evening slot one side vehicle count for Road A = Hourly vehicle count for Road A during evening slot x 5 – (4)

)

Total number of vehicles travelling on one side of Road A during 15 hours = (Morning slot one side vehicle count for Road A) + (Afternoon slot one side vehicle count for Road A) + (Evening slot one side vehicle count for Road A) – (5)

2.2.2.7 Compilation of Extrapolated Data

The number of vehicles approaching a junction in 15 hours as calculated earlier represents the vehicular movement only on one side of a road. To obtain the number of vehicles on both sides of the road, data from other junctions from which vehicles approached the junction currently under consideration was used.

An important assumption in this procedure was that there is no dispersion of vehicles between 2 junctions i.e. the number of vehicles leaving Junction A is equal to the number of vehicles approaching adjacent Junction B. By applying this procedure at every junction, the number of vehicles on both sides of any particular was calculated.

2.2.2.8 Grid-wise road length measurement

After calculation of vehicular movement on both sides of each of the roads considered for traffic count, the lengths of these roads in each grid was calculated. This was done by using the Distance Measurement Tool available in Google Maps.

2.2.2.9 Calculation of emission loads in every grid

Emission factors available from Automotive Research Association of India (ARAI) were used for estimating the PM, CO, HC and NOx emission loads in every grid for each vehicle category. These emission factors are shown in the **Table 2.3**:

Table 2.3 : Emission factors used for calculating vehicular emissions in Chandrapur

Vehicle categories	PM (g/km)	CO (g/km)	HC (g/km)	NOx (g/km)
2 wheelers	0.015	0.93	0.65	0.35
3 wheelers	0.045	1.37	2.53	0.2
4 wheelers (Petrol)	0.004	1.3	0.24	0.2
4 wheelers (Diesel)	0.06	0.3	0.26	0.49
Buses	1.075	3.97	0.26	6.77

(Source: Automotive Research Association of India)

For calculating the amount of specified pollutant resulting from a particular grid, the following equation was used:

Pollutant load (g/day) from vehicle category Y for grid X1
= [No. of vehicles of category Y on Road#1 within grid X1x Length of Road#1 within grid X1 in km x Emission factor for 2 wheelers in g/km] + [No. of vehicles of category Y on Road#2 within grid X1 x Length of Road#2 within grid X1 in km x Emission factor for 2 wheelers in g/km] + ………

- (7)

For example, if Grid no. G6 is considered, the PM emissions resulting from 2 wheelers would be calculated as below:

$PM_{G6\ 2M}$ (g/day) = $(N_{G6\ 2M})$X (L_{G6})X $(EF_{PM\ 2M})$

Where, - (8)

$N_{G6\ 2W}$ is the number of 2 wheelers travelling on road in Grid G6

L_{G6} is the length of the road in Grid G6 (km)

$EF_{PM\ 2w}$ is the emission factor for particulate matter from 2 wheelers (g/km)

By calculating the PM, CO, HC and NOx emissions from each category of vehicle in the grid and considering that the traffic conditions are at their peak for 300 days in a year, the total annual load for each individual pollutant in that grid can be calculated. By application of a similar procedure to every grid which contains roads which are under consideration, we can arrive at a grid-wise emission inventory.

2.2.2.10 Results and discussions

Following the methodology outlined earlier, the vehicle category-wise emissions for PM, CO, HC and NOx were calculated. **Table 2.4** shows the results obtained for the same in Tonnes/year. Similarly, category-wise contributions to each of PM, CO, HC and NOx were calculated. **Figures 2.3 to 2.6** show the results obtained for the same.

Table 2.4 : Vehicle category-wise pollution loads for Chandrapur

	PM2.5 (T/Y)	CO (T/Y)	HC (T/Y)	Nox (T/Y)
2 wheeler	3.36	208.56	145.77	78.49
3 Wheeler	2.34	71.17	131.43	10.39
4 wheeler	56.72	209.46	13.72	357.19
Bus/Truck	45.27	167.17	10.95	285.08
Total	107.69	656.37	301.87	731.15

(all values are in Tonnes/year)

