Project Report on

Baseline Status of Ambient Air Quality in and Around Open Dumping Sites with Emphasis on Odorous Compounds

For

Mumbai Metropolitan Region – Environment Improvement Society *(MMR-EIS)*

By

Waste to Energy Research & Technology Council

(WTERT-INDIA)

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CHAPTER-1
Introduction

1.1 Background of the Project

Open dumping is a primitive method of disposal of Municipal Solid Waste (MSW) followed by most of the Urban Local Bodies in India. It is one of the poorly rendered services by municipal authorities in India and it is unscientific, outdated and inefficient way of solid waste disposal. The decomposition of biodegradable waste on dumping grounds or landfills is known to produce an odour that causes discomfort to nearby residents and is a health hazard. The area around these dumpsites turns into sources of environmental pollution and affecting the nearby residents. The degradation process emanates various gases of odorous or non-odorous nature. Some of them are dangerous for human health and affect the workers and people residing close to the dumpsite. The odours are predominantly caused by Hydrogen Sulphide (H_2S) and Ammonia (NH_3) gases which smell obnoxious and easily sensed by human olfactory system, even when their concentrations are in ppm.

Several studies have been conducted in order to examine the health and environmental effects arising from open dumping of solid waste. The conclusion from these studies has led to an increasing interest of researchers in the study relating to environmental pollution, as well as its effects on plants and animals *(Bogoro Audu Gani. et. al., 2013)*[1].With growing population, industrialization and urbanization, the quantity of Municipal solid waste and adopted practices of its disposal by open dumping, the problems are aggravated and reached to an objectionable proportion. Without proper processing of MSW and disposal by scientific land filling facilities, the problem of odour from open dumping will continue and in rapidly urbanizing cities it is becoming major a problem. Odour is undoubtedly the most complex of all the air pollution problems.

The type of odour generated near a dumpsite depends on the age of the waste, the quantity and composition of waste which is responsible for generation of organic and inorganic odorous compounds. Moisture content of the waste plays a vital role. Normally, it is the wet waste that decomposes and releases foul odour. The odour dissipates in to the surrounding areas depending upon the concentration, wind directions and is carried to several kilometres away from the dumpsite *(Marc, 2006)*[2].These unpleasant odours can lower the quality of life that resides near to the dumpsite/ landfills. In addition, dumpsites close to residential areas are always feeding places for dogs, cats, rodents and other animals. They become carriers of diseases to nearby communities. *(Foday Pinka Sankoh et. al., 2013)*[3].

It is recognized that prolonged exposure to foul odours usually generates undesirable reactions in people, which vary from causing emotional stresses such as feeling uneasiness, nausea, discomfort, irritation or depression including physical symptoms like sensory irritations, headache, respiratory problems or vomiting *(Report: National Research Council Committee on Odours, 1979)*[4]. Sub-irritant levels of odorants may trigger acute symptoms through non-toxicological, odour-related mechanisms *(Jim. Nicell,1999)*[5]. Although landfill odours may not be associated with long-term adverse health effects or illness for most the people, the added disruption and stress of day-to-day activities can adversely impact the quality of life. Odour from landfill sites principally originate from atmospheric release of compounds formed during the biological and chemical processes of waste decomposition *(Foday Pinka Sankoh et. al., 2013)*[1].Landfill gas emissions contain microbes, particles and aerosols of odorous substances. The main chemical compounds in landfill gas include saturated and unsaturated hydrocarbons, acidic hydrocarbons, organic alcohols and aromatic hydrocarbons, halogenated, sulphurous and inorganic compounds *(Tengku Nuraiti TengkuIzharet.al., 2013)*[6].

Presently, government authorities around the world are struggling to find the ways for odour regulation. The existing Rules and Ordinances have been found to be inconsistent and in many cases, insufficient in defining, investigating and even resulting to violations during enforcement. Therefore, they are in process of modifying to protect citizens. Improvement for their determination as well as sufficient testing and modelling methods are being evolved. Recently Central Pollution Control Board (CPCB) has issued Draft Guidelines on Odour Measurements and Management in Urban Municipal Solid Waste Landfill Sites *(Feb., 2017)*[7].

As per estimates, more than 55 million tons of MSW is generated in India per year and the annual increase is estimated to be about 3%. It is estimated that, per day per capita solid waste generated in small, medium and large cities and towns in India is about 0.1 kg, 0.3-0.4 kg and 0.5 kg per respectively. Mumbai, Navi Mumbai, and Thane cities generate about 11198.1 MT, 750 MT & 950 MT per day *(Report: NEERI Waste Characterization Study Report 2016 for Mumbai, Thane ESR 2016-17)*[8&9]. The estimated annual increase in per capita waste generation is about 1.33 % in this region. The solid waste generation varies upon the nature of the place, activities and life style of the residents.

In India, the biodegradable portion dominates the bulk of MSW, mainly due to food and yard waste. With rising urbanization and change in lifestyle and food habits, the amount of Municipal Solid Waste has been increasing rapidly and its composition. Odours associated with the land-filling of wastes can begin with its transportation and due to decomposition processes taking place at sites.

1.2. Techniques and Methods for Odour Analysis

Odour emissions are one of the major environmental problems that several industrial categories have to face with complaints from the population living nearby plants characterized by unpleasant odour emissions like waste treatment, and disposal plants, waste water treatment plants, chemical industries, livestock activities are becoming more and more frequent and often are origin of legal suits. Even high number of industrial typologies facing environmental odour problems, their relative abundance on territory is becoming more sensitive towards topic concerning air quality, regulatory and environmental protection bodies are in need of specific tools for odour emissions assessments. The techniques available for odour nuisance characterization and quantification are of three different kinds *(Gosteloet.al, 2001)*[10].

- Analytical: Chemical analyses
- Sensorial: Dynamic olfactometry
- Senso-instrumental: Electronic nose

Analytical Techniques

Analytical techniques allow determining qualitative and quantitative composition of gas mixture, using suitable separation and identification techniques (i.e. Gas Chromatography coupled with Mass Spectrometry)*(Davoli et al., 2003)*[11].The technique has advantage of being consolidated and therefore considered objective repeatable and accurate. However, the disadvantage relies in the difficulty of relating the chemical composition of odorous mixture to its properties *(Stuetz et al., 1999)*[12].

Sensorial Techniques

Sensorial Technique such as dynamic olfactometry *(EN13725, 2003)*[13] senses by human nose which can be examined by qualified examiners. Several factors that may influence odour, which are assessed by standard procedures *(Laura Capelli, 2008)*[14].The same can be done by other methods reported in literature *(Pearce, 1997)*[15]and *(Micone and Guy, 2007)*[16].

1.3 History and Status of Waste Disposal Sites and Waste Characteristics

(A)Dumping Grounds in the Jurisdiction of Municipal Corporation of Greater Mumbai (MCGM)

Municipal Corporation of Greater Mumbai, established in the year 1865, is one of the biggest municipalities in coastal cities of India and also the largest civic organization in the country covering in an area of 437 Sq. kms. MCGM divides the Mumbai City in 7 zones; and 4 to 5 Wards in each Zone. Presently, the city generates 7500 MT MSW per day and is disposed of at the 3 sites viz.

Kanjur, Deonar and Mulund with open dumping. The solid waste of around 4000 MTD is scientifically processed at Kanjur site which is recently developed using Bio-reactor landfill facility at landfill site and the Processing Plants are set up for producing Compost and Refuse Derived Fuel (RDF) of the capacity together of 1000 MTD. MCGM is also in the process of setting of Waste Processing Facility at Deonar Dumping ground together with scientific landfill. The details of the MCGM sites covered in the study area are as follows:

Site: Deonar Dumping Ground (DDG): - Deonar dumping ground is located in Eastern suburb of Mumbai is an oldest and largest dumping ground in India and came into existence since 1927 and admeasuring the area of 120 Ha. During the site visit, it was observed that the dumping is carried out at 2 places and about 3500 to 4000 M.T. of Municipal Solid Waste is received there every day.

Site: Gorai Dumping Ground (GDG): - Gorai dumping ground came into existence in the year 1972 which has area of 19.6 Ha. and was operative till 2007. This site was creating great odour nuisance to the nearby localities and there were several complaints including PILs filed before the Hon'ble High Court and in pursuant to the orders passed, this site was scientifically closed by MCGM.

(B) Dumping Grounds in the Jurisdiction of Thane Municipal Corporation

The city of Thane is situated on the western bank of Thane creek. The existence of Thane city appears in a global history since the 9th century A.D. The Thane Municipal Corporation was established in 1982. The area of Thane city is 128.23 sq. Km and the population as per census 2011 is 18,18,872. The Thane city is divided into 33 wards. The solid waste is disposed at Diva Khardi site located near to Diva Railway Station. Thane Municipal Corporation is in the process of setting up 600 MT per day scientific processing facility at Daighar.

Site: Diva-Khardi Ground (DKG):Of the total 950 TPD solid waste generated from Thane city, 750 TPD is received at this dumping site *(Report: Thane, ESR 2016 -17)*[9].The dumping ground gets divided into 3 parts due to bisecting public transport road to Diva town and station. During the site visit it was observed that currently the dumping is being done at Sabe village site, which is admeasuring about 5 Ha.

(C) Dumping Grounds in the Jurisdiction of Navi Mumbai Municipal Corporation

The city of Navi Mumbai is the planned city as sister city of Mumbai and carries same habitat as Mumbai. The area of Navi Mumbai City Corporation is 340 sq. Km. and the population is about

11.201 million. *(Census,2011)*. The city has two zones and comprises of 8 wards and generates about 750 MT wastes per day.

Site: Turbhe Waste Processing Facility (WPF): The waste processing facility at Turbhe is operated by Navi Mumbai Municipal Corporation which receives 750 MTD Municipal Solid Waste. The scientific processing and land-filling is done through a private operator and as per the information given the site is being monitored by officers of NMMC.

Some of the relevant data related to waste composition, characterization of all these sites is reported in **Table 1.1.** The Physical Assessment carried out at three sites is reported in **Table 1.2**. However, it is recommended that the Local Bodies shall carry out waste characterization study regularly at least alternate years. The literature survey of measurements of gases emitted at different dumping sites in India and some overseas countries has been reported in **Table 1.3**.

Table1.1: Some of the Waste Composition Data of MSW of Different Corporations (%)

Type of Waste	Deonar (MCGM)*	Navi Mumbai (NMMC)**	Thane (TMC)**
Food waste	79.49	77.23	51.2
Paper waste	4.36	7.7	7.4
Plastic waste	3.40	-	20.1
Metals and Glasses	1.66	1.5	0.13
Inert	11.56	-	6.7

*NEERI Report of 2016-17[8], ** NEERI Report of 2010 for MMRDA[17]*

Table1.2: Waste Characterization of MSW analysed by WTERT-India (Physical Analysis)

Type of Waste	Deonar (MCGM)	Navi Mumbai (NMMC)	Thane (TMC)
Biodegradable	72.67	68.48	81.49
Recyclable	18.13	24.92	14.96
Combustible	9.19	6.14	3.09
Inert	-	0.46	0.45

The detailed Analysis is at **Annexture-1**

Table 1.3: Gases Emission Concentrations of Some Sites (ppm)

Para-meters	Kanjur Dumping	Thane Dumping	Gazipur	Pulau Burung Landfill Site (Malaysia)		Nigeria Rumuolumeni Site of Port Harcourt City(Nigeria)				
				max	min	Site 1	Site 2	Site 3	Site 4	Site 5
VOC	2.0	--	7.0							
NH_3	0.2	0.035	0.414	--	--	20	15	17	16	15
H_2S	0.015	0.015	0.048	363	4	8	4	5	7	7
CH_4	100.0	--	500.0	68%	0.10%	2310	2700	2662	2771	2660

(Source:-Thane ESR [9], Gazipur Landfill Site MSW Pilot Study Report[18], A Distance-Based Study in Malaysia: Semi-Aerobic Landfill [6], Solid Waste Management in Developing Countries: Nigeria a Case Study26th April, 2004[19])

1.4 Need and Objectives of the Report

On the basis of literature survey, it was noticed that, there is no data available for odour Measurements of gaseous emissions of open dumping grounds in MMR, except of measurements of VOCs *"Volatile organic compound emissions from municipal solid waste disposal sites: A case study of Mumbai, India" NEERI, 2012[20].* *Therefore* this exercise was undertaken to generate baseline data of odour and its perception amongst the populous city, about health impacts which could be used for taking some preventive or control measures.

1. To analyse and assess the odour generating gases and their concentrations near open dumping sites at various distances.
2. Assess odour perception in & around the dumping site and its impact.
3. Conduct an experiment for the containment of odour by use of different reagents and mechanisms

1.5 Methodology of the Project

Criteria's of selection of Measurements stations on dumping ground
- Background information of the dumping sites together and overall composition of waste at site.
- Ambient levels of gases and meteorological parameters.
- Development of questionnaire in cooperating multiple attributes such as gender, age distance, occupation, complaints and other relevant queries.
- The National ambient air quality data.

Approach for Measurements

Field visits of 4/5 days were planned for every season for all sites. The probes (GD-102 of HNL make) of Hand Held instruments were used to measure respective gases. Measurements were carried out for 5 days at each site at an interval of 3 hrs. in both upwind and downwind directions for gases methane, hydrogen sulphide, mercaptan, dimethyl sulphide, ammonia, total volatile organic compounds and particulates matters (PM_{10}, $PM_{2.5}$ and PM_1). The report presented here is for the pre and post monsoon of the year 2018 and winter season in the month of Jan/Feb 2019.The distances chosen for perception and Measurements for each site were approx. at a distance 200mtr, 500 mtr, 1 Km and 3 Kms.

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CHAPTER 2
Setting of Measurement Locations at Sites

Sites of all dumping grounds were visited for geographical and physical assessments. Based on their physical characteristics and probable affected areas with respect to residential colonies and movement of residents and public at large were determined. Thereafter distance wise locations on each site were marked. However for the measurements on a given day a fixed direction was considered. The sampling points were marked although looked randomly distributed but each point was on desire distance from center of source was either 200 m, 500 m, 1 Km, 3 Km.

2.1 Deonar Dumping Ground

The measurement point locations have been marked on the map (*source: Google Earth*). The sampling points were marked by taking into consideration of uneven dumping site and taking into consideration nearby residential areas. The points had drawn up to 3 Km distance areas shown in **Figure 2.1 and Table 2.1**. Total 22 sampling points were identified for the Measurements and perception studies.

Figure 2.1: Map of Deonar Dumping Site with Sampling Points

Table2.1: Sampling Point Locations (Deonar Dumping Ground)

Reference Point of Distance	200m	500 m	~1 Km	~ 3 Km
South East Boundary	Site Office Bldg N:19°03'33'' E:72°55'49''	1) Bhadra Hospital N: 19°03'28.76" E: 72°55'40 74" 2) Mankhurd Fire Brigade Station N:19°03'24'' E: 72°55'51''.	1)Atlanta Ground N:19°03'21.73" E:72°55'29.73 2) R.S.C. Bus Stop N:19°03'19.77'' E:72°55'59.67'' 3) R.S. Colony-SE N:19°03'18.84'' E:72°55'58.75''	1) School Bldg. N: 19°03'15.21" E: 72°56'04.10" 2) Maharashtra Nagar N:19°03'06'' E:72°56'15'' 3) Vashi Bridge N:19°03'18.84'' E:72°55'58.75''
South West Boundary	1) Shivaji Nagar Bus Depot N:19°03'54'' E:72°55'40'' 2) Municipal School N:19°04'05'' E:72°55'16''	Ambedkar Ground N:19°03'39.67'' E:72°55'28.67'' Not accessible	Red Brick tower N:19°03'45'' E:72°55'02'' Not accessible	Fire Brigade Colony N:19°03'21.08'' E:72°55'19.02'' Not accessible
South Boundary	Nirankar Nagar Stop N:19°01'39.67'' E:72°55'33''	New Jay Bhim Nagar N:19°03'31'' E:72°55'25''	Swami Samarth Bldg N:19°30'26.19" E:72°55'23.74	Deonar Municipal Colony N:19°03'23.83'' E:72°55'25.29''
West Boundary	Not accessible	Not accessible	S.N. Police Station N:19°03'48'' E:72°54'59''	1) Ramabai Nagar N:19°04'42'' E:72°52'56'' 2) Pestom Sagar N:19°04'10'' E:72°54'09'' 3) Manoranjan Maidan N:19°03'47.92'' E:72°54'47.23''
Total Points (22)	**4**	**4**	**6**	**8**

The above table shows 22 accessible points in different directions which fall on desire distances during measurement on respective days. These will be indicated in the tables of measurements.

2.2 Gorai Dumping Ground

As this dumping site is unevenly spread, the sampling points are determined from overall centre of the dumping site and the peripheral boundary was assigned by us for ease of assessment. Total 18 points were marked for the Measurements and perception as reported in **Figure 2.2 and Table 2.2**.

Figure 2.2: Map of Gorai Dumping Site with Sampling Points

Table2.2: Sampling Point Locations (Gorai Dumping Ground)

Reference Point of Distance	200m	500 m	~1 Km	~ 3 Km
South East	1. On Gorai Site N:19°13'46" E:72°48'57" 2. Shanti Dhaan N:19°13'58" E:72°49'41" 3. Chinmay Soc. N:19°13'59" E:72°49'43"	Gorai Bus Depot N:19°13'57" E:72°49'48"	Not accessible	New MHB Colony N:19°13'40.40" E:72°50'21.64"

Table2.2 (Contd..) : Sampling Point Locations

Reference Point of Distance	200m	500 m	~1 Km	~ 3 Km
South	Malgudi Hotel N:19°13'57" E:72°49'33"	1) Maxus Mall N:19°13'55" E:72°49'43" 2) Dr.Pillai's Academy N:19°13'50" E:72°49'32 3) Pepsi Ground N:19°13'51.43" E:72°49'29.36"	1) Suvidya School N:19°13'45" E:72°49'42" 2) Gorai- 2 Site N:19°13'35" E:72°49'34"	Gorai Bridge N:19°13'35" E:72°49'40"
East	Sonchapha Nursery N:19°13'17" E:72°49'40"	MHB Colony N:19°13'52" E:72°50'17	Gokhale College N:19°13'56" E:72°50'13"	Borivali Fire Stn N:19°13'48" E:72°50'13"
South West	Not accessible	Not accessible	Ferry point 1 N:19°13'46" E:72°48'57"	Ferry point 2 N:19°13'42" E:72°48'29"
Total (18)	**5**	**5**	**4**	**4**

The above table shows 18 accessible points in different directions which fall on desire distances during measurement on respective days. These will be indicated in the tables of measurements.

2.3 Diva-Khardi Dumping Ground

The centre point of this randomly distributed site was selected on one of the portion of dumping site. Sampling points were identified on the same and marked within 3 Km periphery of the site as shown in **Table 2.3 and Figure 2.3**. The below table shows 21 accessible points in different directions which fall on desire distances during measurement on respective days. These will be indicated in the tables of measurements.

Table2.3: Sampling Point Locations (Diva-Khardi Dumping Ground)

Reference Point of Distance	200m	500 m	~1 Km	~ 3 Km
North East	Salvi Nagar 1 N:19°10'37'' E:73°02'24''	Aadarsh Gurukul N:19°10'45'' E:73°02'41''	Global Eng School N:19°11'01'' E:73°03'04''	Bedekar Nagar Datiwali N:19°11'13'' E:73°03'33''
South	Salvi Nagar 2 N:19°10'36'' E:73°02'31''	National School N:19°10'42'' E:73°03'38''	Sudama Regency N:19°10'09'' E:73°02'42''	Rainbow High School N:19°09'07'' E:73°02'46''

Table2.3 (Contd..) : Sampling Point Locations (Diva-Khardi Dumping Ground)

Reference Point of Distance	200m	500 m	≃1 Km	≃ 3 Km
North	Sumit Plaza N:19°10'37'' E:73°02'24''	EkviraChawl N:19°10'47" E:73°02'29"	Gaodevi Apt N:19°10'52'' E:73°02'33''	1) Diva post office N:19°11'11''E:73°02'36'' 2) Diva School N:19°09'07''E:73°02'46''
South West	Not accessible	Sudama Greens N:19°10'11" E:73°02'49"	Om Residency N:19°09'46'' E:73°02'48''	1)Global park N:19°09'42''E:73°01'48'' 2)Kalsekar College N:19°09'28''E:73°01'45' 3)Mumbra Hosp. N:19°11'09''E:73°01'21'' 4) Mumbra Police station N:19°11'01''E:73°01'22'' 5)School bldg N:19°10'53''E:73°01'22''
South East	Not accessible	Not accessible	Not accessible	School(Padlegaon) N:19°09'29'' E:73°03'33''
Total(21)	3	4	4	10
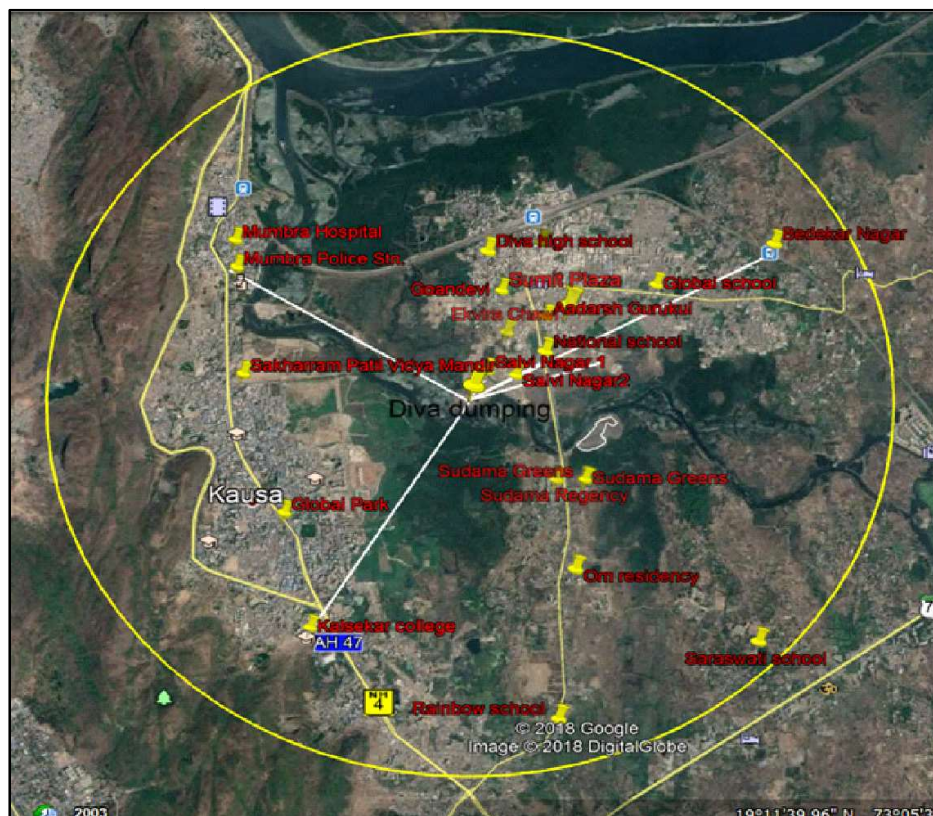
Figure 2.3: Map of Diva-Khardi Dumping Site with Sampling Points

2.4 Navi Mumbai, Turbhe Waste Processing Facility (WPF)

The sampling points were marked by taking into consideration of uneven dumping site and nearby residential areas. The points had drawn up to 3 Km distance areas shown in **Figure 2.4 and Table 2.4**. The below mentioned table shows 20 accessible points in different directions which fall on desire distances during measurement on respective days. These shall be indicated in the tables of measurements.