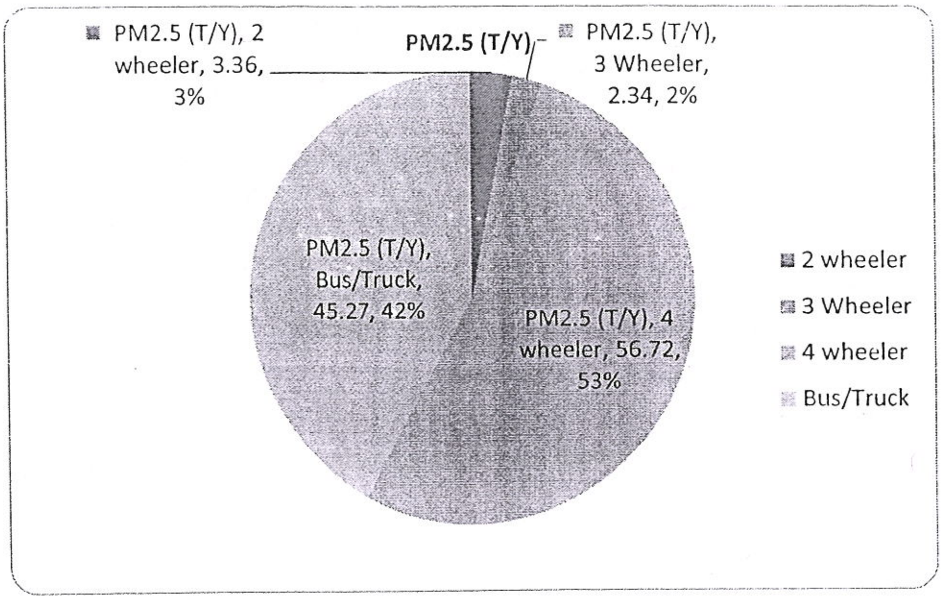

Figure 2.3 Contribution of various vehicle categories to PM emissions

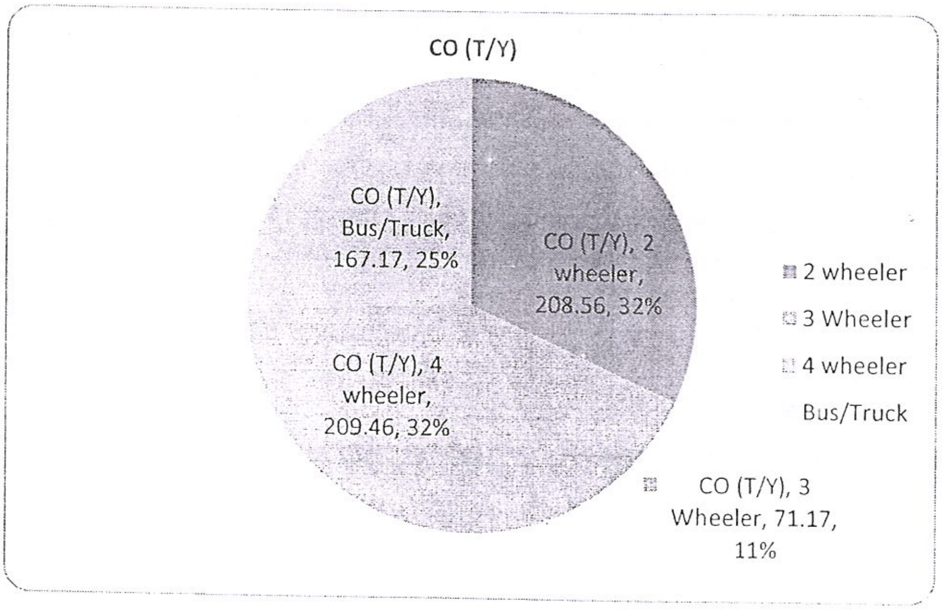

Figure 2.4 Contributions of various vehicle categories to CO emissions

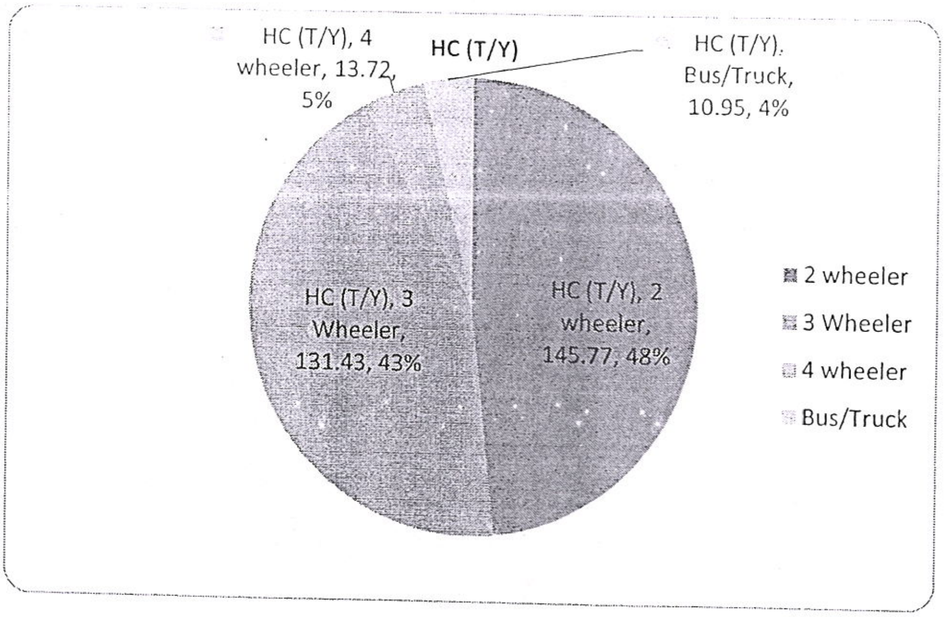

Figure 2.5 Contributions of various vehicle categories to HC emissions

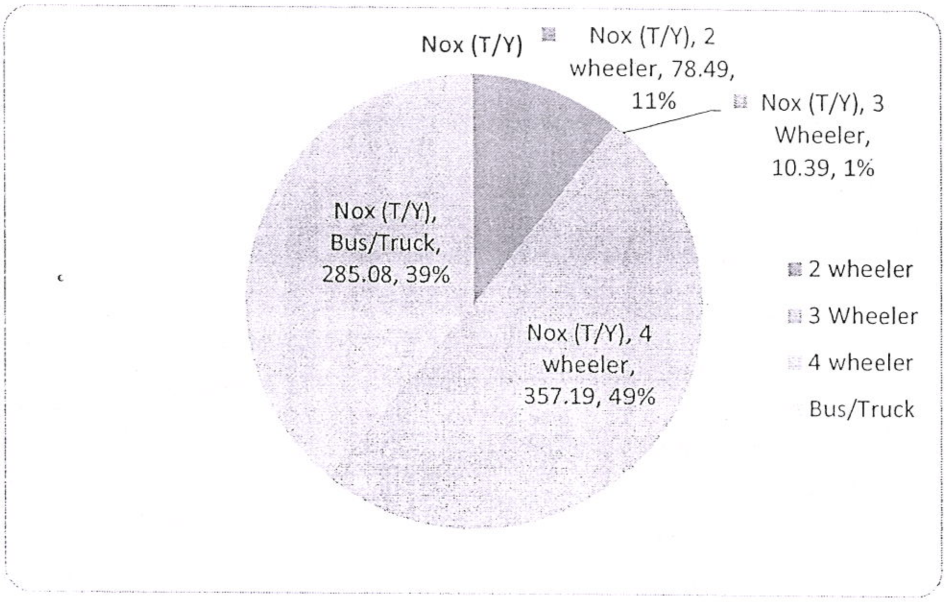

Figure 2.6 Contributions of various vehicle categories to NOx emissions

2.2.3 Area/Distributed Sources

An area source emission inventory estimates the pollutant loads emanating from several small but numerous individual sources in a specific geographic area and which cannot be included under line nor point sources. Some of the most important area sources include:

- Cooking, water heating and other activities in households which require use of fuels
- Hotels, restaurants, bakeries, street vendors and other assorted food establishments which require use of fuels for cooking
- Crematoria
- Open burning of trash
- Construction activities
- Street sweeping operations
- Re-suspension of road dust due to vehicular movement
- Generators used for domestic and commercial purposes

Area sources considered for the purpose of emission inventory for Chandrapur city are:

- Cooking operations in households: Slum and non-slum
- Cooking operations in hotels, restaurants and bakeries
- Crematoria
- Trash burning
- Construction activities
- Street sweeping operations

The following sections will detail the methodology adopted for estimating emissions from each of the above mentioned sources and the results thus obtained.

2.2.3.1 Cooking operations in non-slum households

A survey of 20 non-slum household areas was conducted in randomly selected areas of Chandrapur to understand which fuels are being used in these households and their quantities.

The results of the survey indicated that Liquefied Petroleum Gas (LPG) was the fuel of choice in all the households and that each household used about 1 cylinder per month on average.

Emission calculations were done ward-wise. Data with regards to number of households and the number of slum households in each of the thirty-three (33) wards in Chandrapur was obtained from the Chandrapur Municipal Corporation (CMC). It was assumed that LPG use remains same for all 365 days of the year. The results obtained are presented in **Table 2.5**.

Table 2.5 : Emissions from use of LPG in non-slum households in Chandrapur

(in Tonnes/year)

	PM	SO_2	NO_X	CO
LPG	0.88	3.52	7.03	2.21

2.2.3.2 Cooking operations in slum households

A survey of 55 slum households was conducted, spread over five areas within the city which were known to have significant slum populations, so as to understand which fuels are being used in these households and their quantities.

From the results of the survey, it was seen that a majority of the slum households used a combination of fuels such as LPG, wood, coal and kerosene. LPG in conjunction with wood was found to be the most common combination with 38.18% of respondents relying on this particular combination.

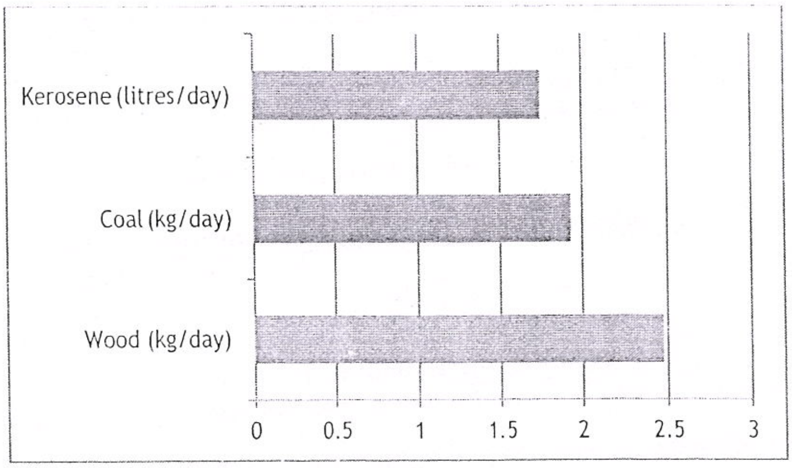

Figure 2.7: Average Consumption of kerosene, Coal and Wood as Obtained from survey results

For the purpose of emission load estimation, it was decided to round off the average consumption values so obtained.

Table 2.6 : Emission factors for LPG, wood, Coal and Kerosene

	PM (g/kg or Lit)	SO_2 (g/kg or Lit)	NOx (g/kg or Lit)	CO (g/kg or Lit)	HC (g/kg or Lit)
LPG	2.1	0.4	1.8	0.252	0.072
Wood	17.3	0.2	1.3	126.3	114.5
Coal	20	13.3	3.99	24.92	0.5
Kerosene	0.61	4	2.5	62	19

(Source: Pune Air Quality Management: Emission inventory and source apportionment studies, 2009-10)

Table 2.7 : Emissions from fuel use in slum households (T/Year)

	PM	SO_2	NOx	CO	
LPG	0.0076	0.0014	0.0065	0.0009	0.0003
Wood	11	0.13	0.83	80.49	72.97
Coal	20.20	13.43	4.03	25.17	0.51

2.2.3.3 Emissions from crematorium

In order to calculate the emissions due cremation of dead bodies, data was obtained from Chandrapur Municipal Corporation with regard to the number of deaths that occurred between 2016 and December 2017 **(Table 2.8 and 2.9)**.

Table 2.8 : Number of deaths in Chandrapur city between 2016 and 2017

	Total deaths
January 2016–December2017	3148

(Source: Chandrapur Municipal Corporation)

Table 2.9 : Quantities of wood, cow dung and kerosene required per body

	Quantities
Wood (kg/body)	300
Cow dung (kg/body)	3
Kerosene (litres/body)	4

(Source: Pune Air Quality Management: Emission inventory and source apportionment studies, 2009-10)

The results thus obtained are presented in **Table2.10.**

Table 2.10: Emissions resulting from crematoria (T/year)

	PM10	PM 2.5	SO2	NOx	CO	HC
Wood	8.17	5.55	0.09	0.61	60	54
Kerosene	0.012	0.0075	0.025	0.016	0.390	0.120

2.2.3.5 Emissions from trash burning

In order to estimate emissions resulting from open burning of trash in Chandrapur city, data with regards to amount of trash collected per day in each of the 33 wards was obtained from Chandrapur Municipal Corporation. Since there was no data available on how much trash is actually burnt in each ward, it was decided to consider that 5% of the trash collected is burnt in the open.

The emission factors for trash burning are presented in **Table 2.11.**

Table 2.11 : Emission factors for trash burning

	PM10	SO_2	NOx	CO
Emissions (kg/MT)	8	0.5	3	42

(Source: United States Environmental Protection Agency)

2.2.3.6 Emissions from construction activities

Construction activities are a source of particulate matter emissions. Emission factors developed by the United States Environmental Protection Agency (USEPA) estimate the amount of PM10 emissions that occur as a result of construction and demolition activities. According to USEPA, 0.11 tons of PM10 emissions occur per acre of construction activity per month i.e. 0.11 tons PM10/Acre-Month. This emission factor is applicable to residential construction activities only.

In order to estimate PM10 emissions from construction activities in Chandrapur, two year data was obtained from the Chandrapur Municipal Corporation regarding building permits sanctioned from 2016-2018. 369 building permits were given in this period. Since data regarding area of construction for each of these permitted buildings was obtained from RERA registration data, as per the suggestion of CMC officials and 12 months as the average duration of each of the construction activities. Results thus obtained are presented in **Table 2.12.**

Table 2.12 : Emissions from Construction Activities

Year	Number of major Construction Permits	Sq. M	Acre	PM10 (T/year)
2016-17	284	189953	43.17	56.98
2017-18	147	30496	7.74	10.22

2.2.3.7 Emissions from street sweeping operations

Street sweeping is associated with particulate matter emissions due to re-suspension of the settled dust on the streets. Manual street sweeping is carried out once a week in all 33 wards of Chandrapur city, as per the information obtained from CMC officials.