Figure 2.4: Map of Turbhe WPF with Sampling Points

Table2.4: Sampling Point Locations Turbhe WPF

Reference Point of Distance	200m	500 m	$\simeq$1 Km	$\simeq$ 3 Km
West Boundary of WPF	Samata Hindi School N:19°04'46" E:73°01'16"	Shivshakti Nagar N:19°04'40" E:73°01'07"	Densely Populated Area so not reachable	Head Post Office Vashi N:19°04'08" E:72°59'47"
East Boundary of WPF	1)WPF entrance N:19°04'37" E:73°01'28 2) Road next to WPF	BASF Chemical Divn. N:19°04'39" E:73°01'36"	Indira Nagar N:19°0437" E:73°01'50"	Due to Hilly Area not approachable

Table2.4 (Contd..) : Sampling Point Locations Navi Mumbai (Turbhe) WPF

Reference Point of Distance	200m	500 m	$\simeq$1 Km	$\simeq$ 3 Km
North Boundary of WPF	Due to landfill area not approachable	Yashraj Biotech N:19°04'54" E:73°01'27"	Wasan Toyota shop N:19°05'12" E:73°01'20" 2) Savita Chemicals N:19°05'06" E:73°01'02"	Khairane Goan Stop N:19°05'54" E:73°00'53" Construction activities in nearby areas
South boundary of WPF	Portion of the site is scientifically closed	Portion of the site is scientifically closed	1)Turbhe Naka N:19°04'10" E:73°01'09" 2)Hari Baba Sadhu Marg N:19°04'08" E:73°01'13 3) Prabhat Dairy- N:19°04'43" E:73°01'04"	1) Shirvane Goan Stop N:19°03'54" E:73°01'15" 2) Juinagar-Municipal School N:19°03'06" E:73°00'58"
South East boundary of WPF	Due to nallah not reachable	Scientifically closure area	Global Lab N:19°04'14" E:73°01'41	Due to hilly area not approachable
North East boundary of WPF	Due to landfill area not approachable	1) Sky Industries N:19°04'51" E:73°01'34" 2) Parsik Hill Stop N:19°04'47" E:73°01'36"	Shalimar Stop N:19°04'07" E:73°01'39"	Due to hilly area not approachable
Total(20)	**3**	**5**	**8**	**4**

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CHAPTER 3

Measurements and Assessment of Gaseous Concentrations

The field visits were conducted to identify the locations of sampling points in all four sites as mentioned in the *Chapter 2.* The Pre-Monsoon assessments at 4 sites were carried out between May-June 2018, Post Monsoon assessments during October-November 2018 and Winter assessments in December 2018 to February 2019. The nomenclature of sites has been defined in *Chapter 2.* The pattern of measurements were decided for all sites and for all seasons by determining peripheral measurements points at 200m, 500m, 1 Km and 3 Km and the measurements were taken continuously for 5 days in a fixed direction for all distances on given day and location name of respective distances and direction were noted along with measurement of concentration for each parameter. The measurements were carried out at an interval of 3 hours with the time period of 24 hours. The average of each day for 24 hour measurements for each parameter measured and accessible noted points have been represented in following tables for each season. Any missing measurements at given site at set distance is due to inaccessibility of the location.

3.1 Measurements and Assessments at Deonar Dumping Ground

The measurements of concentration of the odorous compounds H_2S, CH_4, NH_3, CH_4S, DMS and VOC and Particulate Matter (mg/cum) were carried out over a day at various distances. The seasonal variation of measurement parameters for pre monsoon, post monsoon and winter are presented **Table 3.1, 3.2 and 3.3**(Below Tables)and are depicted in **Figure 3.1**.The overall measurements for three seasons for Deonar dumping site is presented in **Table 3.4**and depicted in **Figure 3.2.**

Table 3.1: Deonar Pre Monsoon Season

	Location	Distance in m	Temp°c	Humidity R/H	WD	WS m/s	VOC ppm	H$_2$S ppm	CH$_4$ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m^3	PM2.5 mg/m^3	PM10 mg/m^3
Day 1	Fire Brigade (SE)	500m	34.6	61.5	SW/NE	9	0.22	0.05	ND	0.06	12.63	607	0.16	0.164	0.173
	Railway Sankalp Colony (SE)	1km	36.1	53.4	NE/SW	6.1	0.3	0.15	ND	0.22	39.4	826.6	0.2	0.223	0.387
	School Bldg (SE)	1km	38.4	52.5	W/E	7.9	0.43	0.2	ND	0.25	32.36	1000	0.45	0.791	1.342
	Maharashtra Nagar(SE)	3km	38.5	55.7	SE/NW	6.8	0.36	0.11	ND	0.16	48.13	901.9	0.24	0.283	0.329
Day 2	Bhadra Hospital (SE)	500m	34.7	54.6	S/N	4.3	1.27	0.11	ND	0.67	29.59	606.2	0.03	0.032	0.12
	Bhim Nagar(S)	500m	34.2	56.5	W/E	3.6	0.75	0.18	ND	ND	54.17	170.4	0.04	0.045	0.186
	Shree Swami Samarth (S)	1km	34.5	57.4	SW/NE	3.6	0.88	0.01	16	0.16	50.65	474.1	0.03	0.036	0.071
	Deonar Municipal Colony (S)	3km	33.4	59.8	N/S	4.7	0.67	0.03	ND	0.14	35.01	1000	0.03	0.038	0.095
Day 3	Shivaji Nagar Bus Depot (SW)	200m	34.3	59.2	W/E	15	0.41	0.24	24.2	0.4	196	1000	0.05	0.053	0.167
	Rafiq Nagar(SW)	200m	36.8	55.8	SW/NE	9	0.44	0.11	ND	0.28	10.05	562	0.06	0.076	0.25
	Ambedkar Ground(SW)	500m	37.5	52.9	W/E	9.7	0.47	0.13	22	0.93	36.11	595.1	0.08	0.091	0.267
	Atlanta Ground(SE)	1km	36.2	54.7	SW/NE	3.6	0.61	0.12	ND	0.24	14.45	657.6	0.13	0.178	0.878
	Deonar BMC Colony(S)	3km	37.8	52.6	SW/NE	2.2	0.46	0.16	ND	0.6	49.31	423.3	0.03	0.038	0.044
Day 4	Red Brick (SW)	1km	34.3	60.4	W/E	7.6	0.24	0.18	18.7	0.88	96.66	815.5	0.11	0.114	0.123
	Shivaji Nagar Police Stn.(SW)	1km	37.2	54.9	E/W	10	0.06	0.15	0.05	0.19	88.62	554.7	0.14	0.156	0.192
	Ambedkar Ground (SW	3km	35.1	61.9	NW/SE	4.3	0.11	0.19	ND	0.29	67.73	658.4	0.12	0.131	0.161
	Pastom Sagar(W)	3km	36.4	59.9	S/N	1.4	0.38	0.07	ND	0.44	45.38	970.8	0.08	0.083	0.112
	Ramabai Nagar(W)	3km	36.2	60.2	-	7.6	0.08	0.05	ND	0.1	35.27	247.8	0.11	0.116	0.138
Day 5	Fire Brigade (SE)	500m	31.3	71.3	W/E	14	ND	0.23	ND	ND	40.41	543.8	0.07	0.08	0.101
	Shivaji Nagar(SW)	1km	30.9	70.9	W/E	8.6	ND	0.19	ND	ND	15.97	574	0.15	0.167	0.168
	Red Brick(SW)	1km	30.9	69.5	E/W	17	0.26	0.2	ND	ND	119.2	73.91	0.09	0.103	0.116
	Manoranjan Maidan (W)	3km	31.1	71.4	W/E	14	ND	0.19	1.48	0.14	24.18	40.12	0.11	0.135	0.177
	Pastom Sagar(W)	3km	30.1	65.4	NE/SW	7.6	ND	0.19	ND	ND	13.54	1000	0.07	0.079	0.094

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

Table3.2: Deonar Post Monsoon Season

	Location	Distance in m	Temp °c	Humidity/ R H	WD	WSm /s	VOC ppm	H2S ppm	CH4 ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	Fire Brigade	500m	35.14	44.81	NE/SW	3.24	0.05	0.15	27.1	0.13	33.66	21.88	0.057	0.062	0.118
	Manoranjan Maidan	1km	34.89	52.26	W/E	2.88	ND	0.28	7.65	0.18	79.38	ND	0.101	0.13	0.529
Day 2	Shivaji Nagar Bus Depot	200m	36.3	46.7	W/E	1.2	ND	0.65	2.29	ND	74.05	ND	0.045	0.053	0.164
	Hindi Urdu Municipal School	1km	37.4	44.4	SW/NE	1.1	ND	0.1	1.03	ND	8.41	ND	0.058	0.07	0.25
	Ambedkar Udyaan	1km	36.8	44.5	SW/NE	0.5	ND	0.14	4.94	ND	16.88	ND	0.08	0.093	0.274
	Ramabai Nagar	3km	35.7	47	N/S	1.4	ND	0.21	8.57	ND	68.48	ND	0.062	0.072	0.162
Day 3	MCGM chowki	200m	36	38.6	E/W	5.04	0.15	0.02	0.12	ND	21.41	2.27	0.041	0.05	0.169
	Opp. Railway Soc.	1km	39.1	33	E/W	2.88	0.06	0.12	ND	ND	34.33	67.9	0.044	0.054	0.209
	Railway Soc.	1km	37.6	34	SE/NW	4.68	0.09	0.65	ND	ND	108.2	311.83	0.031	0.043	0.169
	Maharashtra Nagar	1km	39.6	31.4	-	3.24	0.17	0.1	ND	ND	104.86	27.42	0.068	0.085	0.265
	Mohite Patil School	1km	38.4	31.5	E/W	3.6	0.05	0.11	ND	ND	45.52	142.63	0.103	0.139	0.549
Day 4	New Bhim Nagar	500m	37.9	40.3	S/N	5.4	ND	0.08	3.4	0.27	17.18	ND	0.037	0.047	0.186
	Swami Samarth Building	1km	38.9	40.1	SW/NE	2.88	ND	0.06	4.28	0.2	35.62	57.04	0.03	0.035	0.074
	Atlanta Ground	3km	37.6	44.5	NE/SW	3.96	ND	0.07	2.06	0.11	35.34	ND	0.024	0.028	0.097
	Deonar Municipal Colony	3km	38.8	42.6	NE/SW	2.52	ND	0.07	2.82	0.2	26.28	ND	0.033	0.037	0.095
	Fire Brigade Colony	3km	38	42.1	SE/NW	3.24	ND	0.04	1.33	0.12	34.32	ND	0.033	0.033	0.12
Day 5	Shivaji Nagar Police station	1km	31.4	59.4	N/S	5.4	ND	0.28	5.03	0.55	50.56	ND	0.099	0.108	0.191
	Red Brick	1km	31.2	58.9	E/W	8.64	ND	0.3	13.81	0.74	26.05	ND	0.076	0.086	0.237
	Pastom Sagar	3km	30.2	59.3	S/N	3.24	ND	0.23	6.64	0.23	59.8	ND	0.056	0.064	0.125
	Vashi Bridge	3km	29.9	60.1	NE/SW	7.92	ND	0.12	ND	ND	64.94	ND	0.074	0.09	0.164

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan DMS- Dimethyl Sulphide

Table3.3: Deonar Winter Season

	Location	Distance in m	Temp °c	Humidity R/H	WD	WSm /s	VOC ppm	H$_2$S ppm	CH$_4$ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m^3	PM2.5 mg/m^3	PM10 mg/m^3
Day 1	Shivaji Nagar Police Stn	1km	33	44.2	N/S	7.56	0.27	0.09	7.45	ND	111.45	ND	0.093	0.115	0.187
	Shree Swami Samarth Mandir	1km	32.8	44.2	E/W	2.52	0.37	0.02	2.58	ND	32.19	ND	0.064	0.077	0.114
	Atlanta Ground	1km	34	42.8	NW/SE	1.8	0.52	0.02	1.26	0.13	116.73	ND	0.041	0.05	0.221
	Railway Sankalp Colony	1km	34	40.5	NW/SE	5.4	0.47	0.08	2.36	ND	63.99	ND	0.104	0.165	0.255
	Red Brick Point	1km	32.9	43.2	W/E	2.16	0.64	0.09	6.74	ND	101.98	ND	0.146	0.255	0.473
	Railway Sankalp Colony opp. Bus Stop	1km	33.7	41	N/S	10.8	0.5	0.05	3.29	ND	94.36	ND	0.107	0.134	0.231
Day 2	BMC Building	200m	33.4	41	NW/SE	6.48	1.32	0.15	0.39	ND	18.43	ND	0.091	0.1	0.246
	Shivaji Nagar Bus Depot	200m	32.9	40.7	N/S	6.48	1.25	0.26	ND	0.11	68.57	ND	0.107	0.117	0.227
	Nirankar Nagar	200m	33.3	39.6	NW/SE	7.2	1.32	0.06	1.39	ND	41.59	ND	0.085	0.094	0.2
	Hindi Urdu MNC School	200m	33.8	39.1	SW/NE	6.84	1.43	0.07	ND	0.16	27.04	ND	0.095	0.104	0.216
Day 3	Bhim Nagar	500m	31	41.9	S/N	3.6	0.85	0.16	ND	0.12	22.65	ND	0.059	0.073	0.226
	Ambedkar Ground	500m	32.2	41.8	W/E	5.4	1.15	0.24	ND	ND	38.93	ND	0.103	0.143	0.622
	Bhadra Hospital	500m	33.1	39.4	NW/SE	4.68	1.11	0.21	6.82	0.09	21.26	ND	0.068	0.091	0.343
Day 4	Mankhurd Fire Station	500m	28.9	39	W/E	5.04	1.29	0.17	16.08	0.3	17.03	57.52	0.054	0.067	0.144
	Maharashtra Nagar Bus Stop	3km	28.4	39.3	E/W	2.52	1.23	0.11	6.03	0.29	30.05	40.39	0.134	0.162	0.328
	Vashi Bridge	3km	28.5	37.3	N/S	7.56	1.22	0.12	6.66	0.2	148.32	1.99	0.074	0.098	0.236
	Mohite Patil School	3km	28.5	37.4	NW/SE	5.04	1.38	0.09	6.04	0.23	60.11	9.91	0.135	0.196	0.72
	Fire Brigade Colony	3km	27.6	37.9	NE/SW	3.24	1.27	0.09	4.19	0.1	22.5	24.88	0.097	0.124	0.355
Day 5	Pestom Sagar	3km	30.7	34.8	N/S	2.52	1.68	0.07	7.73	ND	25.07	119.42	0.138	0.159	0.37
	Ramabai Nagar	3km	31.6	32.5	N/S	4.32	1.21	0.31	19.84	ND	75.98	281.52	0.124	0.141	0.299
	Manoranjan Maidan	3km	31.9	32.6	E/W	3.24	1.46	0.04	12.04	1.4	65.99	228.97	0.142	0.167	0.431
	Deonar MNC Colony	3km	32.1	34.7	S/N	0.72	1.22	0.2	4.18	ND	42.88	65.11	0.117	0.137	0.324

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan DMS- Dimethyl Sulphide

Table 3.4: Range and Average Concentrations of Pollutants at three Seasons

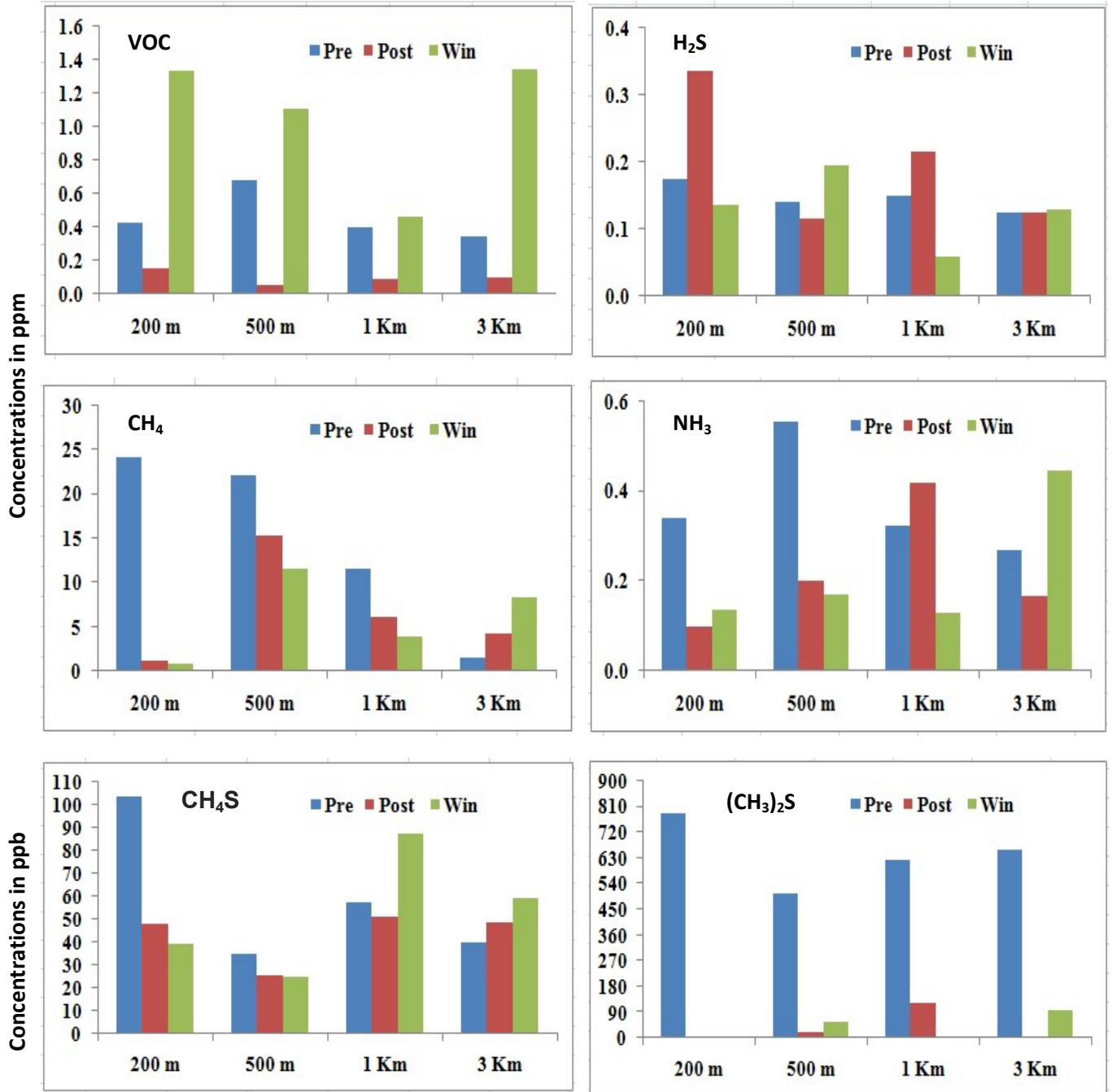| Name of the Parameter	VOC (ppm)		H$_2$S (ppm)		CH$_4$ (ppm)		NH$_3$ (ppm)	
Range/Average	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
Pre Monsoon	0.06 - 1.27	0.46	0.01 - 0.24	0.14	0.05 - 24.15	11.90	0.06 - 0.88	0.33
Post Monsoon	0.05 - 0.17	0.10	0.02 - 0.65	0.19	0.12 - 27.1	6.07	0.11 - 0.74	0.27
Winter	0.27 - 1.68	1.05	0.02 - 0.31	0.12	0.39 - 19.84	6.39	0.09 - 1.14	0.28

Deonar Dumping Ground
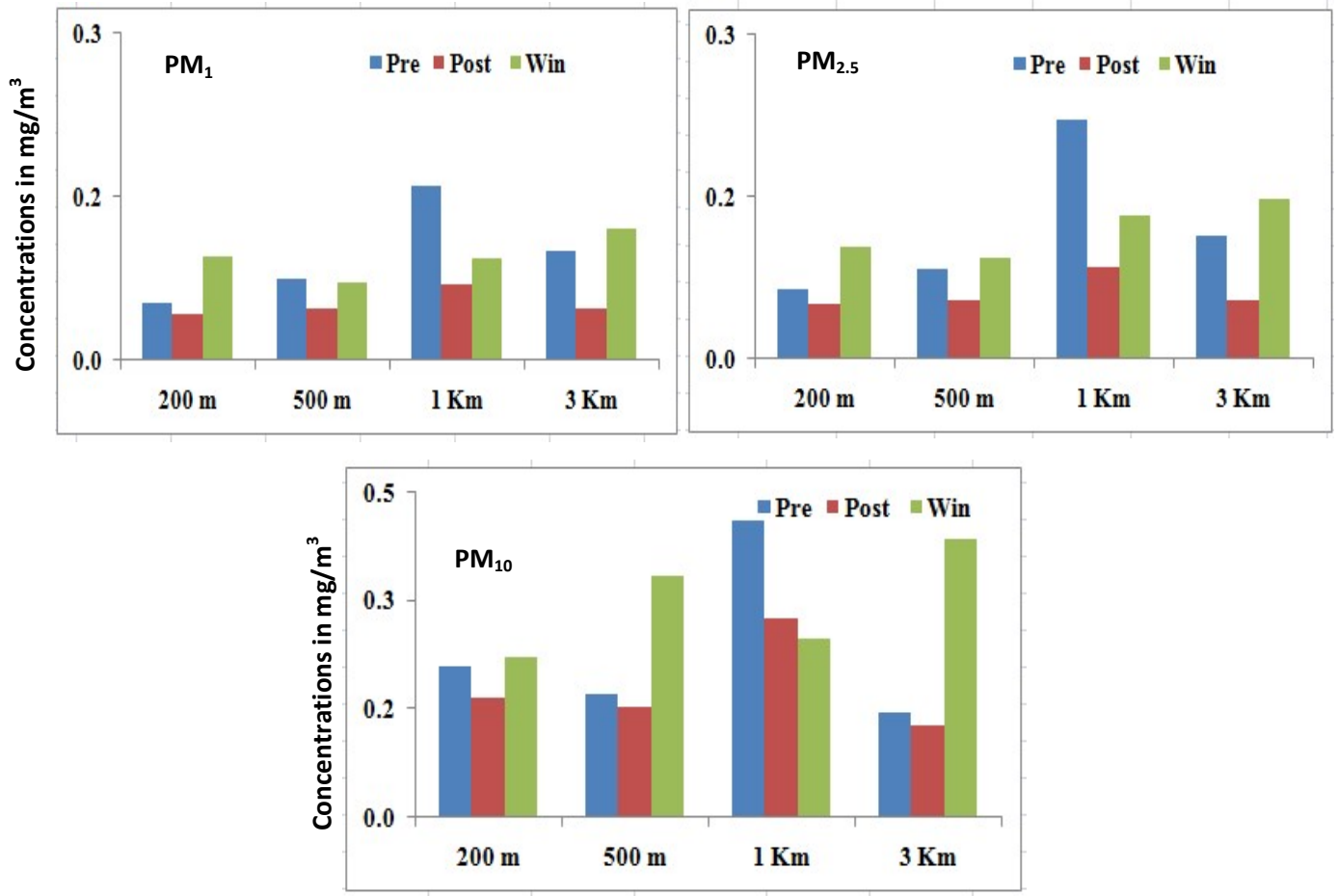

Figure 3.1: Three Seasons concentrations

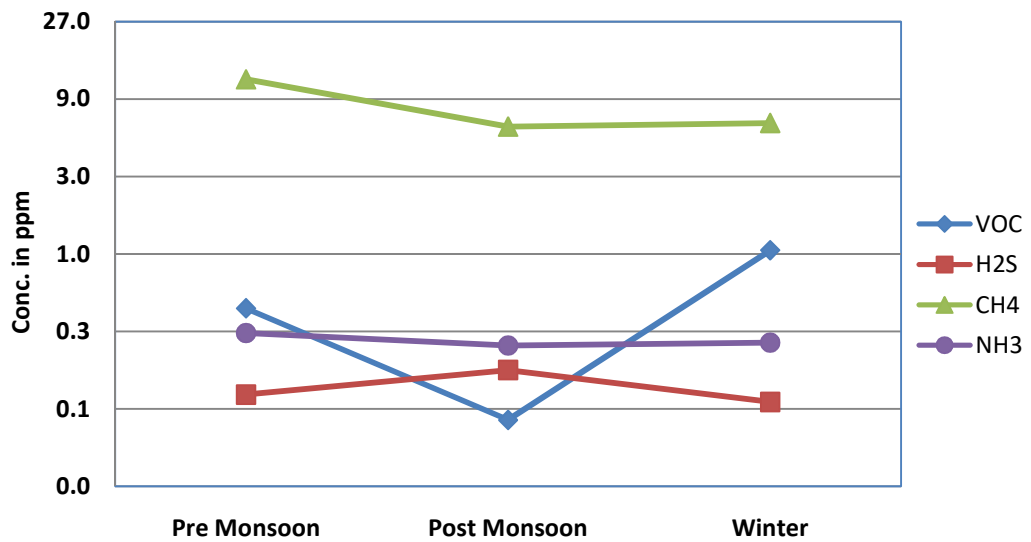Figure 3.1 (Contd..) : Three season concentrations

Figure 3.2: Three season average concentrations

3.1.1 Observations for three Seasons

All around the Deonar area, the exceeding concentrations of all gases are found in South-West and North -West directions, which shall carry health impacts on thickly populated residents in that area. The most impacted area is found to be Deonar dumping site.

The VOC concentration for Pre-Monsoon varies from 0.4 ppm to 0.7 ppm which falls to 0.1 ppm to 0.2 ppm at all distances in Post Monsoon and again shows the rise in the Winter at all distances between 0.4 ppm to 1.4 ppm.

In case of H_2S, the Post Monsoon concentrations are dominating over the Pre-Monsoon and Winter Season. The H_2S concentration is seen as high as 0.35 ppm at 200 mtr, which substantially falls up to 0.1 ppm at 3 Km. the H_2S gas seems to be uniform beyond 200 mtr in all season's right upto 3 Km and shows stable concentration of about 0.13 ppm.

As far as CH_4 gas is concerned, it drastically and uniformly reduces from 24 ppm at 200 mtr to 2 ppm at 3 Km in Pre-Monsoon and shows some abrupt rise to 15 ppm at 500 mtr in Post-Monsoon and falls gradually to 4 ppm at 3 Km, whereas in winter season, it ranges from 8 ppm to 10 ppm.

NH_3 concentration is showing larger concentration from 0.25 ppm to 0.6 ppm in Pre-Monsoon which is as per expectation and falls in Post-Monsoon between 0.1 ppm to 0.4 ppm due to diffusion in high moisture contents, whereas in Winter it is found to be diffused and drifted away from 0.1 ppm at 200 mtr and goes on increasing to about 0.4 ppm at 3 km.

The Marcaptan (CH_4S) concentration ranges from 100 ppb to 40 ppb and uniformly decreases from 200 mtr to 3 Km in Pre-Monsoon, whereas in Post Monsoon level it remains almost constant of about 50 ppb, whereas in Winter the concentration ranges from 30 ppb to 80 ppb.

The Dimethyl Sulphide, $(CH_3)_2S$ gas concentration is incidentally noticeable at 200 mtr in Pre-Monsoon season. From about 700 to 800 ppb between distance 200 mtr to 3 Km. This gas falls to very negligible concentration in Post Monsoon and Winter season probably due to diffusion in water vapour and hence falls drastically in Post Monsoon season.

PM_1, $PM_{2.5}$ and PM_{10} are incidentally showing very uniform pattern and concentration for PM_1 and $PM_{2.5}$ again show a uniform pattern of distribution from 200 mtr to 3 Km oppose to slight inagreemeent values. The Pre-Monsoon level as expected are higher and show value of about 0.3

mg/cum, whereas PM_{10} contrations is quite high for all seasons ranging from 0.2 mg/cum to 0.5 mg/cum and high of 0.5 mg/cum at a distance of 1 Km in Pre-Monsoon time. $PM_{2.5}$ concentrrations are over 10 to 20 times higher in Pre and Post monsson season whereas for PM_{10} concerntration are far about 10 to 20 times higher to permissible level in all seasons except falling to almost half level in a Winter season.

Therfore, the site can pose considereble hazardous effects of above measured gases to the residents. SPM and DMS in perticular are showing much higher concentration than pemisible limit, therefore it can cause chronic diseases as mentiond in *Chapter 4 Section 4.3*.
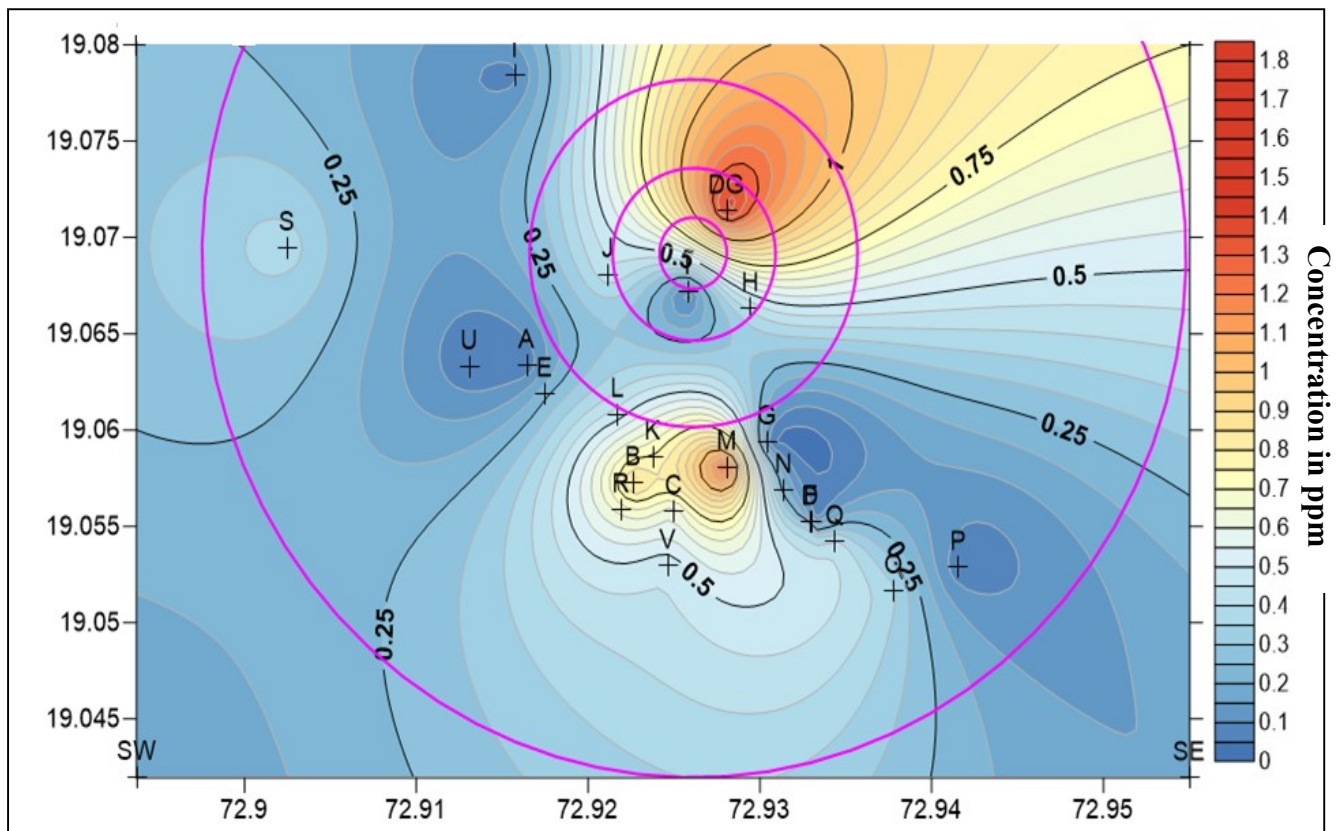
3.1.2 Expression of Measurements and Diffusion through Contour Maps - Deonar

The above measurements are also shown by drawing contour map for each gas with respect to the diffusion of the gas and to know the impact of emission of every hazardous entities of gases. To know wide spread impact up to 3 Km from lower to higher concentration. Sure, in some season the outreach of impact can spread even beyond 3 Km. The distances shown in the contour in red colour are from the periphery point of the boundary of the dumping ground as centre of the circles and gases concentration were measured at 200m, 500m, 1km and 3km.

We chose to represent spread on each gas across the area through contour maps. They are represnted in **Figures 3.3 through 3.9**. The contour map can help to show the impact of meterological parameters for the gases and due to in situ dynamics based upon their chemical and physical propeties. The diffusion and spread of each gas can not be ascertained as it cannot hold uniformity across dumping area. However, it gives an overall idea for the directions in which could be having maximum impact. Earmarking the measurement spots wherin some of them are the schools, colonies, official establishements or complete township,shall help to identify the population with expected health impacts. The health survey for the residential population for impacts of each of these hazarodous gas may reveal the data of health impairement or chronic problems.

The contour maps as shown in figures for each parameter and seasons are inconformity with the trends of measurements at Deonar site. The colour codes indicate the concentration as specified in the figures. The impact of wind obviously seen through merges of colour resembling the fall or rise in concentration. The contours of the graphical assessment and closely signify the concentration of every parameter at <u>any given place within</u> the range of measurement. Some abruption can be seen in every map of either increased or abrupt decrease of concentration at places or otherwise steady

decrease of concentration as one goes away from the site the aberration seen to be change due to wind direction and meteorological parameters.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.3 a: Contour Map of VOC Concentrations during Pre Monsoon Season (Site Deonar)

VOC observed at Bhadra Hospital which isat a distance of 500 mtrs. from the boundary of dumping site is 1.27 ppm. Fire Brigade, Atlanta ground and Shree Swami Samartha Building showed 0.22 ppm, 0.61 ppm and 0.88 ppm concentrations respectively. These locations are within the range of 500 mtrs. to 1 km from dumping ground. There is one industrial unit in this Govandi area. It is observed that the dumping is still being continued in the extended part of dumping ground in line with Fire Brigade Station. Moreover the Biomedical incineration plant is situated close by these are the contributory sources of VOC showing this peak.
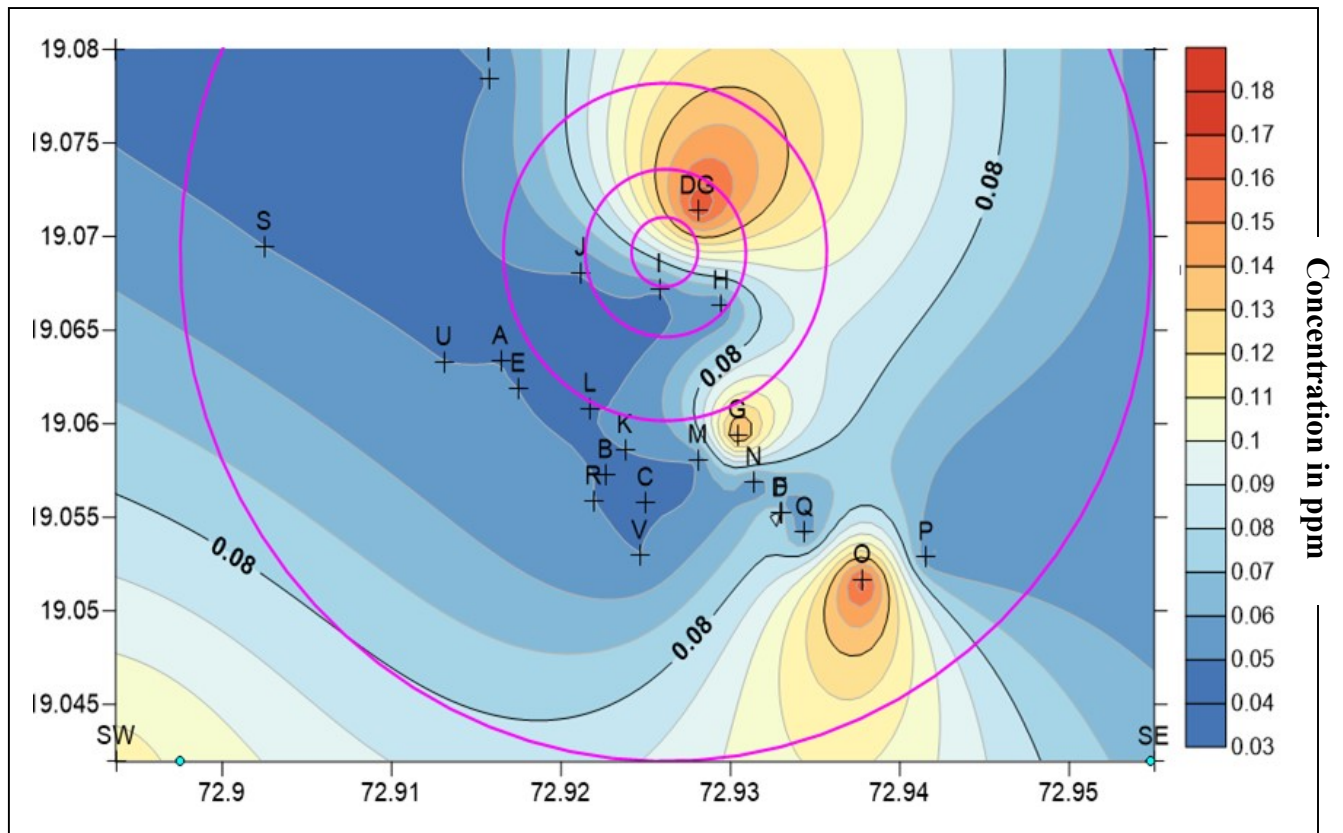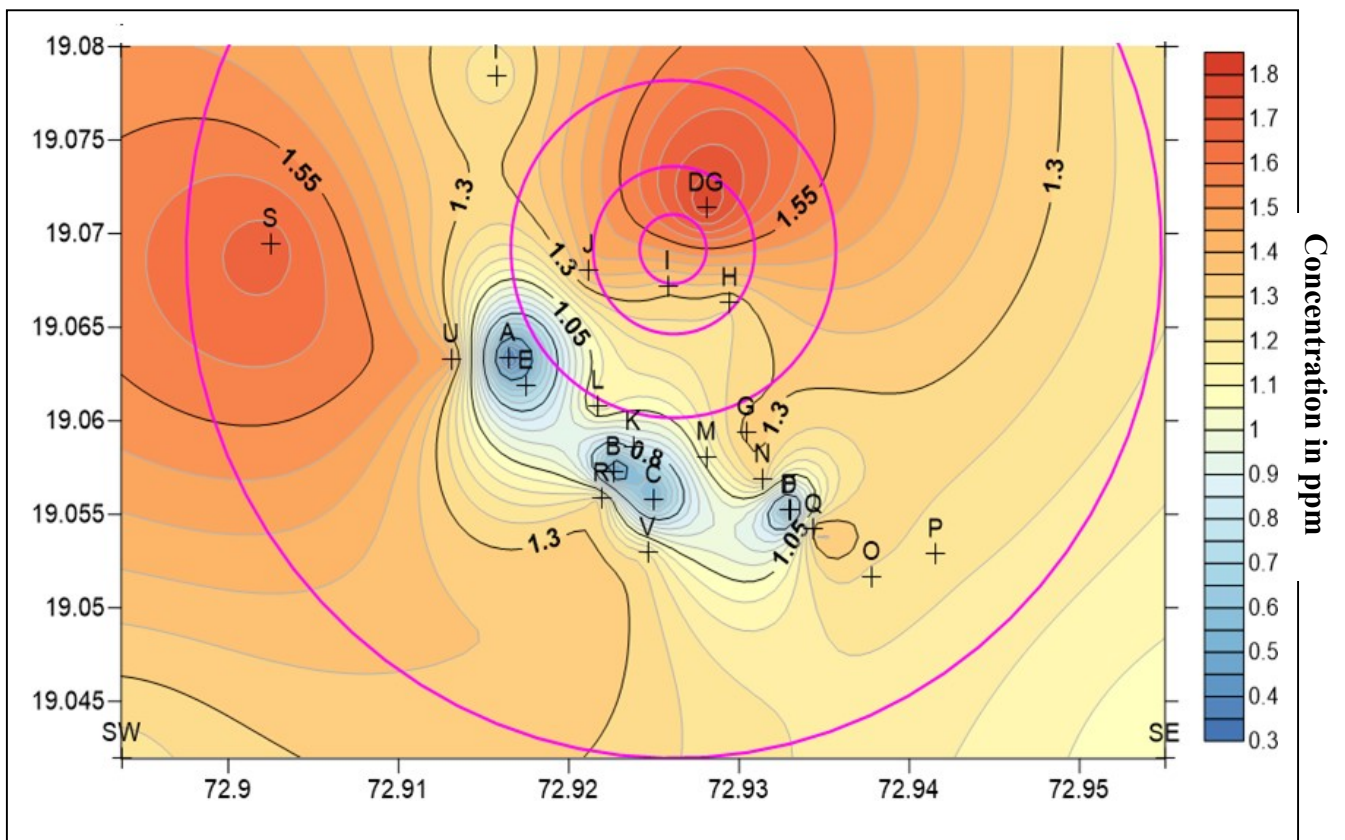
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.3b: Contour Map of VOC Concentrations during Post Monsoon Season (Site Deonar)