Emission factor for PM emissions from street sweeping = 637.47 g/km (AP 42, USEPA)

In order to calculate these emissions, data with regards to the total road length in each ward that is manually swept every week was obtained and it was assumed that these operations were carried out for 45 weeks annually. The PM emissions resulting from street sweeping are presented in **Table 2.13.**

Table 2.13: Emissions from street sweeping

	PM (Tonnes/year)
Streetsweeping	16.27

2.2.3.8 Emissions from bakeries

Data was collected from 4 major bakeries operating in Chandrapur. Out of these 4, one was using electrical ovens. The emissions of this bakery were not considered. 2 bakeries used about 80 kg of wood per day, one of which also used about 1 LPG cylinder of 19 kg every 2 days. The remaining one used about 15 kg of wood per day and 15 litres of diesel per day. Emission factors used for LPG and wood are shown in **Table 2.14** below.

Table 2.14 : Emission factors for LPG and wood

	PM_{10} (g/day)	$PM_{2.5}$ (g/day)	SO_2 (g/day)	NOx (g/day)	CO (g/day)	HC(g/day)
LPG	0.06	0.05	0.01	0.05	0.01	0.00
Wood	0.10	0.07	0.0012	0.01	0.74	0.67

2.2.3.9 Emissions from hotels and restaurants

There are 6 major hotels in Chandrapur. It was possible to obtain data regarding fuels used and their quantities from 4 of these hotels. One of the hotels refused to provide the required data whereas for the other one, the person who could provide the necessary data could not be contacted.

It was found that 3 of the 4 hotels surveyed each used one 19 kg cylinder per day whereas the other one used three 19 kg cylinders per day. For the remaining 2 hotels from which data could not be obtained, one of them was regarded as using one 19 kg cylinder per day whereas the other one was regarded as using three 19 kg cylinders per day. This consideration was based on the size of the hotels and the data obtained for hotels of similar size was considered to be applicable for the 2 remaining hotels.

With regards to wood use, 4 of the 6 hotels were found to be using 5 kg of wood per day, one hotel used 10 kg of wood per day while the remaining one used 80 kg of wood per day.

None of the hotels were found to be using coal for cooking activities. Using the emission factors shown in **Table 2.15,** the emissions from each hotel were calculated. The cumulative emission from hotels have been presented in **Table 2.16.**

Table 2.15 : Emission factors for LPG and Wood

	PM (g/day)	PM2.5 (g/day)	SO2 (g/day)	NOx (g/day)	CO (g/day)	H|C (g/day)
LPG	0.74	0.50	0.14	0.63	0.09	0.02
Coal	0.53		0.35	0.11	0.66	0.01

Table 2.16 : Emissions from hotels (tonnes/year)

	PM	SO_2	NOx	CO
LPG (Tonnes/year)	0.15	0.028	0.12	0.017
Coal (Tonnes/year)	0.59	0.0077	0.054	4.42

Emissions from Muncipal Solid Waste

Chandrapur city is producing 143 T/day of Municipal Solid Waste out of which about 130 T/day is collected. There is a small composting plant for biodegrable portion of MSW on pilot level. There is a portion of solid waste estimated to be burnt. By 2020 estimated generation of MSW will be 170 T/day.

MSW Emissions		Quantity	PM2.5	PM10	CO	SOx
	T/d	MT/Year	T/Year	T/Year	T/Year	T/Year
Solid waste Generation	143.93	52534				
Complete Treatment	25	9125				
Not collected /as it is	13.93	5084				
Burnt (20%)		1017	6	8.95	46.98	0.56
As it is		37308				

3. AMBIENT AIR QUALITY DATA

3.1 Data for Monthly average reading recorded at Chandrapur

Station Name	Year	Month	Average of SO_2	Average of NOx	Average of RSPM
			50	*40*	*60*
Ghuggus	2017	Apr	4	22	335
		May	4	28	293
		Jun	4	9	193
		Jul	4	33	163
		Aug	4	21	201
		Sep	5	26	242
		Oct	4	29	119
		Nov	4	32	339
		Dec	4	26	417
	2018	Jan	4	25	433
		Feb	5	31	438
		Mar	4	28	496
Chandrapur - MIDC	2017	Apr	**4**	**23**	80
		May	4	31	69
		Jun	4	12	55
		Jul	4	34	91
		Aug	4	25	42
		Sep	4	28	50
		Oct	4	30	55
		Nov	4	32	95
		Dec	4	31	112
	2018	Jan	5	21	72
		Feb	5	32	83
		Mar	5	34	87
Chandrapur - SRO MPCB	**2017**	**Apr**	**4**	**31**	**123**
		May	4	33	88
		Jun	4	28	66
		Jul	4	33	59
		Aug	4	22	60
		Sep	4	26	61
		Oct	4	31	110
		Nov	4	33	91
		Dec	4	32	108
	2018	Jan	4	24	109
		Feb	5	29	90
		Mar	4	33	127
Tadali MIDC	**2017**	**Apr**	**4**	**22**	**129**