The 2nd small peak seen here can be attributed to same reason as stated in 3.3a as the location is same. The 3rd peak with maximum concentration of 0.17 ppm can be attributed to large quantity of sewage generated in this area which stagnates in marshy land around in addition to large solid waste generated which is not falling under daily collection drive. In addition this location is close to Mumbai- Pune highway and also subjected to traversing Mankhurd - Ghatkopar road resulting into generation of significant amount of VOC due to vehicular traffic.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.3c: Contour Map of VOC Concentrations during Winter Season
(Site Deonar)

The second peak with concentration of about 1.68 ppm in this case may be attributed to three reasons. 1. The area is surrounded by several waste water nallahs. 2. There is sewage treatment plant across Thane highway 2nd this area faces location in line with wind direction in line of dumping ground as the wind direction at the measurement was North-South.
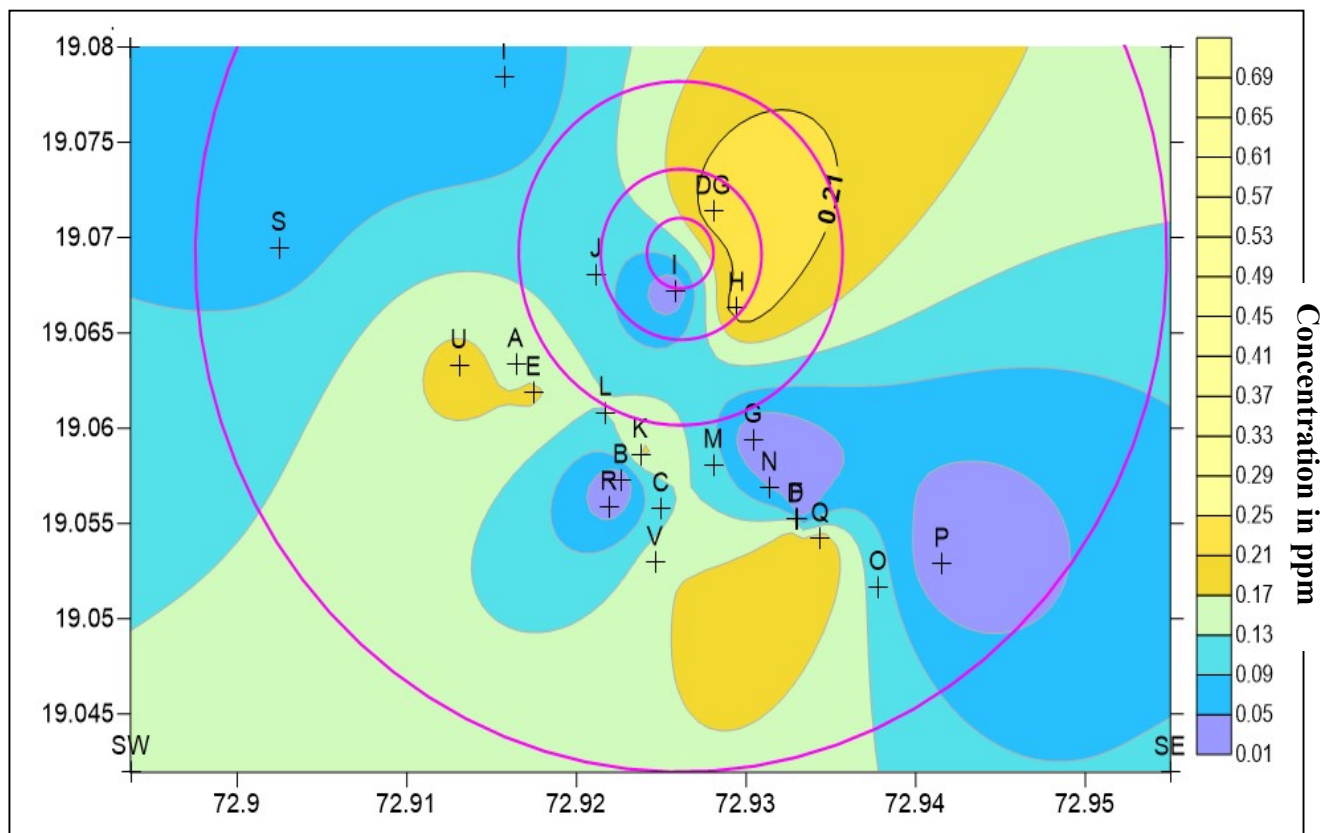
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.4 a: Contour Map of H$_2$S Concentrations during Pre Monsoon Season (Site Deonar)

The second small peak with about 0.21 ppm H$_2$S concentration may be attributed to source of H$_2$S from adjoining nallah carrying significant quantity of sewage. Whereas 3rd peak with about same concentration can be attributed to huge marshy land with thick mangrove forest across the road, which is good source of H$_2$S generation.
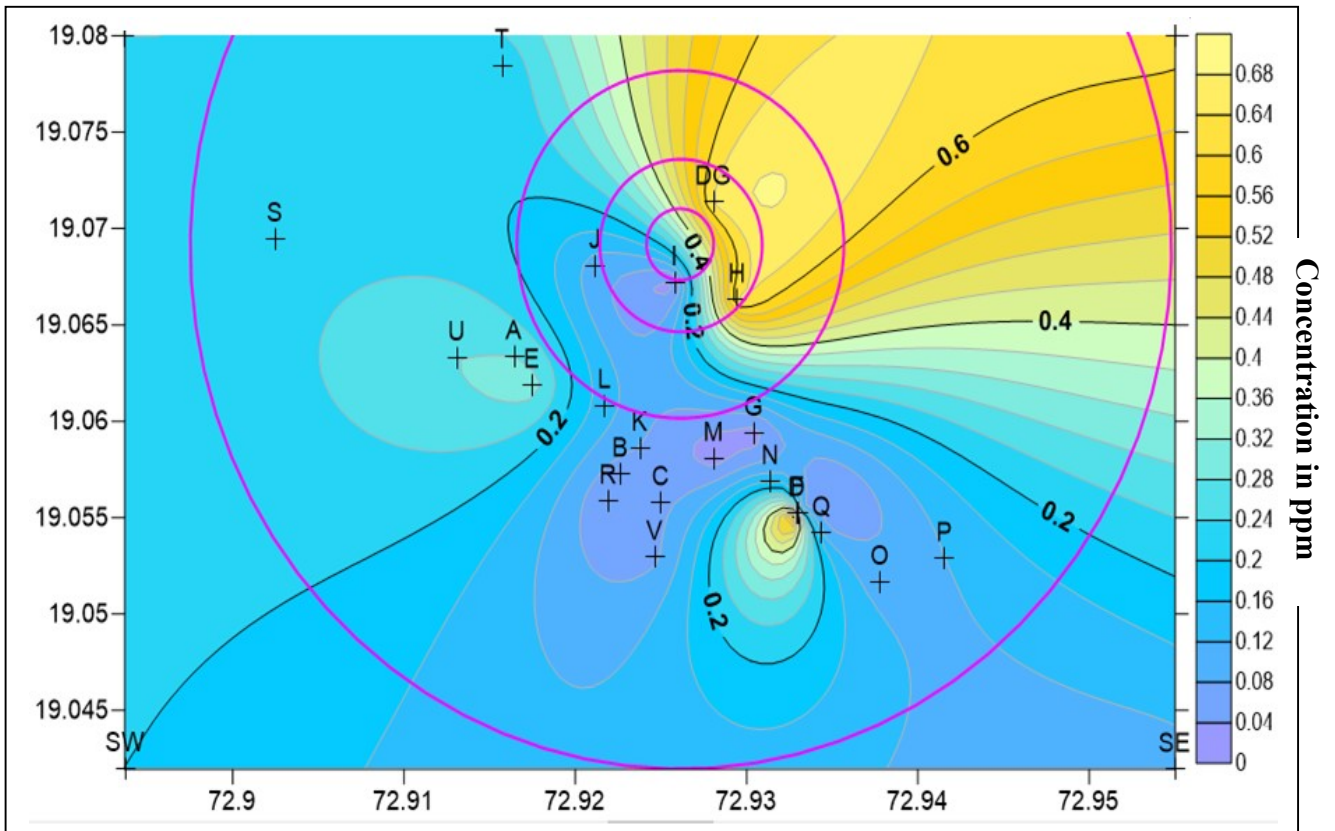
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.4 b: Contour Map of H$_2$S Concentrations during Post Monsoon Season (Site Deonar)

The second peak with about 0.6 ppm H$_2$S concentration can be attributed to same reasons as stated in 3.4 a.
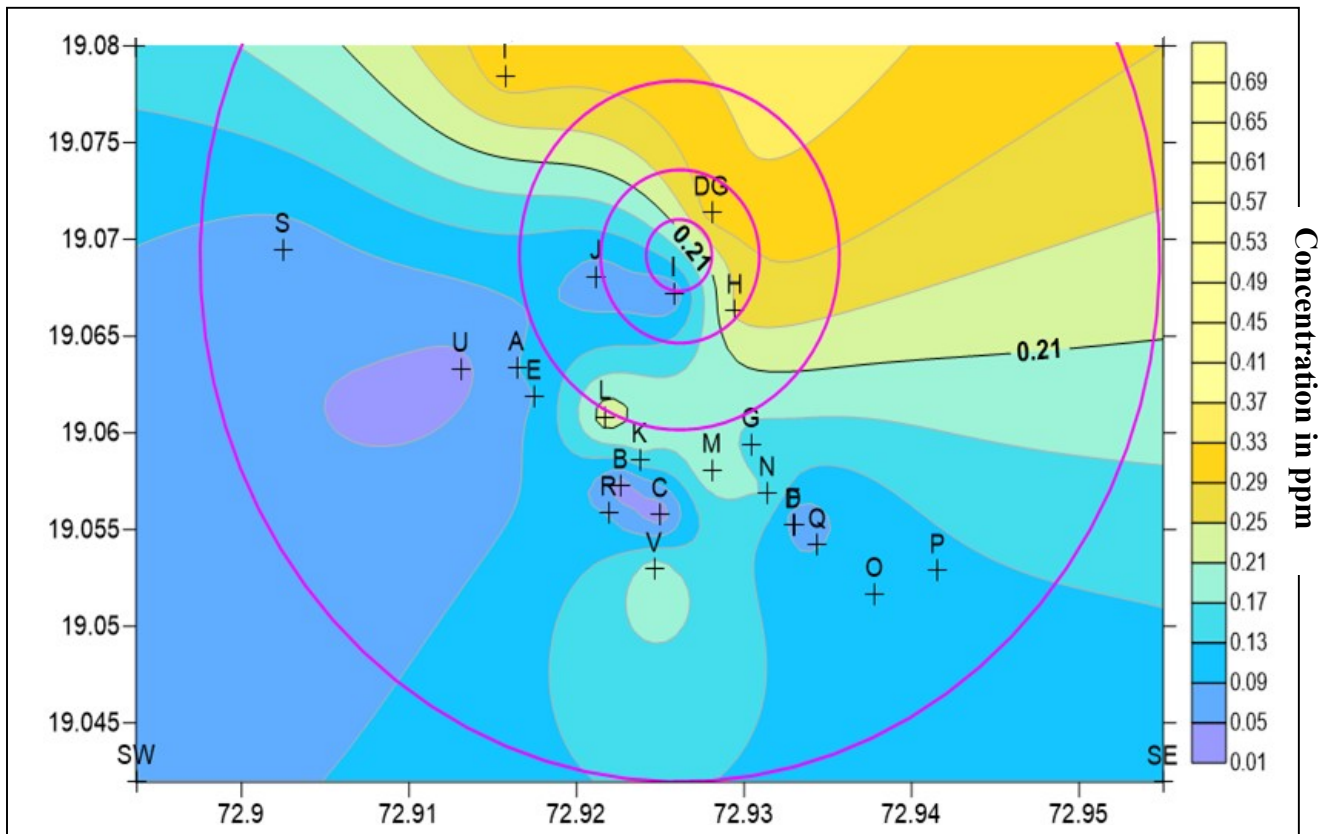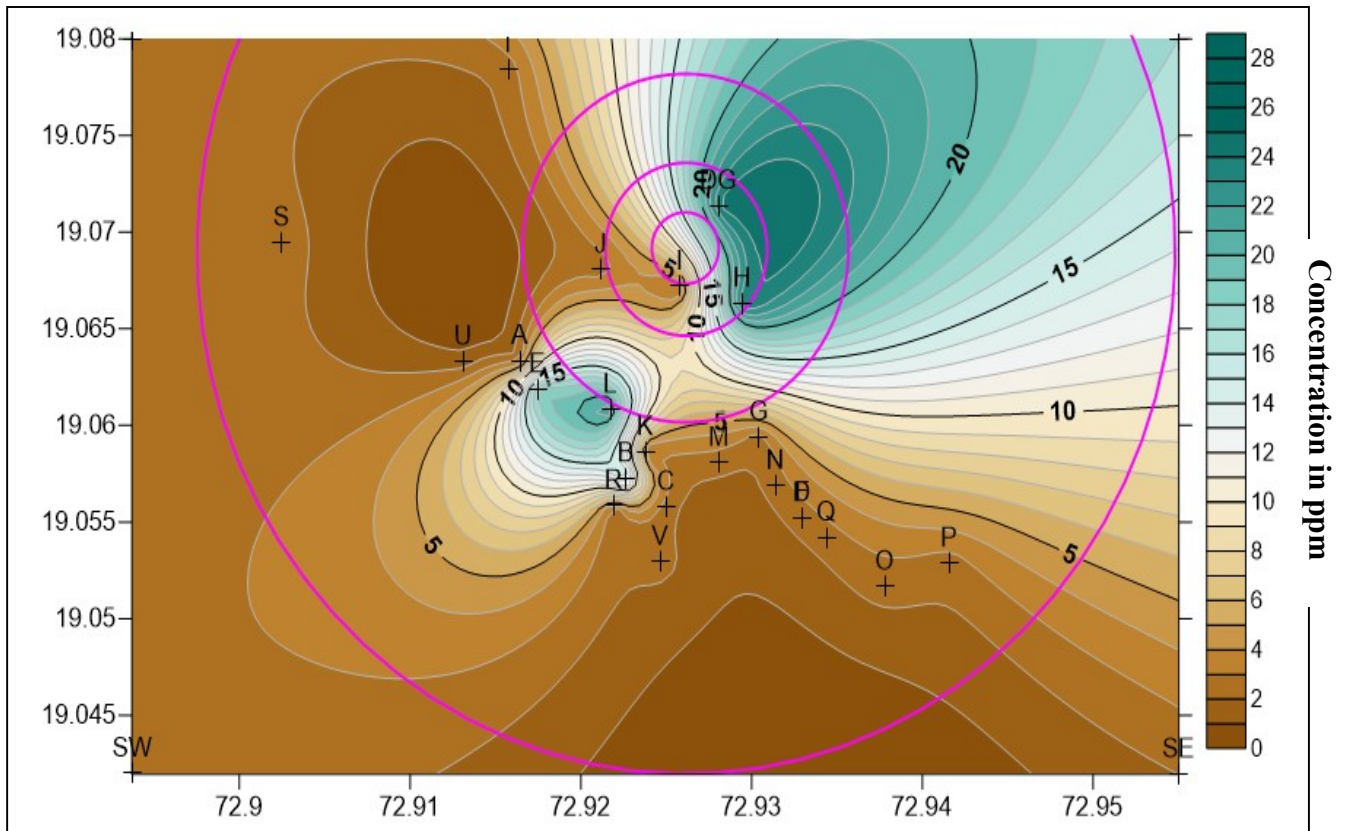
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.4 c: Contour Map of H₂S Concentrations during Winter Season
(Site Deonar)

Shivaji Nagar bus depot at 200 mtr. and Ambedkar Ground & Bhadra Hospital at 500 mtr. Showed 0.26, 0.24 and 0.21 ppm concentrations of H_2S respectively. The H_2S concentration in winter season observed at each location, but with the decreasing level as compared to Pre & Post Monsoon which may be due to temperature effect.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.5 a: Contour Map of CH$_4$ Concentrations during Pre Monsoon Season (Site Deonar)

The 2nd peak with about 20 ppm CH$_4$ concentration can be attributed to the stock of gas cylinder belonging to the Gas Agency. Moreover the location is facing Biomedical Incineration Plant of MCGM
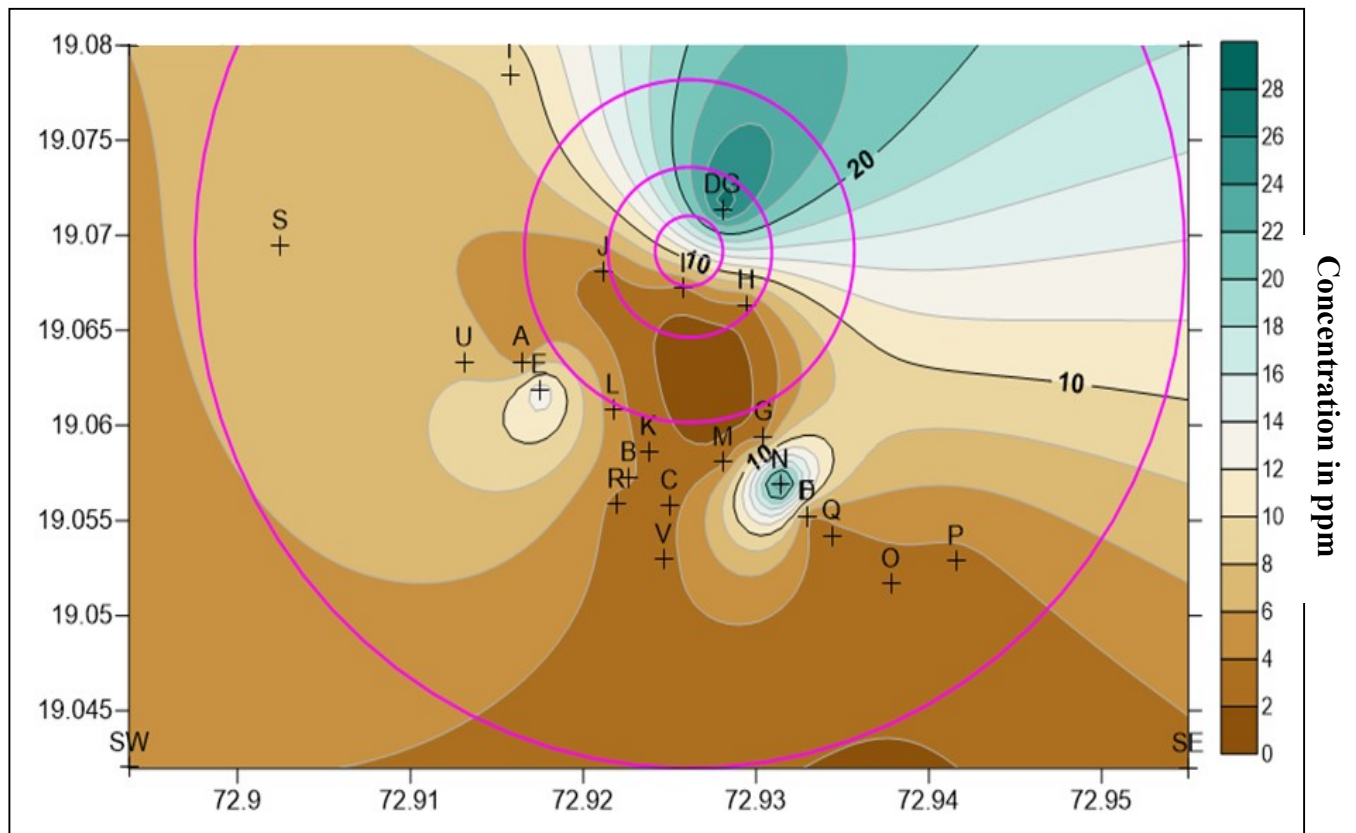
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.5 b: Contour Map of CH$_4$ Concentrations during Post Monsoon Season (Site Deonar)

The 2nd peak at this Fire Brigade station with about 26 ppm CH$_4$ concentration can be attributed to the generation from close by and across site of dumping as well as the proximity of Biomedical Incineration Plant and may be the stock of various gas cylinders at Fire Brigade Station.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

**Figure 3.5 c: Contour Map of CH$_4$ Concentrations during Winter Season
(Site Deonar)**

The small 2nd peak here with 16ppm CH$_4$ concentration can be attributed to same reasons as stated in 3.5b.
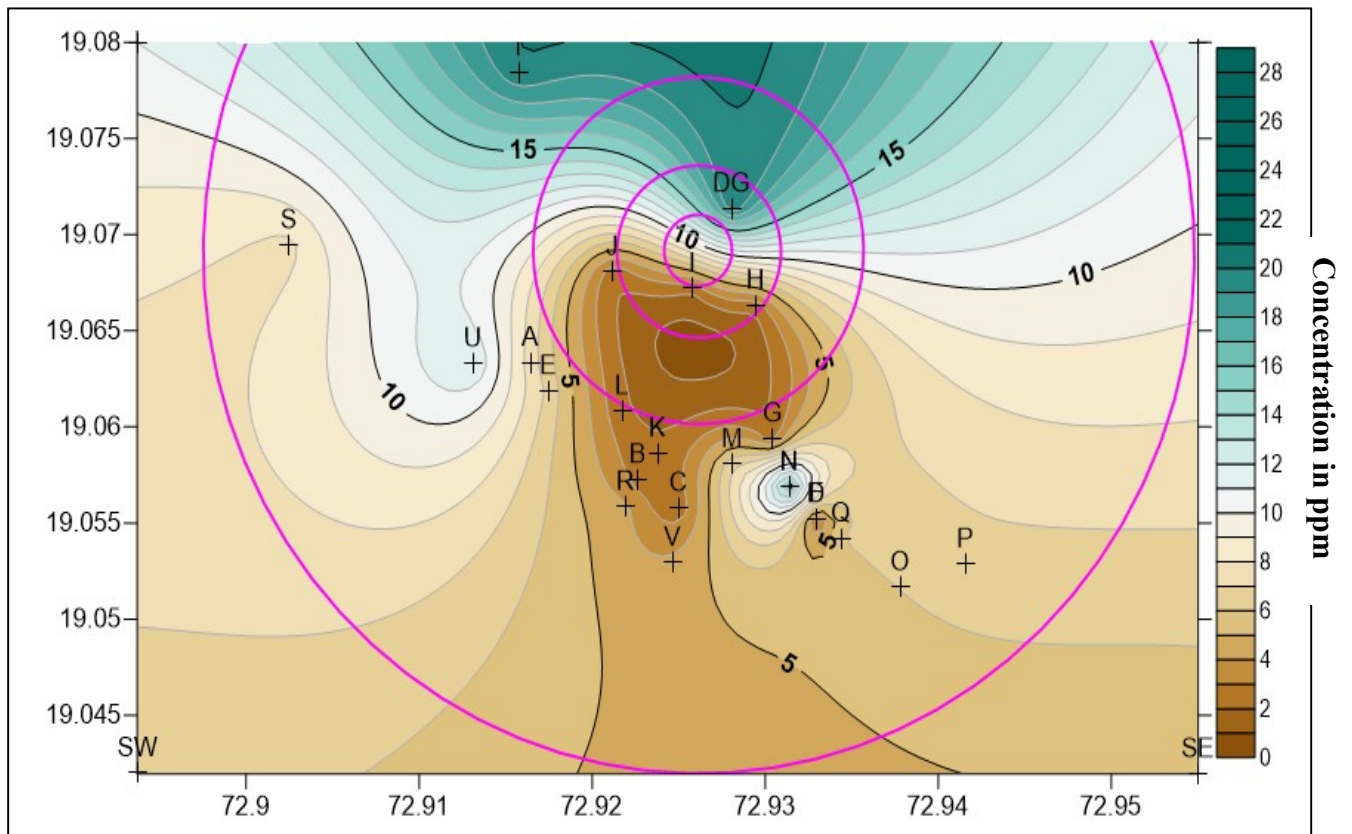
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.6a: Contour Map of NH$_3$ Concentrations during Pre Monsoon Season (Site Deonar)

The 2nd peak with 0.93 ppm NH$_3$ and 3rd peak with 0.67 ppm can be attributed to as they line up in direction of extended part of dumping ground.

Figure 3.6 b: Contour Map of NH₃ Concentrations during Post Monsoon Season
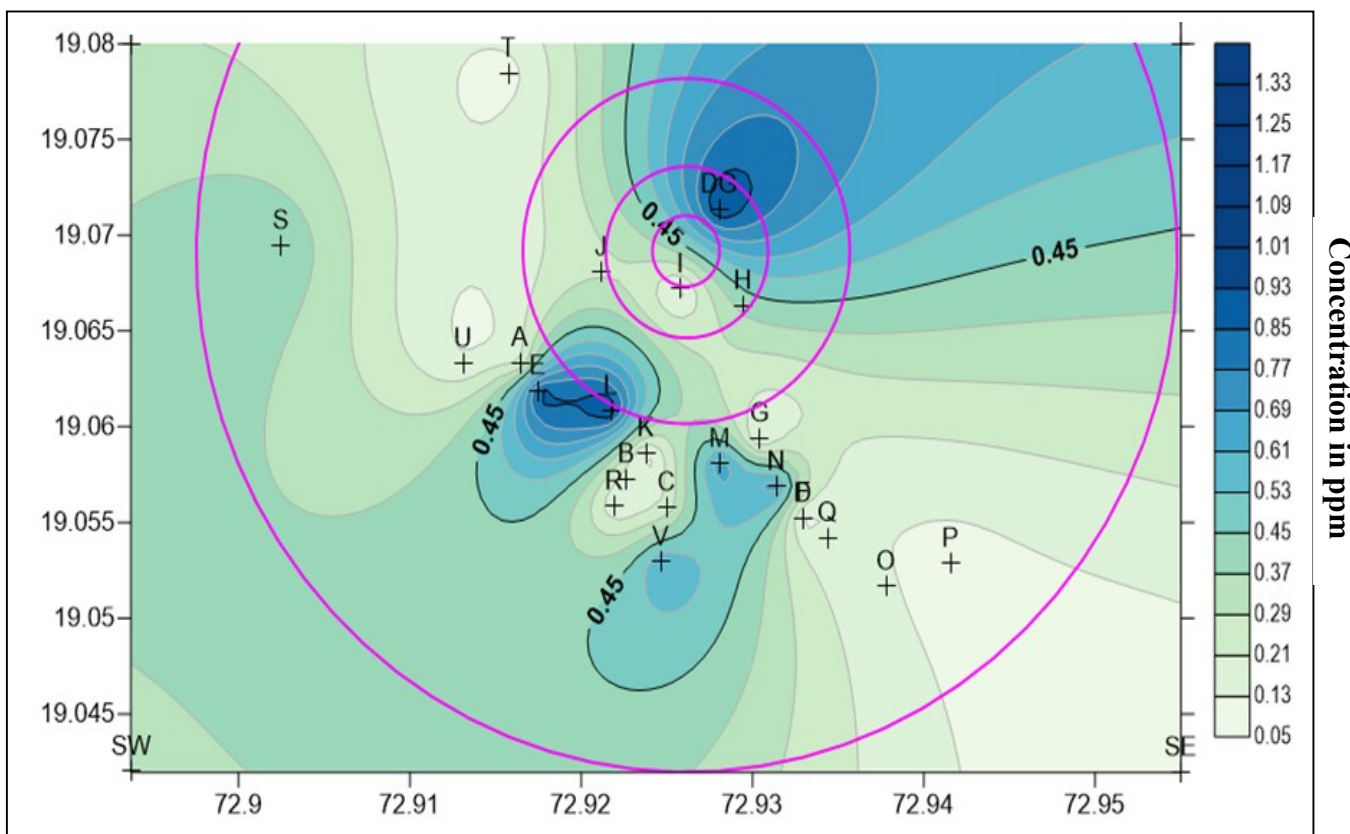**(Site Deonar)**

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

The 2nd peak with 0.55 ppm concentration of NH₃ can be attributed to as this location is facing exact opposite direction of major dumping site and North–South direction brings the gases in this mainly affected region.
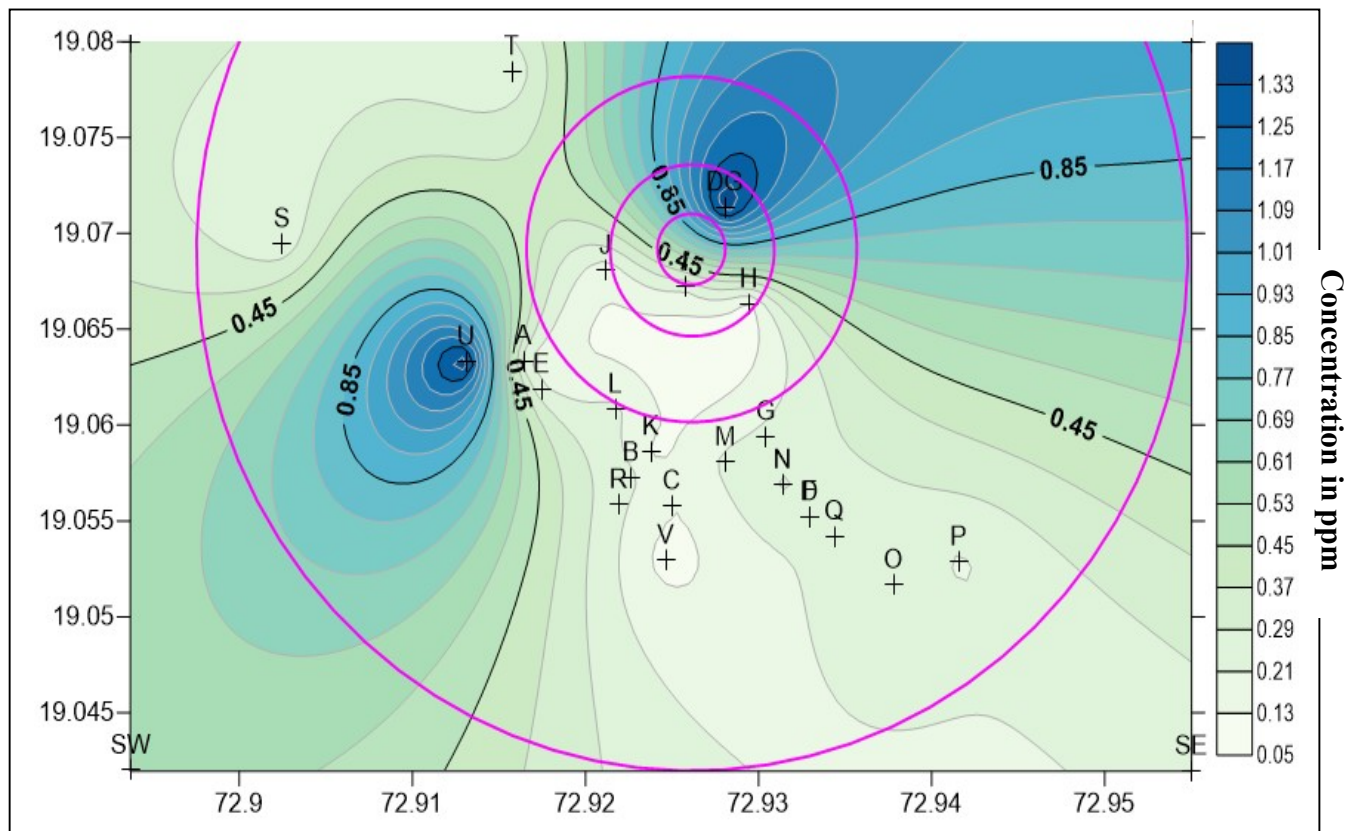
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.6 c: Contour Map of NH$_3$ Concentrations during Winter Season (SiteDeonar)
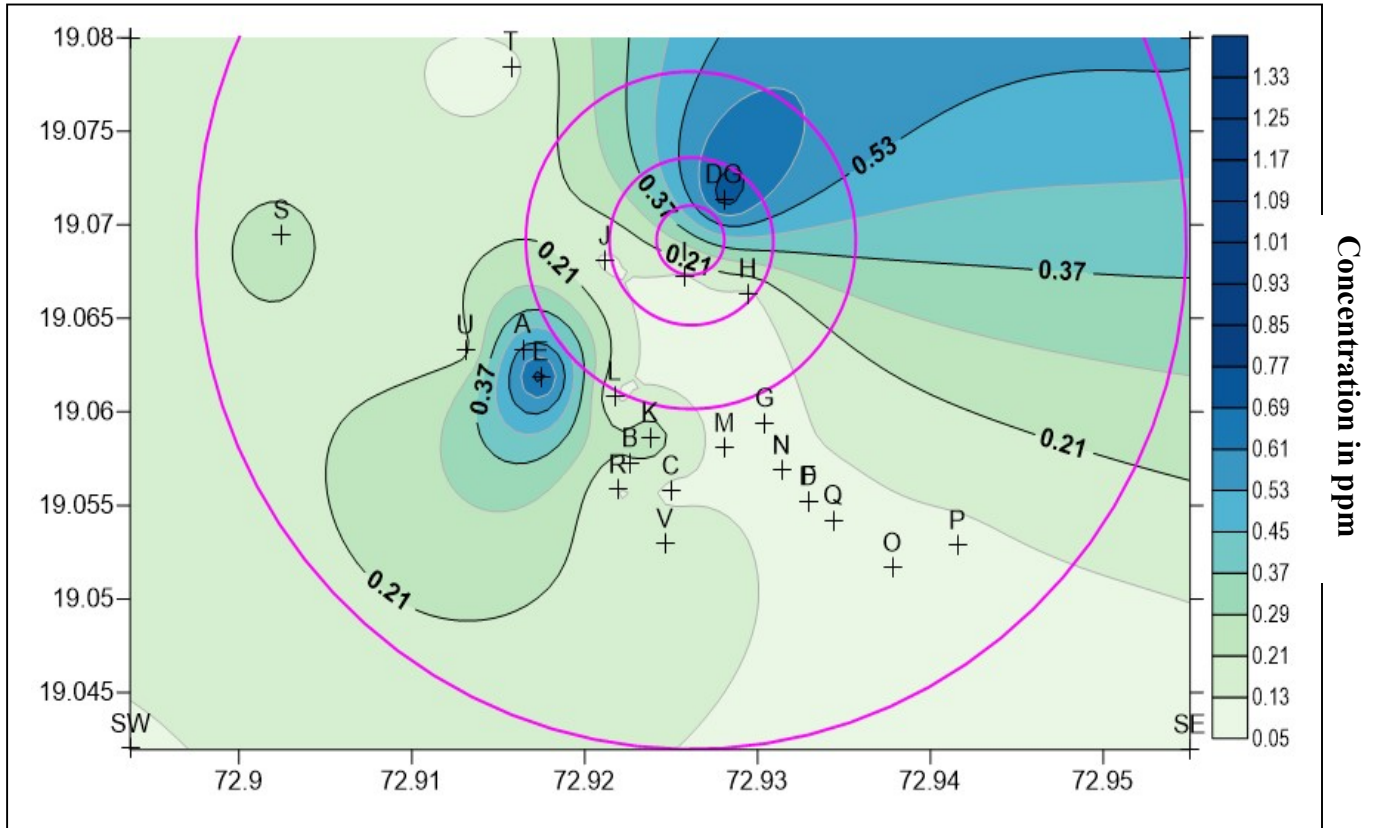
The 2nd peak observed at the Manoranjan Maidan at a distance of 3 km. with 1.4ppm concentration may be due to NH$_3$ emission from adjoining sewer nallah in addition to the location is vertically opposite to the main dumping site.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.7a: Contour Map of Mercaptan Concentrations during Pre Monsoon Season (Site Deonar)

The 2nd peak with the concentration of 88.62 ppb mercaptan at this location may be attributed to the same reasons as stated in 3.6 c

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.7b: Contour Map of Mercaptan Concentrations during Post Monsoon Season (Site Deonar)

The locations of Manoranjan maiden, Railway Sankalpa Society, Maharashtra Nagar, Red Brick tower, Shree Samartha Building, & Shivaji Nagar Police Station which are at a distance of 1 km. showed high concentrations of 79.38, 108.2, 104.86, 286.5, 35,62, 50.56 ppb respectively than other locations. Among these, Maharashtra Nagar, Railway Sankalpa colony and Manoranjan maidan showed higher concentrations which might be due to adjacent marshy land and nallah flowing through nearby area.
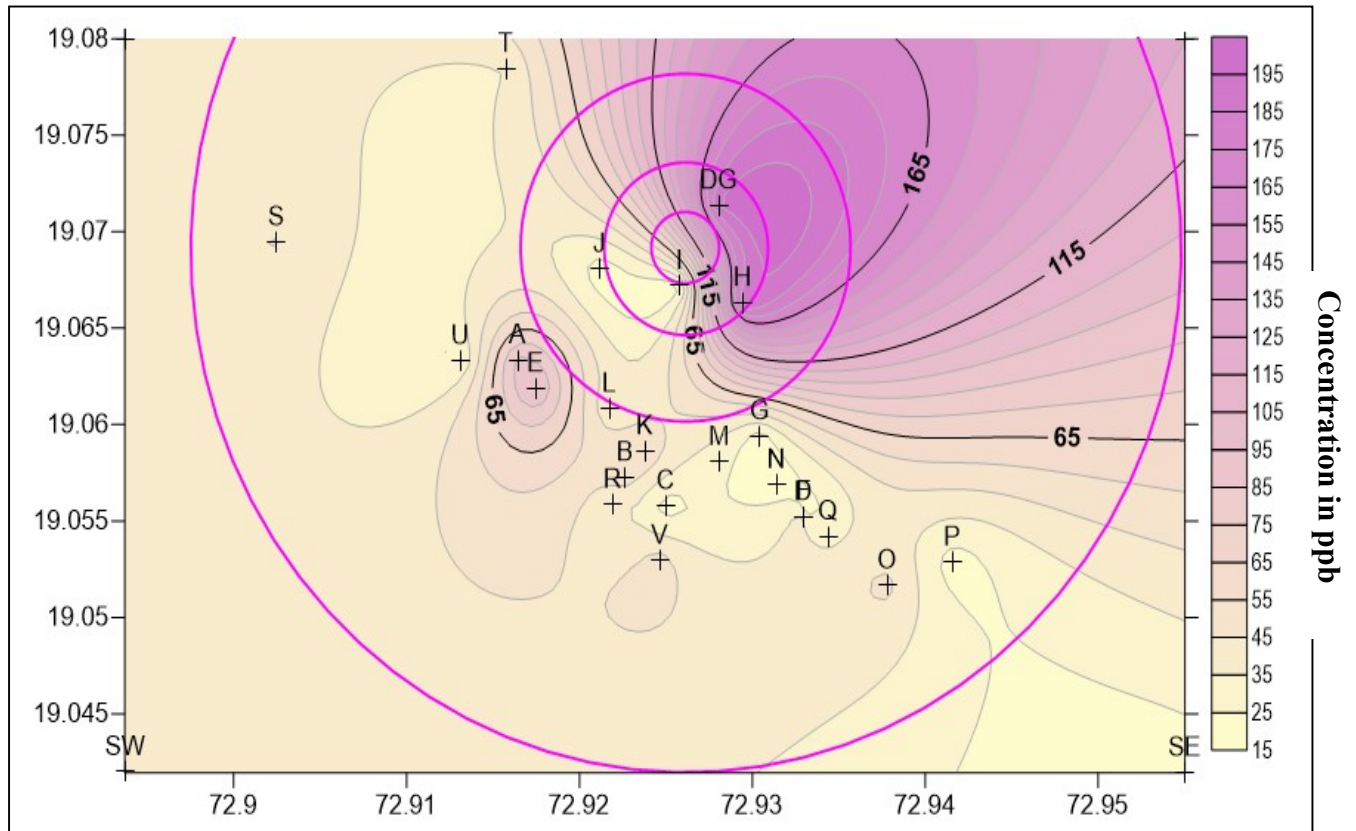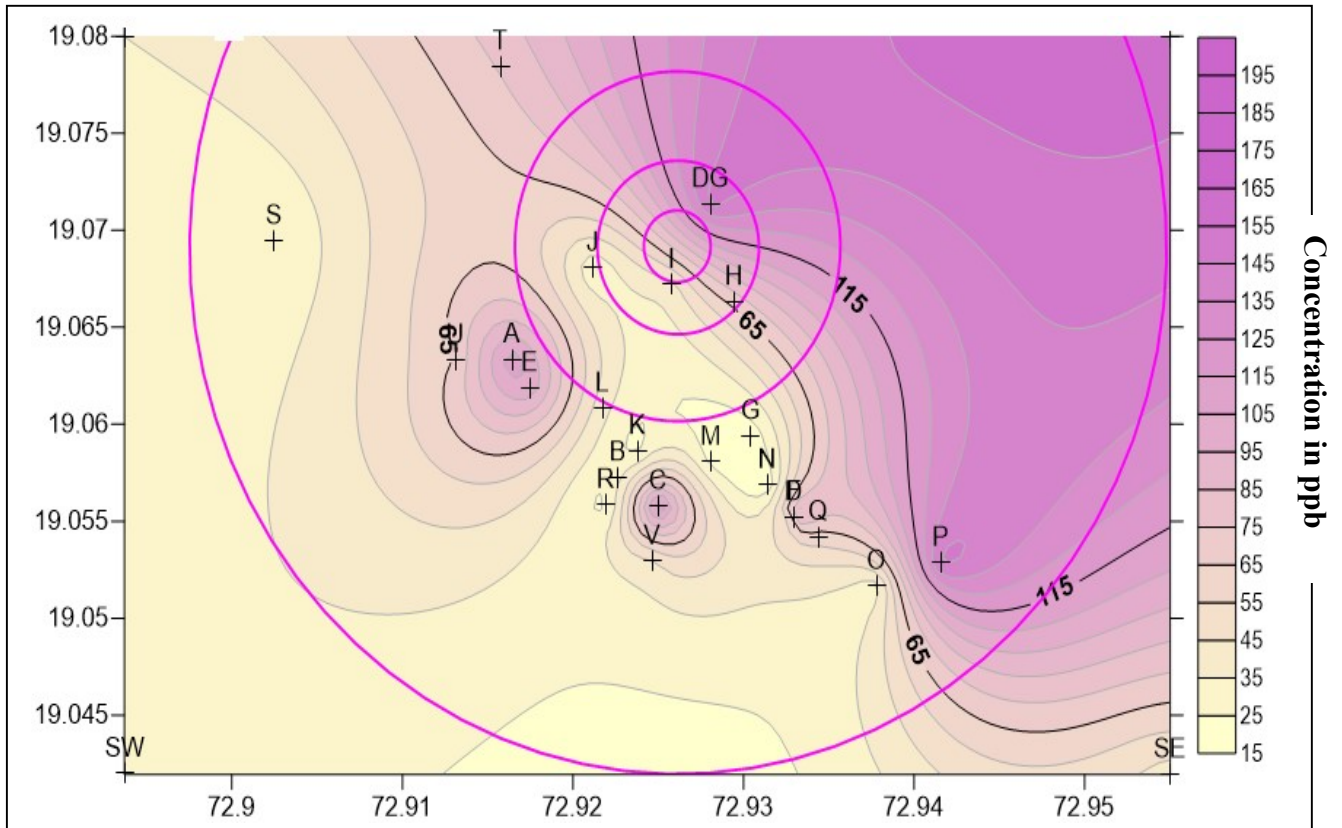
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.7c: Contour Map of Mercaptan Concentrations during Winter Season (Site Deonar)