		May	4	27	190
		Jun	4	21	71
		Jul	4	33	163
		Aug	4	23	70
		Sep	4	26	80
		Oct	4	31	124
		Nov	4	32	105
		Dec	4	25	123
	2018	Jan	4	21	90
		Feb	5	32	85
		Mar	4	32	67
Ballarshah	2017	**Apr**	**4**	**24**	**160**
		May	4	34	150
		Jun	4	17	93
		Jul	4	34	121
		Aug	4	25	104
		Sep	4	28	94
		Oct	4	29	99
		Nov	4	34	176
		Dec	4	29	171
	2018	Jan	5	24	133
		Feb	5	35	138
		Mar	4	33	147
Rajura	**2017**	**Apr**	**4**	**24**	206
		May	4	34	282
		Jun	4	10	112
		Jul	4	34	158
		Aug	4	23	177
		Sep	4	28	140
		Oct	4	31	129
		Nov	4	32	164
		Dec	4	26	222
	2018	Jan	4	26	199
		Feb	5	24	233
		Mar	4	26	196
Civil Lines, Chandrapur	**2017**	**Apr**	**12**	33	197
		May	12	25	165
		Jun	9	21	74
		Jul	9	26	56
		Aug	9	24	58
		Sep	9	24	75

		Oct	9	24	116
		Nov	9	24	134
		Dec	10	25	164
	2018	Jan	11	26	154
		Feb	10	25	133
		Mar	10	25	176

Station Name	Year	Average of SO_2	Average of NO_x	Average of RSPM
		50	*40*	*60*
Ghuggus	04-05	18	28	80
	05-06	21	31	131
	06-07	31	39	139
	07-08	36	53	186
	08-09	34	54	172
	09-10	46	32	180
	10-11	23	24	211
	11-12	18	21	206
	12-13	11	13	207
	13-14	9	19	174
	14-15	9	14	140
	15-16	4	17	180
	16-17	4	25	242
	17-18	4	26	298
Chandrapur - MIDC	04-05	25	37	110
	05-06	26	37	130
	06-07	38	41	123
	07-08	37	50	125
	08-09	34	53	148
	09-10	63	31	141
	10-11	25	25	150
	11-12	21	35	131
	12-13	14	17	105
	13-14	18	27	60
	14-15	14	30	70
	15-16	7	26	75
	16-17	4	34	77
	17-18	4	28	74
Chandrapur - SRO MPCB	04-05	23	34	107
	05-06	20	30	116
	06-07	31	38	130

	07-08	30	46	161
	08-09	26	45	159
	09-10	41	35	74
	10-11	21	27	92
	11-12	18	31	66
	12-13	14	17	75
	13-14	10	26	66
	14-15	7	23	87
	15-16	4	20	70
	16-17	4	28	84
	17-18	4	29	90
Tadali MIDC	09-10	29	19	169
	10-11	18	20	216
	11-12	16	18	151
	12-13	9	13	173
	13-14	7	16	195
	14-15	7	15	112
	15-16	4	20	58
	16-17	4	23	79
	17-18	4	27	110
Ballarshah	09-10	32	35	122
	10-11	17	32	129
	11-12	19	24	123
	12-13	9	19	192
	13-14	10	37	135
	14-15	10	48	130
	15-16	4	28	123
	16-17	4	32	108
	17-18	4	29	132
Rajura	09-10	34	37	119
	10-11	17	19	115
	11-12	16	19	159
	12-13	9	21	196
	13-14	10	31	145
	14-15	7	17	144
	15-16	4	17	127
	16-17	4	27	156
	17-18	4	27	185
Chandrapur CAAQMS	16-17	13	19	69
	17-18	8	19	64
Civil Lines , Chandrapur	17-18	10	25	125

4. Monitoring Mechanism for Implementation

The aforesaid action plan shall be implemented by Maharashtra State Pollution Control Board with coordination of concern departments/stakeholders.