This 2nd and 3rd peak with about 70 to 100 ppb and 116 ppb respectively may be attributed for the reasons as stated in 3.6 b. & 3.3 c. This might be due to Vashi creek.
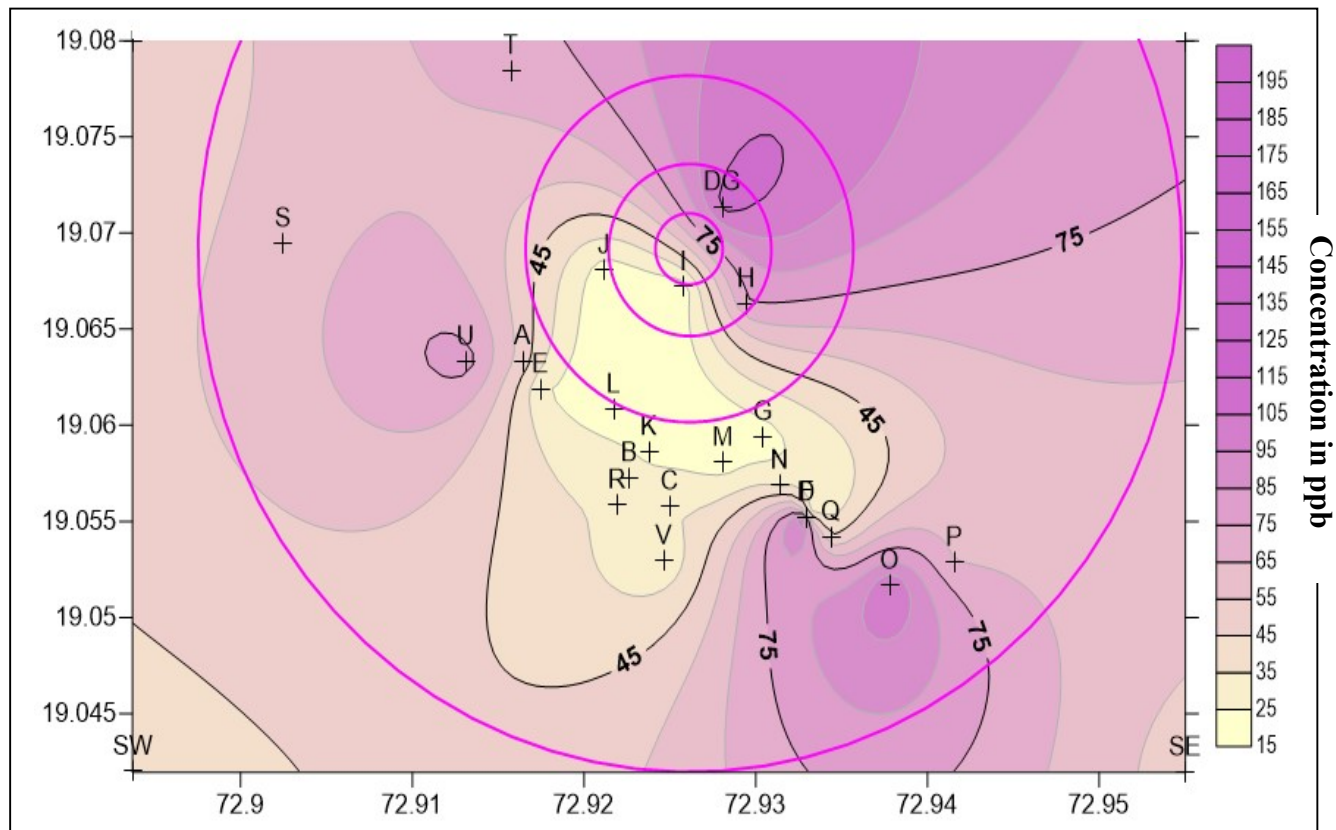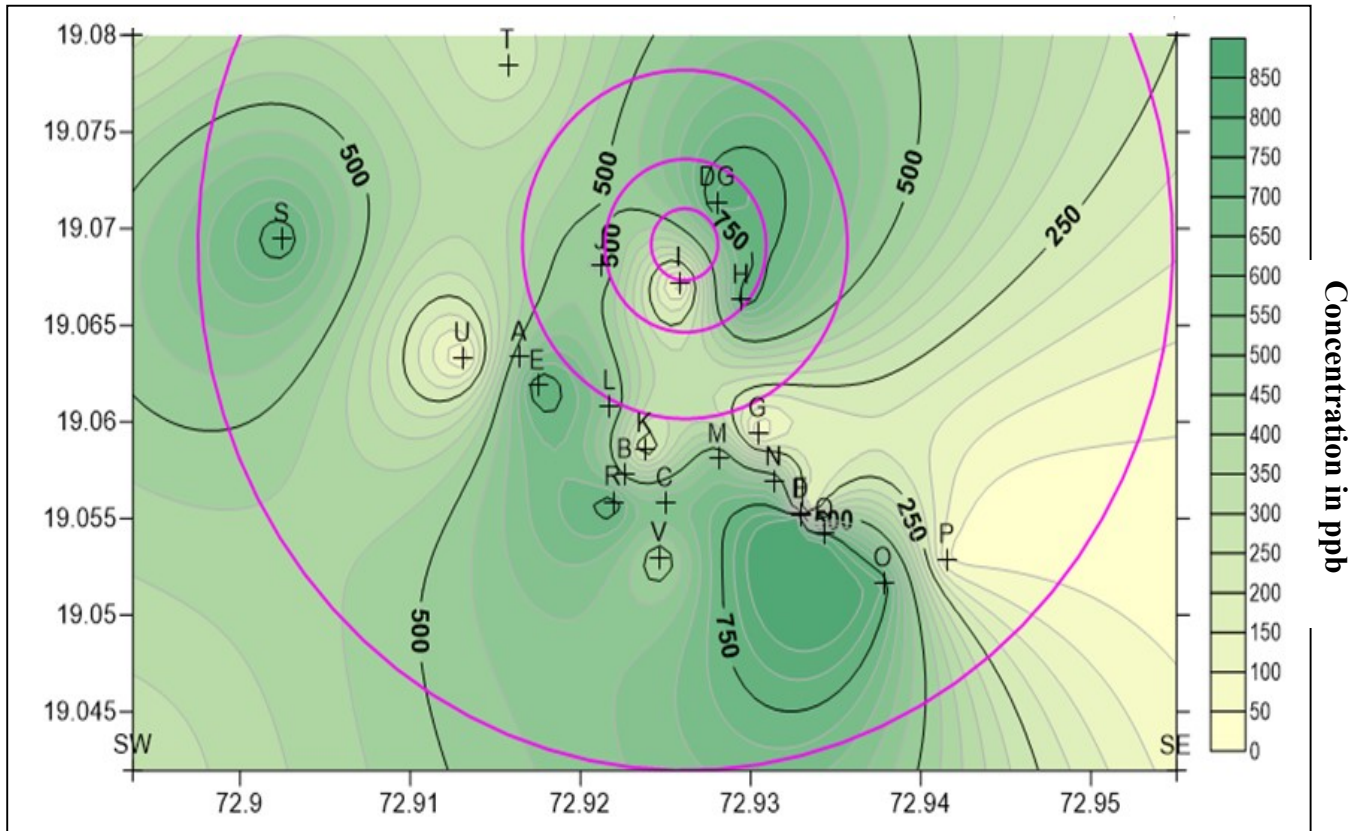
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

**Figure 3.8a: Contour Map of DMS Concentrations during Pre Monsoon Season**
(Site Deonar)

Shivaji Nagar bus depot located at 200 mtr. Distance showed 1000 ppb concentration. At a distance of 1 km. school building, Railway Sankalpa colony, Atlanta Ground, Red Brick tower, Shivaji Nagar Police station, showed 1000 ppb, 826.6 ppb, 656.6 ppb, 815.5 ppb, 574 ppb concentrations respectively. At a 3 km distance, Pestom Sagar, Deonar Municipal Colony, Maharashtra Nagar showed 900 to 1000 ppb concentrations. This might be due to the climatic effect.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

**Figure 3.8b: Contour Map of DMS Concentrations during Post Monsoon Season**
(Site Deonar)

DMS observed only at 500 mtr. and 1 km. At a distance 1 km. the Railway Sankalpa Colony and Mohite Patil School observed higher concentrations of 311.83 ppb and 142.63 ppb respectively which are due to nallah flowing in the nearby area.

A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.8c: Contour Map of DMS Concentrations during Winter Season
(Site Deonar)

At a distance of 3 km. the concentration observed higher at Ramabai Nagar, Manoranjan Maiden and Pestom Sagar locations of 281.52, 228.97 and 119.42 ppb respectively, which might be due to the nallah and Sewage treatment lagoon in the nearby area.
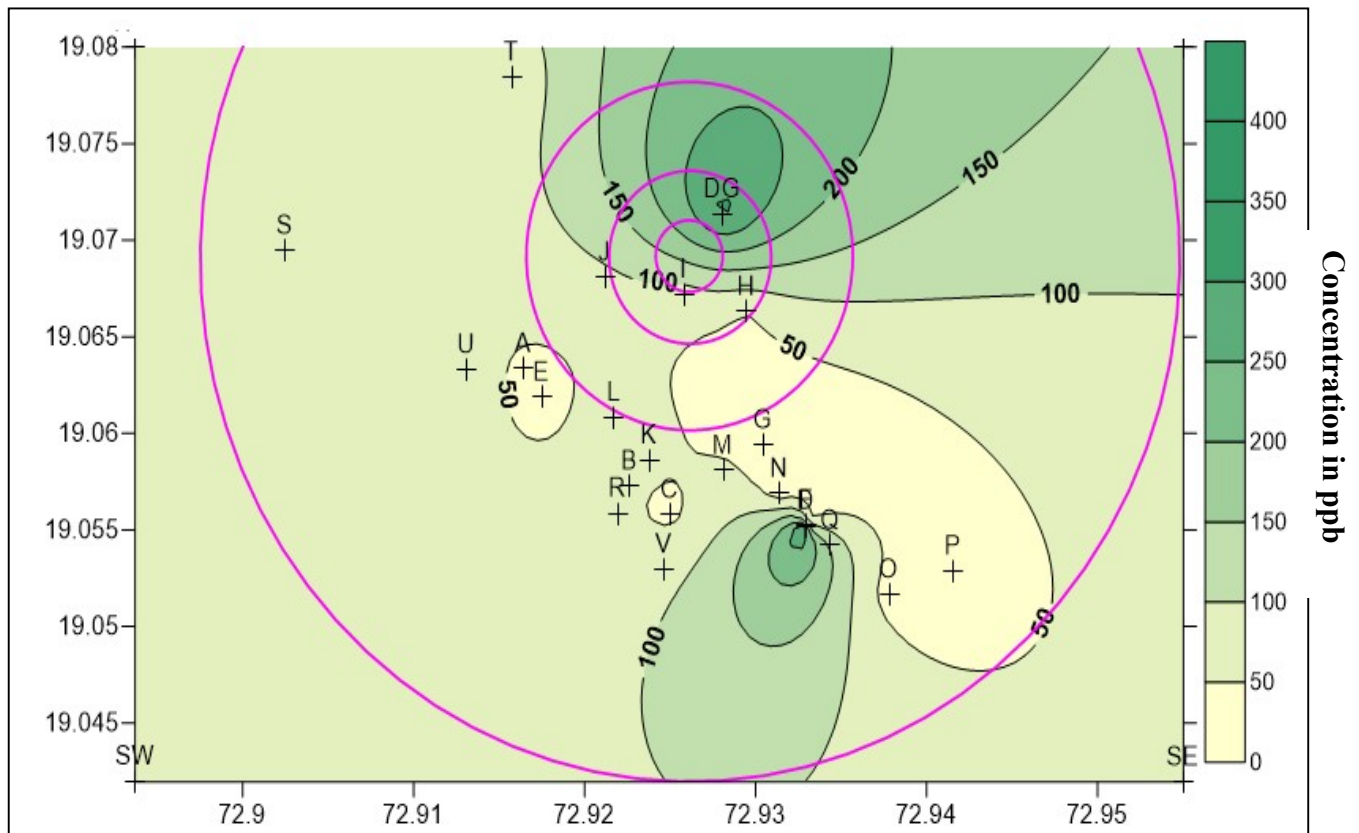
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.9a: Contour Map of PM Concentrations during Pre Monsoon Season (Site Deonar)

PM10 observed higher of 1.342 mg/cum and 0.878 mg/cum. at the locations Mohite Patil School Building & Atlanta Ground respectively. This might be due to continuous vehicular traffic in this area.
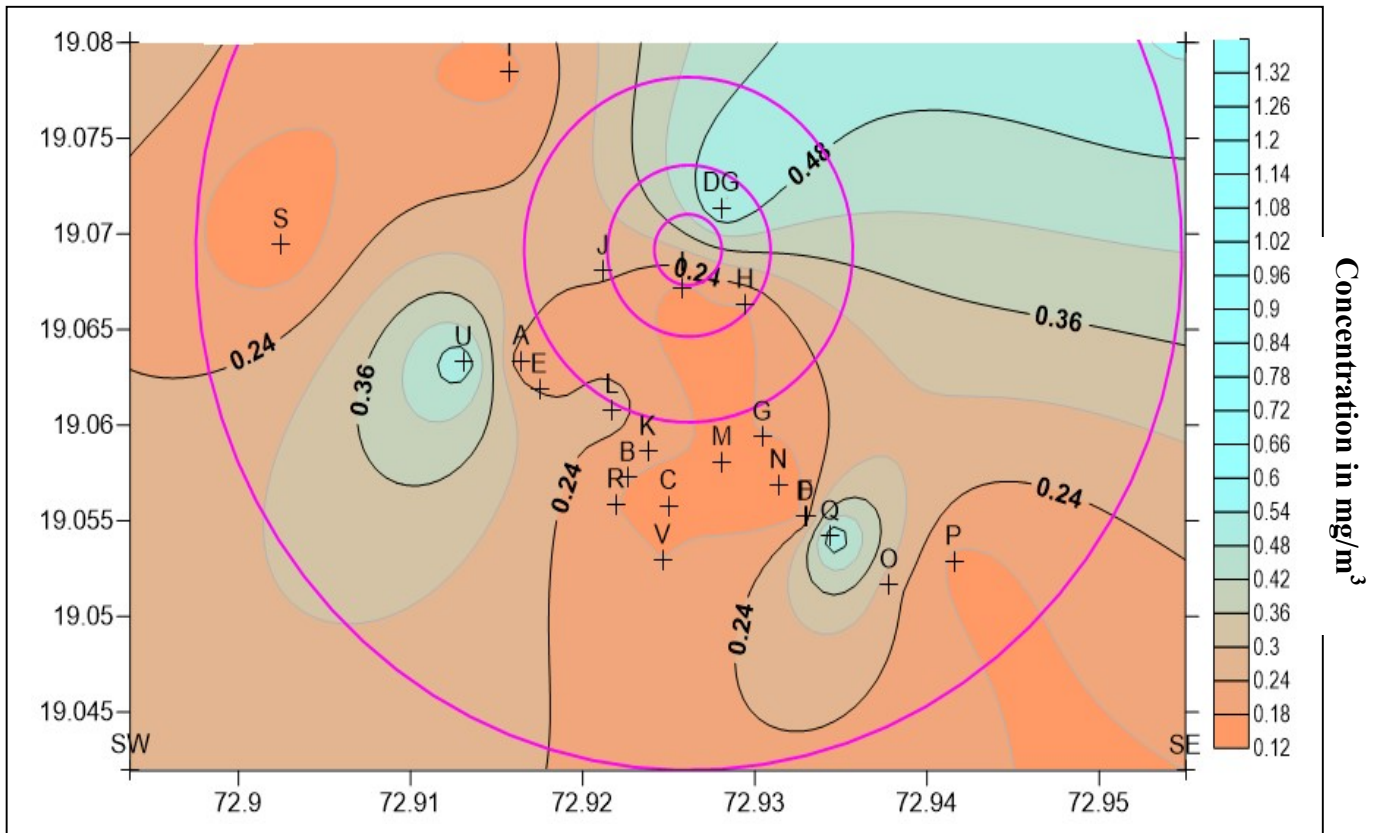
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Figure 3.9b: Contour Map of PM Concentrations during Post Monsoon Season (Site Deonar)

The concentration observed more at Manoranjan maidan and Mohite Patil Street which is at the distance of 3 km. MCGM building showed 0.169 mg/m^3 concentration and Shivaji Nagar Bus depot showed 0.164 mg/m3 concentration which is lying within 200 mtr. Distance area.
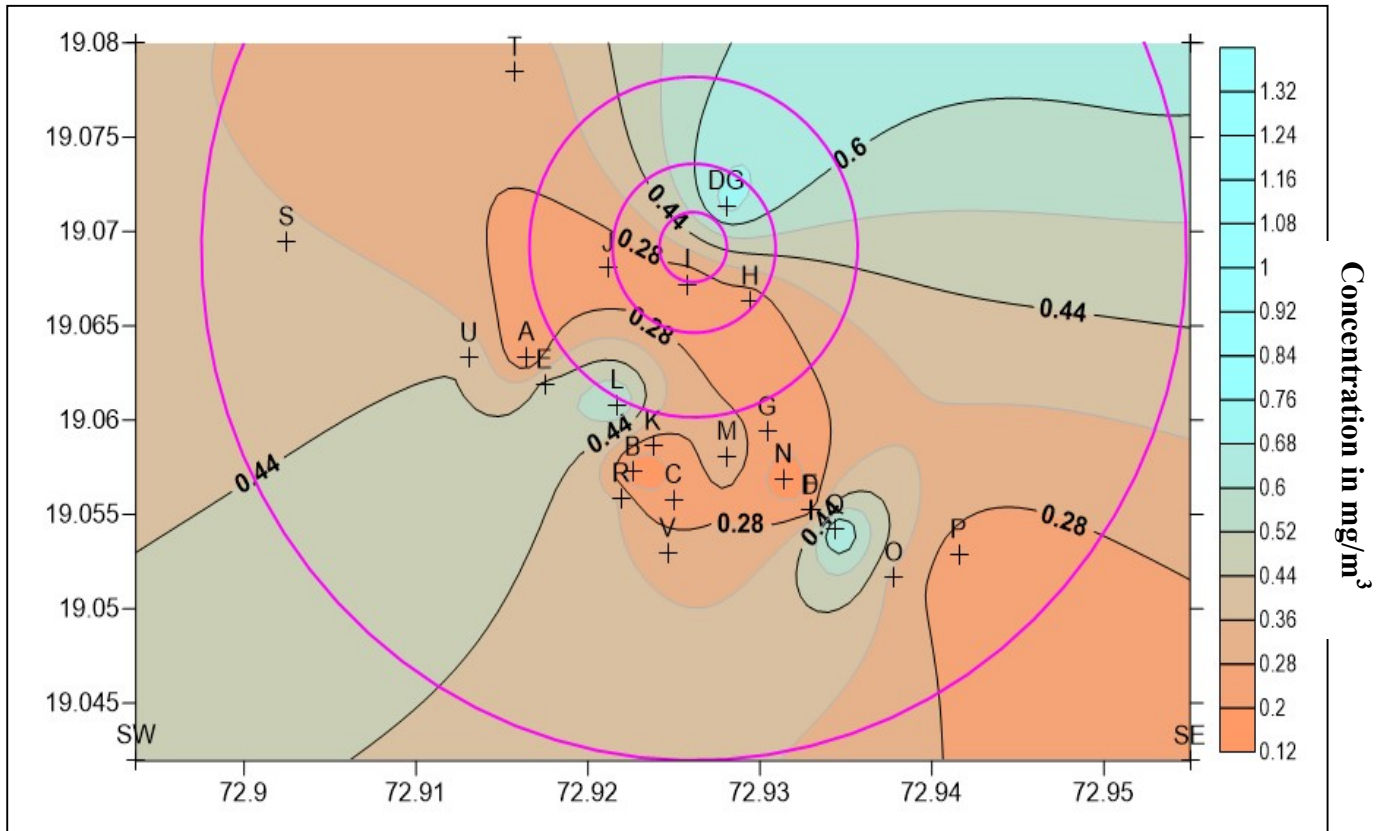
Figure 3.9c: Contour Map of PM Concentrations during Winter Season (Site Deonar)
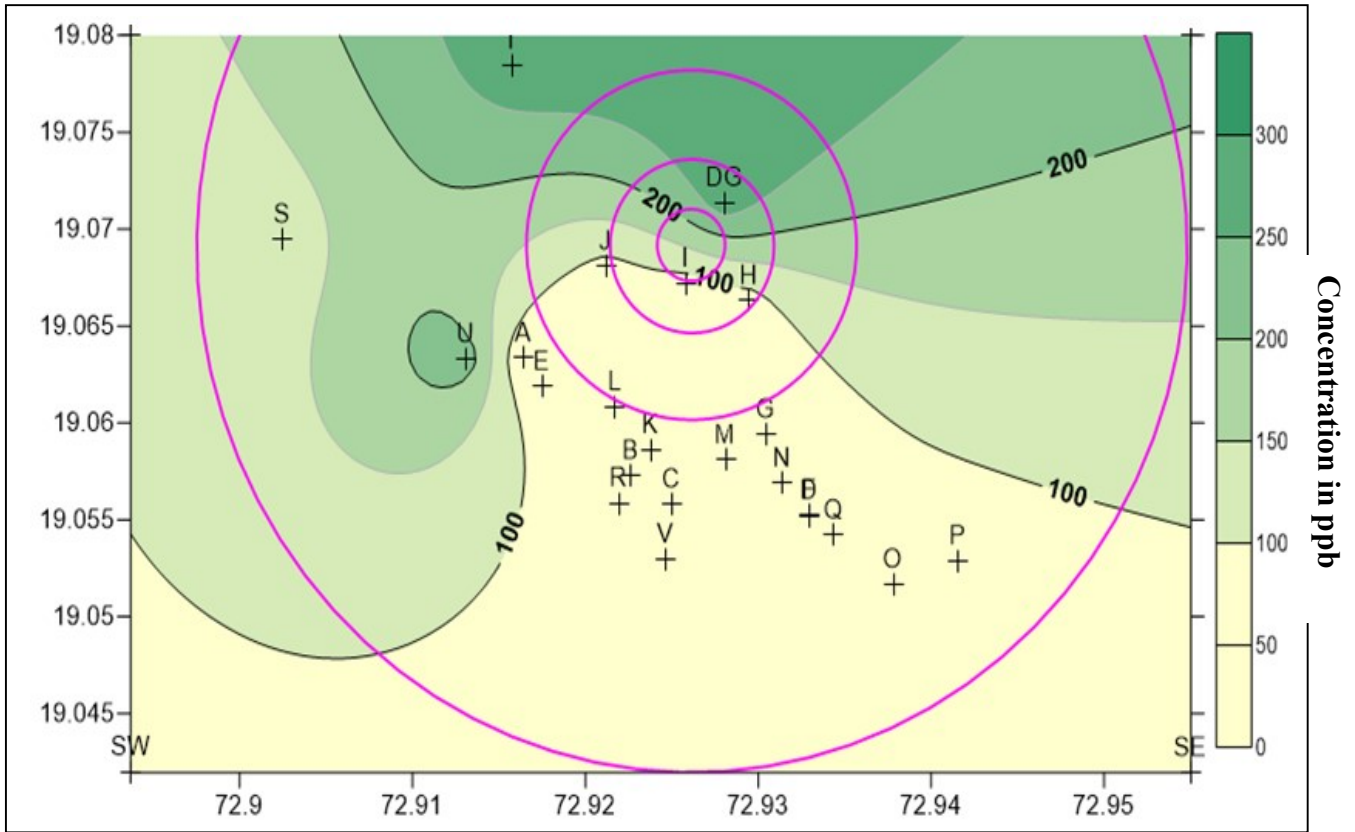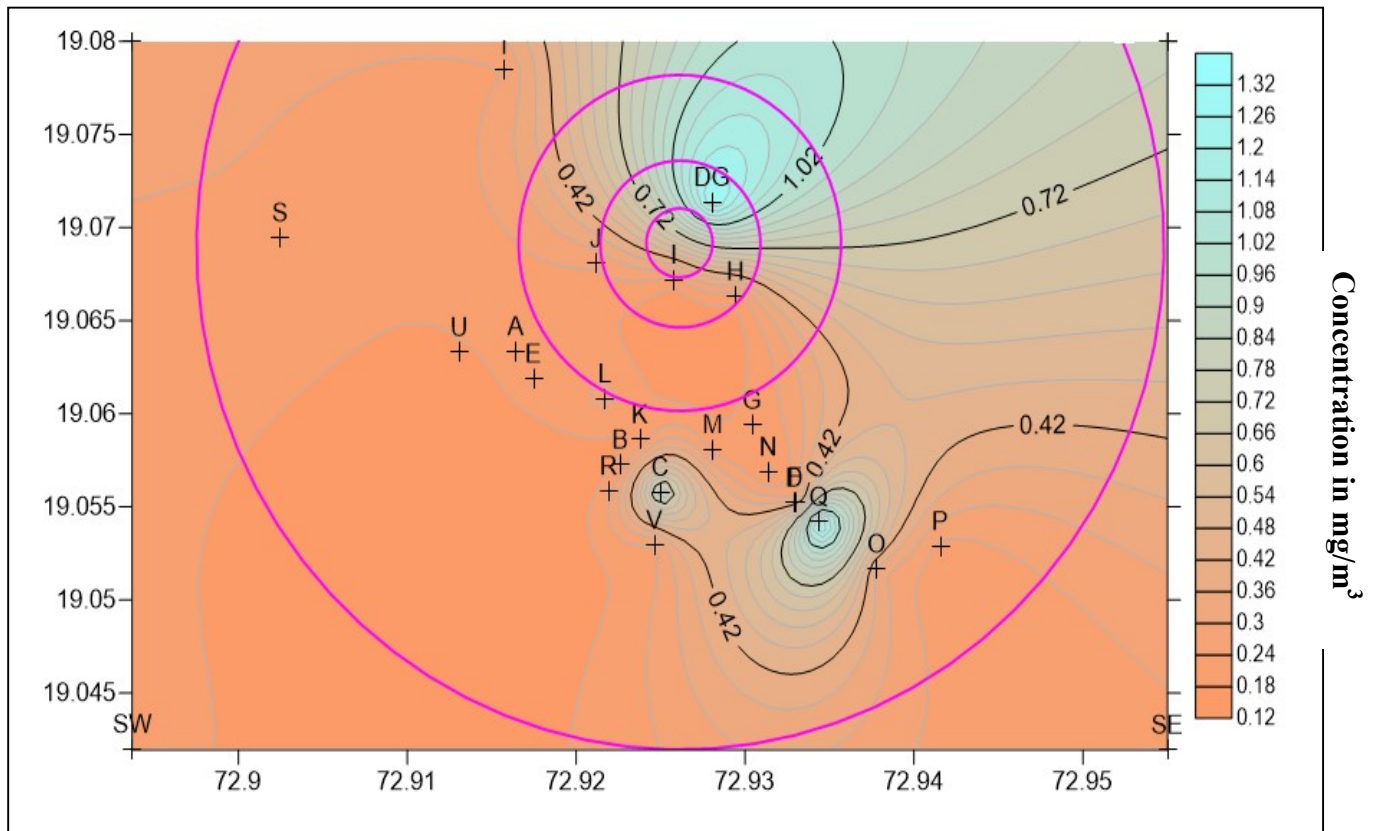
A: Shivaji Nagar Police Stn. B: Shree Swami Samarth Bldg., C: Atlanta Ground, D: Railway Sankalp Colony, E: Red Brick Bldg., F: Railway Sankalp Colony Bus Stop, G: MCGM Bldg. Chowky, H: Shivaji Nagar Bus Stop, I: Nirankar Nagar, J: Hindi Urdu MNC School, K: New Bhim Nagar, L: Ambedkar Maidan, M: Bhadra Hospital, N: Fire Brigade Mankhurd, O: Maharashtra Nagar Bus Stop, P: Vashi Bridge, Q: Mohite Patil School, R: Fire Brigade Colony,S: Pastom Sagar, T: Ramabai Nagar, U: Manoranjan Maidan, V: Deonar Municipal Colony, DG: Dumping Ground

Concentration observed at Ambedkar ground is 0.622 mg/m3 which is higher than other locations at 500 mtr. Red Brick tower located at 1 km. distance shows 0.473 mg/m3 concentration. It was observed that Red Brick Tower area has maximum concentration of all gases. This may be due to the temperature effect.

3.2 Measurements and Assessment at Gorai Dumping Site

The measurements of concentration of the odorous compounds H$_2$S, CH$_4$, NH$_3$, CH$_4$S, DMS and VOC and Particulate Matter (mg/cum) were carried out over a day at various distances. The seasonal variation of measurement parameters for pre monsoon, post monsoon and winter are presented **Table 3.5, 3.6 and 3.7** and are depicted in **Figure 3.10**.

Table3.5: Gorai Pre monsoon

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H$_2$S ppm	CH$_4$ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m^3	PM2.5 mg/m^3	PM10 mg/m^3
Day 1	Malgudi Hotel (S)	200m	37.1	38.2	N/S	2.9	ND	0.14	21.1	0.23	18.66	ND	0.04	0.042	0.086
	Pillai Academy (S)	500m	40.4	40.4	E/W	1.8	ND	0.15	ND	ND	14.38	66.09	0.03	0.037	0.075
	Gorai 2 (S)	1km	38.4	37	NE/SW	2.5	ND	0.19	40	ND	70.5	ND	0.03	0.036	0.078
	Suvidya School (S)	1km	38.8	37.6	N/S	1.8	ND	0.13	7.6	ND	24.37	ND	0.04	0.05	0.103
	Gorai Bridge (S)	3km	39	36.9	S/N	3.6	0.16	0.16	1.28	ND	42.59	ND	0.04	0.045	0.116
Day 2	Maxus Cinema (S)	500m	38.8	41.4	N/S	0.8	ND	0.22	1.3	ND	38.8	41.4	0.05	0.059	0.108
	MHB Colony (E)	1km	38.2	43	SW	0.6	ND	0.19	1.41	0.22	38.2	43	0.06	0.062	0.113
	Borivali Fire stn.(E)	3km	39.6	40.3	N/S	0.7	ND	0.13	0.43	0.28	39.6	40.3	0.06	0.065	0.112
Day 3	Chinmay Society (SE)	200m	39.7	38.7	S/N	2.5	ND	0.13	ND	ND	108.51	ND	0.04	0.049	0.089
	Shanti Daan (SE)	200m	41.8	35.8	N/S	2.2	ND	0.16	ND	ND	128.72	ND	0.04	0.046	0.079
	Gorai Depot (SE)	500m	41.6	35	NE	3.6	ND	0.17	ND	ND	109.33	ND	0.05	0.062	0.133
	Gokhale College (E)	1km	41.4	34.9	N/S	2.2	ND	0.2	ND	1.84	122.91	ND	0.07	0.083	0.162
Day 4	Gorai Closure (SE)	200m	36.4	42.3	SW	2.5	ND	0.19	ND	ND	60.48	ND	0.05	0.059	0.102
	Sonchafa Nursery(E)	200m	37.3	41.6	N/S	1.4	ND	0.14	ND	0.29	52.72	ND	0.05	0.058	0.083
	Ferry pt.1(Pagoda) (SW)	3km	37.4	43	E/W	3.2	ND	0.23	ND	0.26	56.41	ND	0.06	0.065	0.098
	Ferry pt.2(Uttan) (SW)	3km	32.4	52.2	N/S	1.4	ND	0.11	15.1	ND	71.82	ND	0.15	0.205	0.891
Day 5	Maxus Mall (S)	500m	29.2	50.5	E/W	2.9	ND	0.39	17.9	0.26	9.05	ND	0.05	0.051	0.11
	Gorai Depot(SE)	500m	29	51.6	N/S	2.9	ND	0.45	19.7	0.49	27.96	ND	0.05	0.052	0.098
	Pillai Academy (S)	500m	29	48.6	NE	0.7	ND	0.15	26.1	0.46	36.87	ND	0.04	0.049	0.137
	Gokhale College(E)	1km	28.9	53.5	SW	2.9	ND	0.12	ND	ND	33.89	ND	0.05	0.061	0.101
	Borivali Fire stn. (E)	3km	29.3	51.4	N/S	5.8	ND	0.56	17.7	0.4	44.95	ND	0.04	0.044	0.111

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan DMS- Dimethyl Sulphide

Table3.6: Gorai Post Monsoon Season

	Location	Distance in m	Temp°c	Humidity RH	WD	WS m/s	VOC ppm	H_2S ppm	CH_4 ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	Maxus Mall	500m	33.5	46.3	E/W	2.16	ND	0.18	6.45	0.39	1	ND	0.047	0.057	0.108
	Gorai Depot	500m	33.7	44.7	W/E	2.52	ND	0.35	7.45	0.24	49.58	ND	0.049	0.057	0.127
	Pillai Academy	500m	33.6	44.4	E/W	0.72	ND	0.24	25.73	0.37	19.5	ND	0.037	0.043	0.106
	Gokhale College	1km	33.9	46.2	W/E	2.88	ND	0.33	0.41	2.69	77.04	ND	0.063	0.07	0.136
	Borivali Fire stn.	3km	33.8	45.2	E/W	3.24	ND	0.26	14.95	0.91	24.11	ND	0.078	0.149	0.147
Day 2	Chinmay Society	200m	37.2	43.8	S/N	1.8	ND	0.13	ND	ND	101.5	ND	0.046	0.052	0.086
	Shanti Daan	200m	37	44.1	SE/NW	2.88	ND	0.17	ND	ND	90.59	ND	0.041	0.046	0.078
	Pepsi Ground	500m	37.2	43.8	N/S	3.96	ND	0.18	ND	ND	18.67	ND	0.032	0.035	0.048
	New MHB Colony	3km	36.6	44.7	E/W	2.16	ND	0.29	ND	ND	30.62	ND	0.072	0.088	0.139
Day 3	Malgudi Hotel	200m	36	41	N/S	1.8	ND	0.2	6.03	ND	19.27	ND	0.036	0.043	0.086
	MHB Colony	1km	38.7	41.2	W/E	2.52	ND	0.18	0.58	ND	7.26	ND	0.056	0.061	0.103
	Gorai 2	1km	38	39.3	NE/SW	2.88	ND	0.12	ND	0.43	10.45	ND	0.03	0.036	0.078
	Suvidya School	1km	37.7	40.6	S/N	3.96	ND	0.14	6.05	1.18	20.48	ND	0.032	0.04	0.098
	Gorai Bridge	3km	37.4	39.8	SE/NW	2.52	ND	0.19	2.96	ND	31.83	ND	0.05	0.059	0.116
Day 4	Gorai Closure	200m	36.7	43.1	N/S	2.52	ND	0.14	ND	ND	66.86	ND	0.055	0.061	0.106
	Sonchafa Nursery	200m	37.6	40.4	N/S	1.8	ND	0.24	ND	0.3	80.89	ND	0.05	0.057	0.084
	Gorai (Pagoda)	3km	37.4	43.7	W/E	3.6	ND	0.21	1.19	0.11	47.3	ND	0.051	0.066	0.1
	Uttan	3km	33.9	53.5	N/S	2.16	ND	0.04	14.62	ND	107.92	ND	0.168	0.213	0.922

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan DMS- Dimethyl Sulphide

Table3.7: Gorai Winter Season

	Location	Distance in m	Temp°c	Humidity RH	WD	WSm /s	VOC ppm	H₂S ppm	CH₄ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	Malgudi Hotel	200m	32.6	37.8	S/N	2.16	1.27	0.17	4.85	ND	57.32	222.28	0.094	0.105	0.209
	Maxus Mall	500m	33.3	37.7	S/N	4.32	1.41	0.13	9.8	ND	41.7	102.59	0.087	0.096	0.167
	Suvidya School	1km	33.8	36.2	S/N	2.52	1.2	0.28	4.05	ND	25.17	40.44	0.087	0.1	0.217
	Gorai Bridge	3km	33.8	36.2	S/N	2.88	1.12	0.15	4.09	ND	53.87	84.09	0.099	0.118	0.398
Day 2	Pillai Academy	500m	33.4	36.7	W/E	1.44	0.91	0.26	0.37	0.34	54.42	23.83	0.081	0.087	0.158
	Pepsi Ground	500m	34.4	34.4	SW/NE	1.44	0.77	0.1	ND	ND	54.81	129.23	0.065	0.07	0.117
	Gorai 2	1km	35.1	35.9	W/E	2.16	0.5	0.07	10.61	ND	100.38	ND	0.073	0.079	0.141
Day 3	Ferry Point 1	3km	34.9	37.9	W/E	3.24	0.34	ND	2.32	0.29	15.71	ND	0.067	0.07	0.087
	Ferry Point 2	3km	33.3	40.2	W/E	10.44	0.33	0.11	2.55	0.04	22.74	ND	0.079	0.082	0.098
Day 4	Chinmay Society	200m	30.4	52.1	NE/SW	5.04	0.49	0.09	2.64	0.27	29.89	ND	0.094	0.103	0.204
	Shanti Daan	200m	31.3	51.1	NW/SE	3.96	0.6	0.04	1.72	0.11	32.47	ND	0.097	0.102	0.142
	Gorai Bus Depot	500m	30.8	50.7	W/E	3.6	0.47	0.09	3.05	0.14	27.52	ND	0.092	0.099	0.136
	New MHB Colony	3km	30.9	50.3	W/E	4.32	0.5	0.07	2.32	0.07	36.54	ND	0.09	0.097	0.133
Day 5	Closure Point	200m	31.2	46.9	W/E	4.68	0.71	0.09	3.03	ND	20.67	ND	0.105	0.117	0.211
	Sonchafa Nursery	200m	31.6	46	NW/SE	6.48	0.73	0.08	2.92	ND	13.27	ND	0.103	0.113	0.244
	Gokhale College	500m	30.4	48	N/S	3.96	0.64	0.13	1.6	ND	17.75	ND	0.141	0.151	0.204
	MHB Colony	1km	30	49.4	W/E	2.52	0.58	0.17	2.33	ND	13.93	ND	0.103	0.11	0.166
	Borivali Fire Station	3km	30.3	47.3	E/W	4.32	0.59	0.05	1.93	ND	27.99	ND	0.09	0.098	0.162

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

The overall measurements for all seasons for Gorai dumping site is presented in **Table 3.8** and depicted in **Figure 3.11.**

Table 3.8: Range and Average Concentrations of Pollutants at Different Seasons

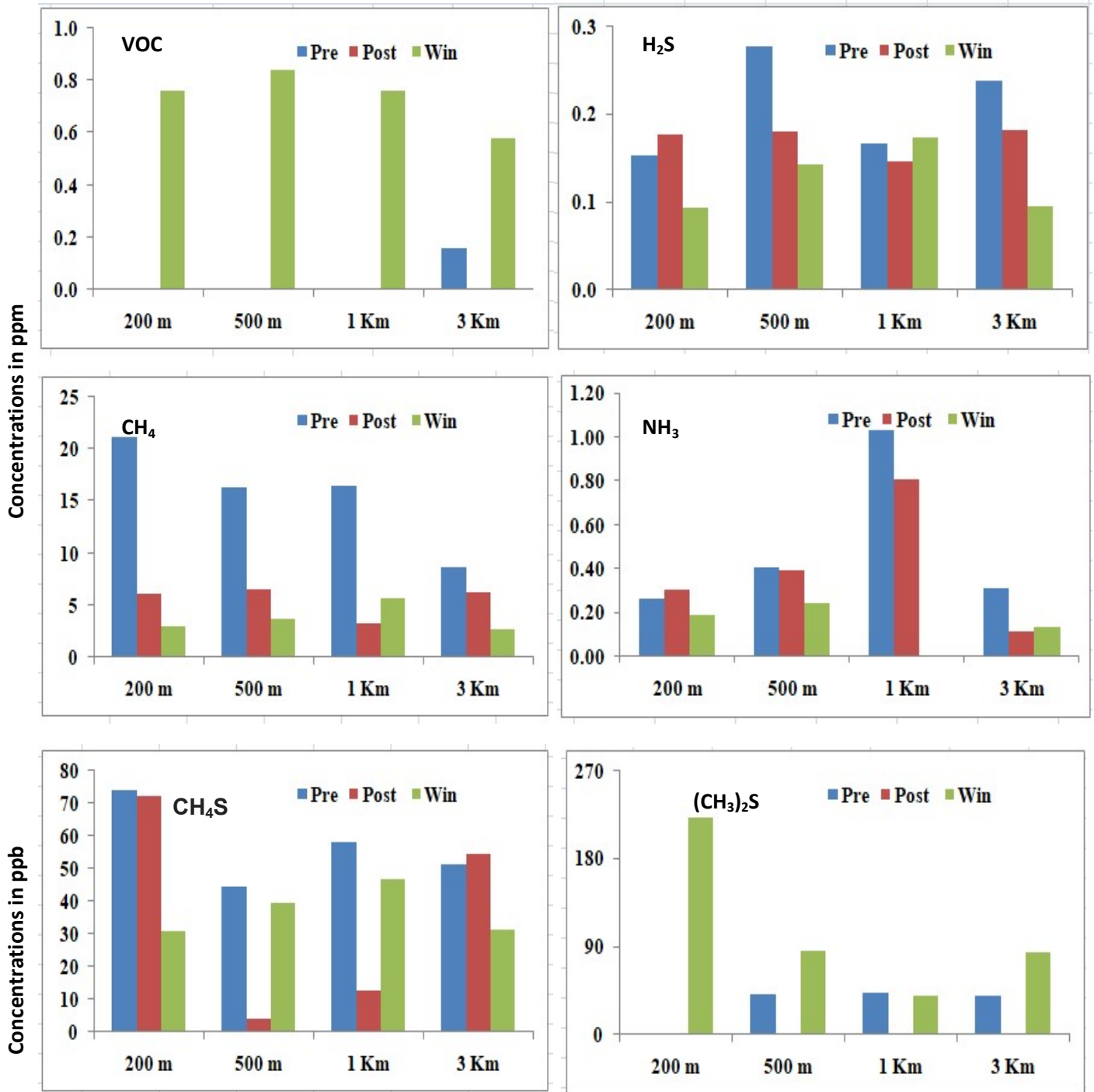| Name of the Parameter	VOC (ppm)		H₂S (ppm)		CH₄ (ppm)		NH₃ (ppm)	
Range/Average	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
Pre Monsoon	0 - 0.16	0.16	0.11 - 0.23	0.16	0.43 - 40.02	12.69	0.22 - 0.46	0.29
Post Monsoon	0	0	0.04 - 0.35	0.20	0.41 - 25.73	7.86	0.11 - 2.69	0.74
Winter	0.20 - 1.41	0.75	0.03 - 0.28	0.12	0.37 - 10.61	3.54	0.04 - 0.34	0.18