5.Implementation status

The Chief Secretary, Govt. of Maharashtra to convene the meetings with different concerned departments and direct for compliance of directions for implementation of air quality of Amravati. The Principal Secretary, Environment and Forest, Govt. of Maharashtra to also convene the meeting for follow up of the aforesaid directions. The Maharashtra Pollution control Board continuously conducted the meetings with all stakeholders for preparation of comprehensive action plan for city and its implementation.

6.0 Action Plan

Development of Action Plan for Control of Air Pollution in Non-attainment Cities

Plan for Chandrapur

Sr.No		Source group	Control option	Action	Expected reduction & impacts	Technical feasibility	Requirement of financial resources	Implementation period (short/mid/long-term)	Time target for implementation	Responsible agency(ies)	Any other information
1	(i)	**Vehicle emission**	Launch extensive drives against polluting vehicles for ensuring strict compliance	Monthly special drive at toll plaza for random checking of PUC for vehicles.	Medium	Feasible		Short Term	3 Month	R.T.O.	
			No heavy duty vehicle traffic through city	Promting use of by-pass road ro avoid entry of heavy vehicles in the city.Major haul trucks with heavy loads should not pass through the main city. The plan being made shold be implemented in next 1-1.5 years.	High	Feasible	Can be estimated for Roads as well as manpower	Mid term	9-12 months	RTO and PWD	

				Overloading of vehicles to be stopped	Online checking when vehicles leave industries with their guarantee that the vehicle is not carrying more material than its designated loads. All commercial vehicle carrying coal, cement etc must get tagged with user industries.	High	Feasible		Short temrs	3-4 months	RTO, Concenred Industry, WCL	
				Regular I & M Programme	Set up a mechanism of Inspection and Maintenance programme for all vehicles in the district through automated system assessment. The I &M center shall also test all	Medium	Feasible		Mid term	12-15 months	RTO	

				vehicles for their in built emission tests.						
			Phasing out polluting engines and vehicles beyond a fixed period of use	All commercial vehicles should be phased out after 8 years of age or subjected to two years extension after rigorous I&M tests. All private vehicles should be subjected to proper assessment and fitness tests through I&M centers. All autos and buses shall also be subjected to I&M tests	High	Feasible		Long term	24-36 Months	RTO	
			Designated place for truck parking and maintenance related activities.	A separate designated place should be allocated to prevent illegal parking and	Medium	Feasible		Mid Term	9-12 Months	CCMC, RTO	

				repair shops on the roads and kerb side.							
			Public Transport Improvement	Public transport improvement needs to be undertaken on urgent basis. There is a need of at least 75 additional buses in addition to industrial transport systems being made available by industries for its workers.	Medium	Feasible		Mid Term	9-12 Months	CCMC	
			Pilots on Bioswale for dust reduction	Bioswale design and implementation for roadside improvement of dust control	Medium	Feasible		Mid Term	9-12 Months	CCMC	
			Road Design for improved traffic management	Current road design makes the kerb side open and that leads to illegal	Medium	Feasible		Long Term	18-24 Months	CCMC	

				movement of vehicles. The future road and kerb side design must take into account the method wherein the kerbside is completely made inaccessible for vehicle plying. This would help prevent dust entering on to the road.							
		Road dust and C&D	Reduction in Fugutive dust at Construction Site	Propoer onsite provisions for avoiding dust created such as sprinkling of water. Use of RMC instead of insitu concreting	Medium	Feasible		Long term	12-24 months	CCMC	
			Road Dust reduction	Blacktopping of metaled Roads including pavement of Road shoulders	Medium	Feasible		Long term	12-24 months	CCMC, PWD	

			Concrete Roads	More Concrete Roads to be made in city with planning of over 50% main roads to be concretized.	Medium	Feasible		Long term	12-24 months	City Engineer, CCMC, PWD	
		Solid waste /open burning	Segrigation and Collection of MSW	About 143 T/day of MSW. Segrigation is initiated. Segrigation of waste need to followed strictly	High	Feasible		Short term	3-6 months	City Engineer, CCMC	
			Composting	Composting plant capacity 50 MT/day.	Medium	Feasible		Short term	3-6 months	City Engineer, CCMC	
			House hold composting to community level	In each wards some house hold composting pits are created in un-scientific manner, a guideline to be issued by Municipal Corporation for house hold	Medium	Feasible		Mid term	6-9 months	Public, Ward members, CCMC	

				composting plants.							
			Bio-gas Plant at MC	For segregated waste installation of Bio gas plant of capacity of 30-50 MT/day may be considered	High	Feasible		Mid term	6-9 months	CCMC	
			Community level Bio-gas plants	Bio-gas plants for vegetable markets, function halls etc.	High	Feasible		Mid term	6-9 months	Communities as well as CCMC	
		Crematoria	Improved fuels for Creatoria	currently either wood or kerosene is used, use of electric fired crematoria to be promoted	Low	Feasible		Mid term	6-9 months	CCMC	
		Beckeries, Eat-outs, Hotels and Restaurants	Cleaner Fuel for Hotels and Dhabas	Hotels and dhabas need to be educated and compulsorily asked to use LPG for its cooking	Medium	Feasible		Mid term	6-9 months	MPCB, CCMC	

				purposes. Registration of all eatouts							
			Improved combustion devices	Use of the efficient tandoors can be made compulsary for restaurants and hotels. Improved ovens for beckeries	Medium	Feasible		Mid term	6-9 months	MPCB, CCMC	
		Household	Promotion of LPG to stop use of coal	Increased use of LPG through promotional scheme.	Medium	Feasible		Mid term	6-9 months	CCMC, Industries through CSR	
			Improved Chulahs	Actions for prohibiting use of low calorific fuels in the house holds for unavoidable low calorific value fuel usage providing smoke-less chulhas (certified by MNRE) for a limited period till	Medium	Feasible		Mid term	6-9 months	CCMC, Industries through CSR, MPCB	

				use of such fuels is completely stopped.							
			Reduction of the trash and MSW burning	Prohibitory actions for stopping open air trash burning and awareness programmes	Medium	Feasible		Mid term	6-9 months	MPCB	
		Industry Power Plants	Use of high quality coal	Power plants in Chandrapur region should be allowed to use high quality Coal (low ash). The units connected with the low stack height should not be allowed to operate on high ash containing coal. The other units of CSTPL can use high ash coal, however, their ESP system need to meet the	High	Feasible / with challeng es		Mid term	9-12 months	MPCB, CTPS and other poer plants	

					load of PM							
				Proper use of PM reduction actions such as ammonia dosing	Use of ammonia emission has been of limited use and the data indicates it is not based on PM load and corresponding loads. The ammonia dosing is primarily done on preliminary estimates but the same cannot be checked and verified.	High	Feasible / with challenges		• Mid term	9-12 months	MPCB, CTPS and other poer plants	
				Ash bund management	Ash bund management of the CSTPL is very poor resulting in spillage of the ash pond and pollution of water courses and natural drains. The same should	High	Feasible		Mid term	9-12 months	MPCB, CTPS and other poer plants	

				be completely revamped as minor repair and maintenance carried out after every incident has not been very effective.							
			Data triangulation	The air pollution control units, data triangulation method through audit process wherein all data sources and measurements are seen together to assess the efficiencies	High	Feasible		Mid term	9-12 months	MPCB, CTPS and other poer plants	
		Industry Mining Industries	Use of Dust suppression Chemicals for Loading of vehicles/wagons	Trucks carrying coal must be loaded within the carriage area and after it, a chemical dust suppression spray should be carried out to	High	Feasible		Mid term	9-12 months	MPCB, RTO, WCL	

				prevent dust particle getting blown away due to wind effect during transportation. This technique can also be used on railway wagons after the laoding has been done. There is a need to undertake a pilot for a particular mine area completely and compare the same with other mine, so that it can be replicated.							
			Coverted trucks for coal transporation	The average trucks carrying the coal, must be converted gradually to closed system so that on road spillage can be avoided. These	High	Feasible		Mid term	9-12 months	MPCB, RTO, WCL	

			Over Burden Management	designs need to be implemented at the earliest as the open truck with tarpaulin cover has limited efficiencies. Implementat ion of DGMS rules. for New dumps.	High	Feasible		Mid term	9-12 months	MPCB, WCL	
			Stablization of Old OB dumps	For old dumps, slope stabilization and Platation	Medium	Feasible		Mid term	9-12 months	MPCB, WCL	
		Industry Cement Industries	Air Pollution Control Equipment Assessment	The air pollution control units assessment should be carried out with proper data triangulation method through audit process wherein all data sources and measuremen ts are seen together to	High	Feasible		Short term	3-6 months	MPCB, Cement Industry	

					assess the efficiencies. This assessment should be carried out through third party and appointed independently by MPCB to avoid any conflict of interest.							
				Air Quality Prediction	A fine grid air quality management model for cement should be set up to predict PM and NOx, based on real term emission which shall come from its data feed of stacks emissions. This model should be aligned with MPCB and a public domain to share the information to all.	High	Feasible		Short term	3-6 months	MPCB, Cement Industry	

			Material Handling for Dust reduction	Fugitive dust emission control could be achieved through site specific analysis and assessment of each plant. Proper Loading unloading and specific parking areas for trucks	High	Feasible		Short term	3-6 months	MPCB, Cement Industry	
			Road Cleaning	Once every week, all the internal haul roads as also 2 km radius roads should be cleaned either mechanically or through water sprinkler. Since the region is water scarce, they can use treated domestic water	High	Feasible		Short term	3-6 months	Cement Iny	