Gorai Dumping Ground

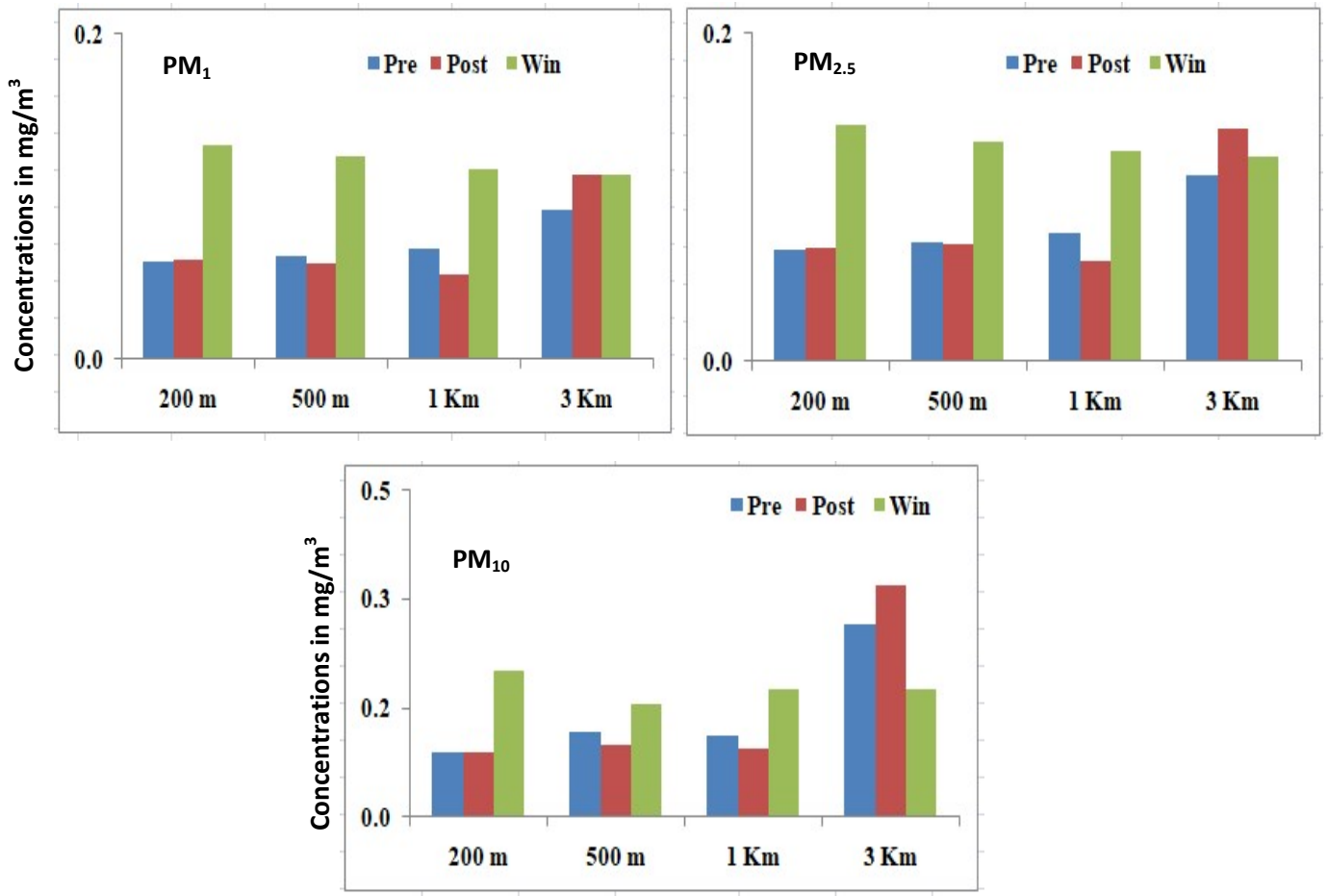**Figure 3.10: Three seasons concentrations**

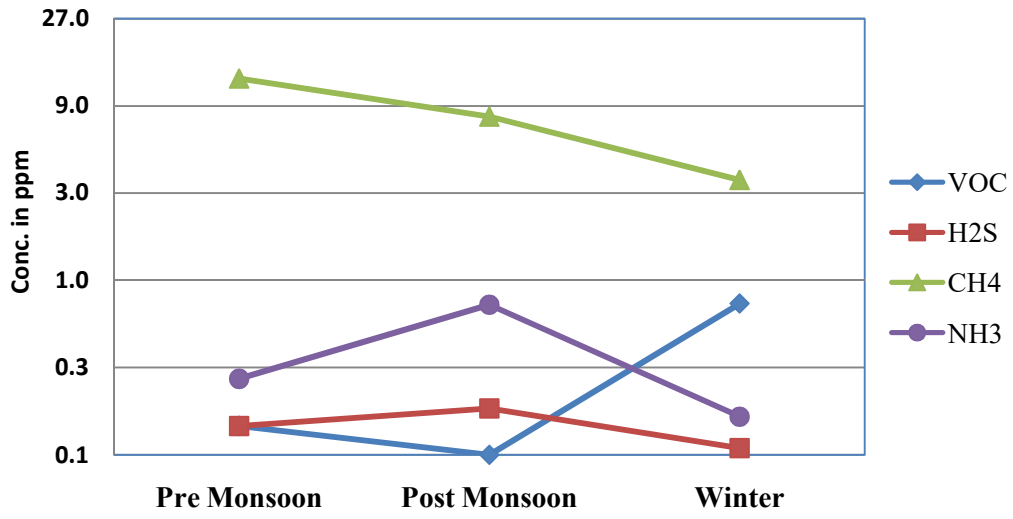**Figure 3.10 (Contd..) : Three seasons concentrations**

Figure 3.11: Three seasons average concentrations

3.2.1 Observations for three seasons

This site is scientifically closed in the year 2007 and the remaining operations are over in the year 2009-10. Apparently certain parameters of pollution are observed low due to activity of scientifically closed as expected.

There is no reason to see VOC in all seasons; however they are not surfacing in Pre and Post Monsoon seasons except some concentrations i.e. 0.2 ppm at distance of 3 Kms. The trend of VOC declines from almost 0.8 ppm at 200 mtr to 0.6 ppm at 3 Km in Winter due to non-dispersion effect because of fall in temperature in Winter season. The VOC concentration indicates the decomposition process under the surface it appears to live and on-going indicating the site is not got fully stabilized. It is expected to continue generating other gases as they are expected to be degenerated might be due to on-going decomposition process beneath. As VOC levels are between level 0.6 ppm to 0.8 ppm, i.e beyond permisible limit of 0.75 ppm it requires an action.

H_2S appears to be 0.3 ppm at all over the area and falls down in Winter to less than 0.1 ppm, whereas CH_4 appears emanated from loosely bound soil, so as NH_3 and CH_4S, the maximum level of these gases appear to be in Pre-Monsoon season, may be due to temperature effect.

DMS shows significant concentration of about 200 ppb at a distance of 200 mtrs which further falls down to 90 ppb in Winter. The generation of the same is the minimum undetectable in Pre and Post seasons.

H_2S and CH_4S levels are well below the permisible level, whereas $(CH_3)_2S$ above permisible level of 0.1 ppm, so it requires action.

PM of all sizes and at all distances being high above permisible level, they invite immidiate remedial measures at least to the residential areas. With respect to PM2.5concentrations all are exceeding by over 10 times of the standard values at places during all seasons. It remains to be 10 times higher; the reason can be attributed to overall SPM level in Mumbai is close to 400 ppm (400000 mg/cum) also due to strong winds directly coming from Arabian Sea. The hazardous effects at the site can be as reported in *Chapter 4 Section 4.3*.

3.2.2 Expression of Measurements and Diffusion through Contour Maps -Gorai

The contour maps as shown in **Figure 3.12 to 3.17**for each parameter and season showed inconformity with the trends of measurements at Gorai site. The impact of wind obviously seen through merges of colour resembling the fall or rise in concentration. The contours of the graphical assessment and closely signify the concentration of every parameter at <u>any given place within </u>the range of measurement. Some abruption can be seen in every map of either increased or abrupt decrease of concentration at places or otherwise steady decrease of concentration as one goes away from the site. The aberration is seen to be change due to wind direction and meteorological parameters.
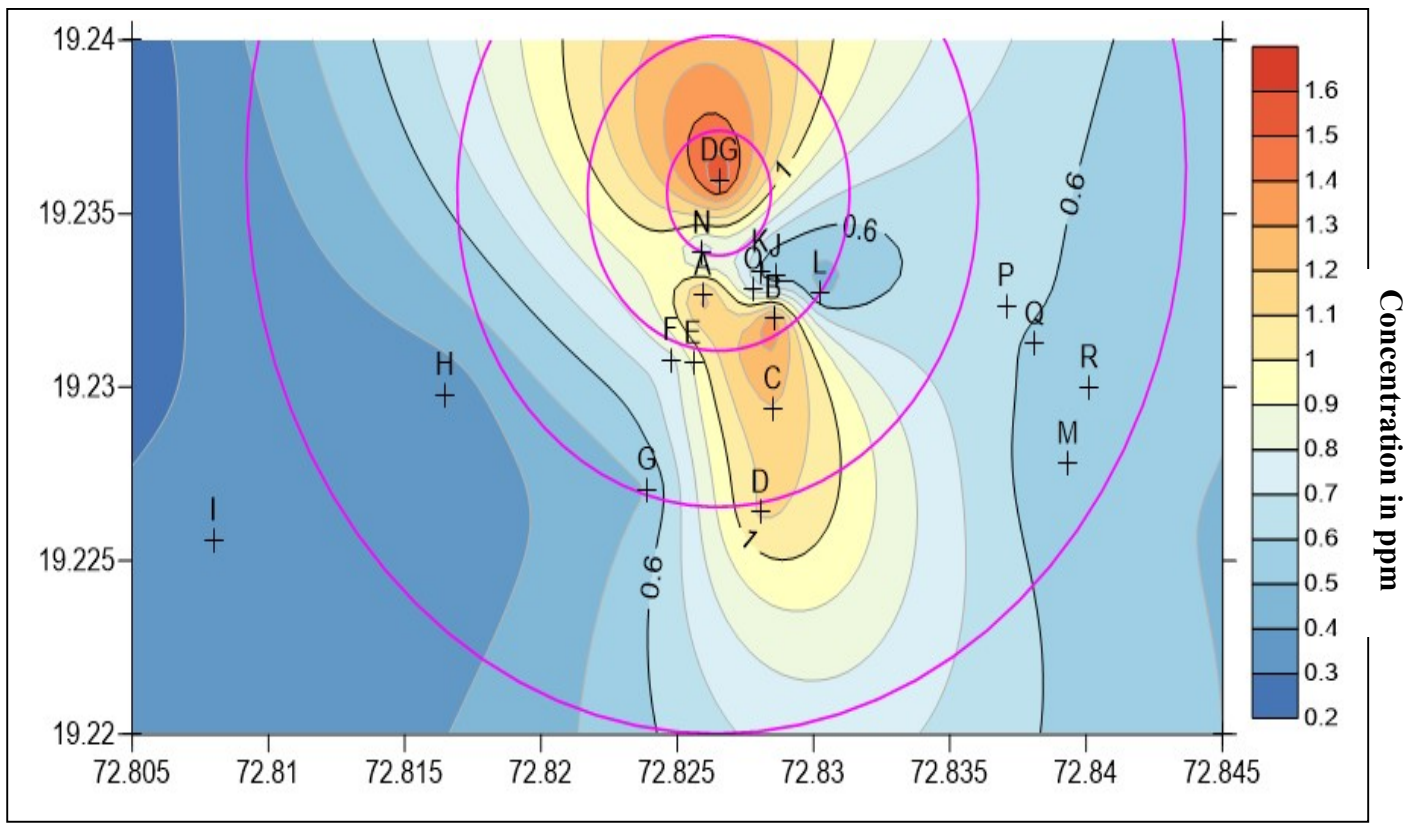
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy;
F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.12 a: Contour Map of VOC Concentrations during Winter Season
(Site Gorai)

The 2nd peak observed at Maxus Mall at a distance 500m with concentration 1.4 ppm of VOC. The concentration can be attributed to the loading unloading of waste in the nearby area.
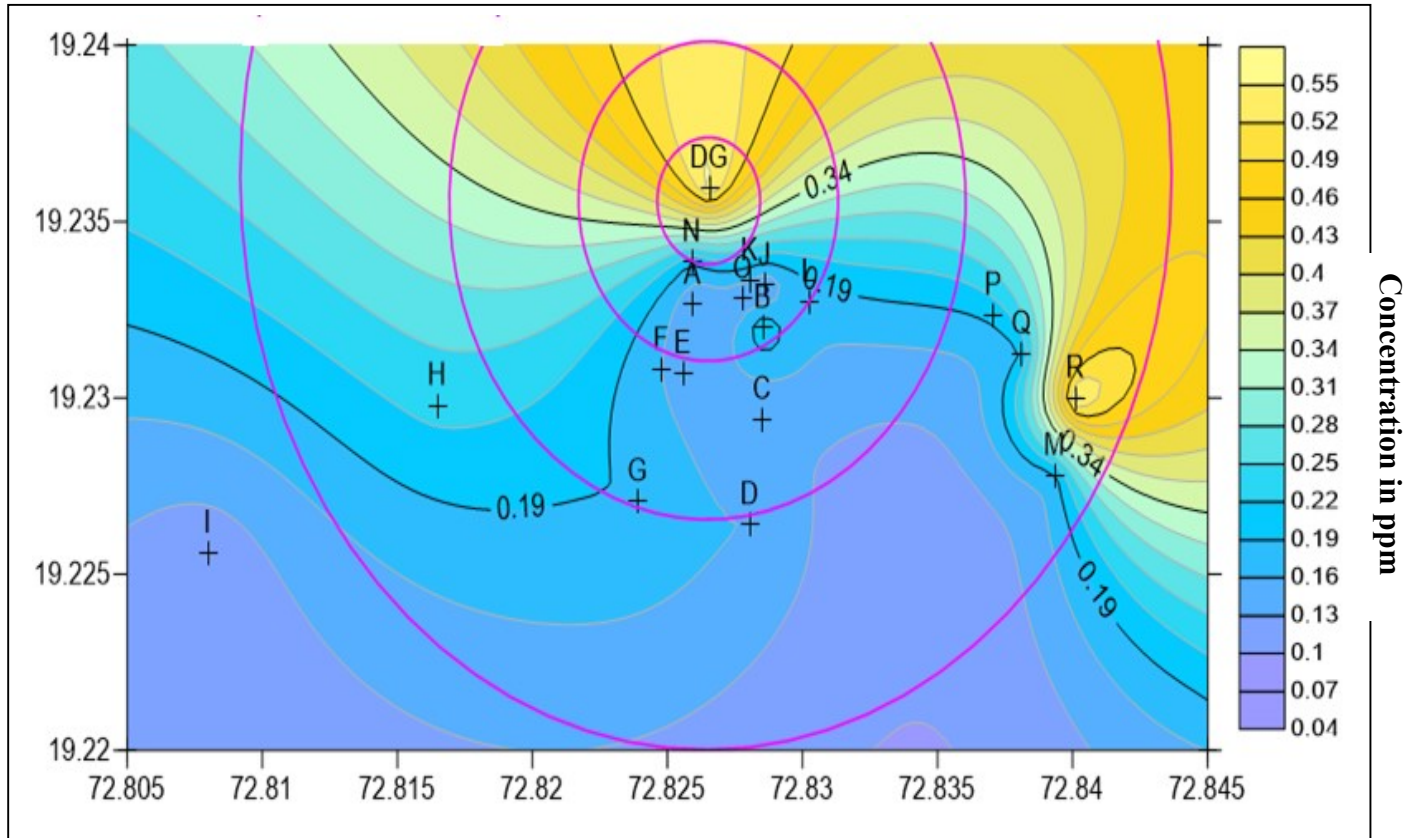
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.13 a: Contour Map of H2S Concentrations During Pre Monsoon Season (Site Gorai)

The 2nd peak was observed at a distance of 3km at Borivali Fire Brigade Station of concentration 0.56 ppm of H$_2$S. This may be due to the handling of Natural Gas cylinders by the fire the Fire Brigade Station.
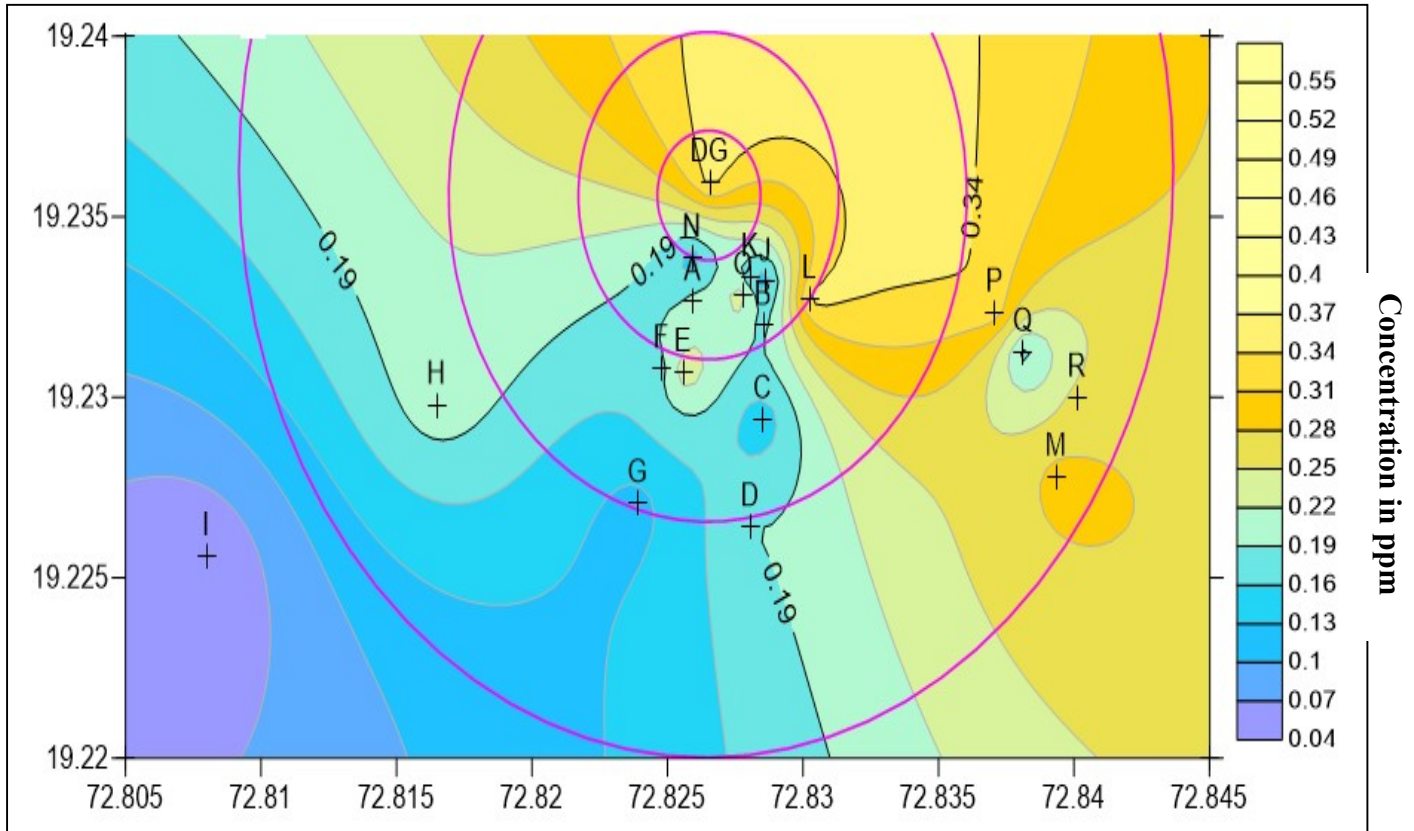
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy;F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

**Figure 3.13 b: Contour Map of H$_2$S Concentrations during Post Monsoon Season
(Site Gorai)**

In post monsoon period, the 2nd peak observed of H$_2$S at a distance of 500m at Pillai Academy with concentration 0.24 ppm could incidental as no distinct source is noticed there except nearby chicken market. The 3rd peak was observed at New MHB Colony at a 3km distance with the concentration of 0.29 ppm and this might be due to the nullah flowing in this area carrying lot of sewage and solid waste.
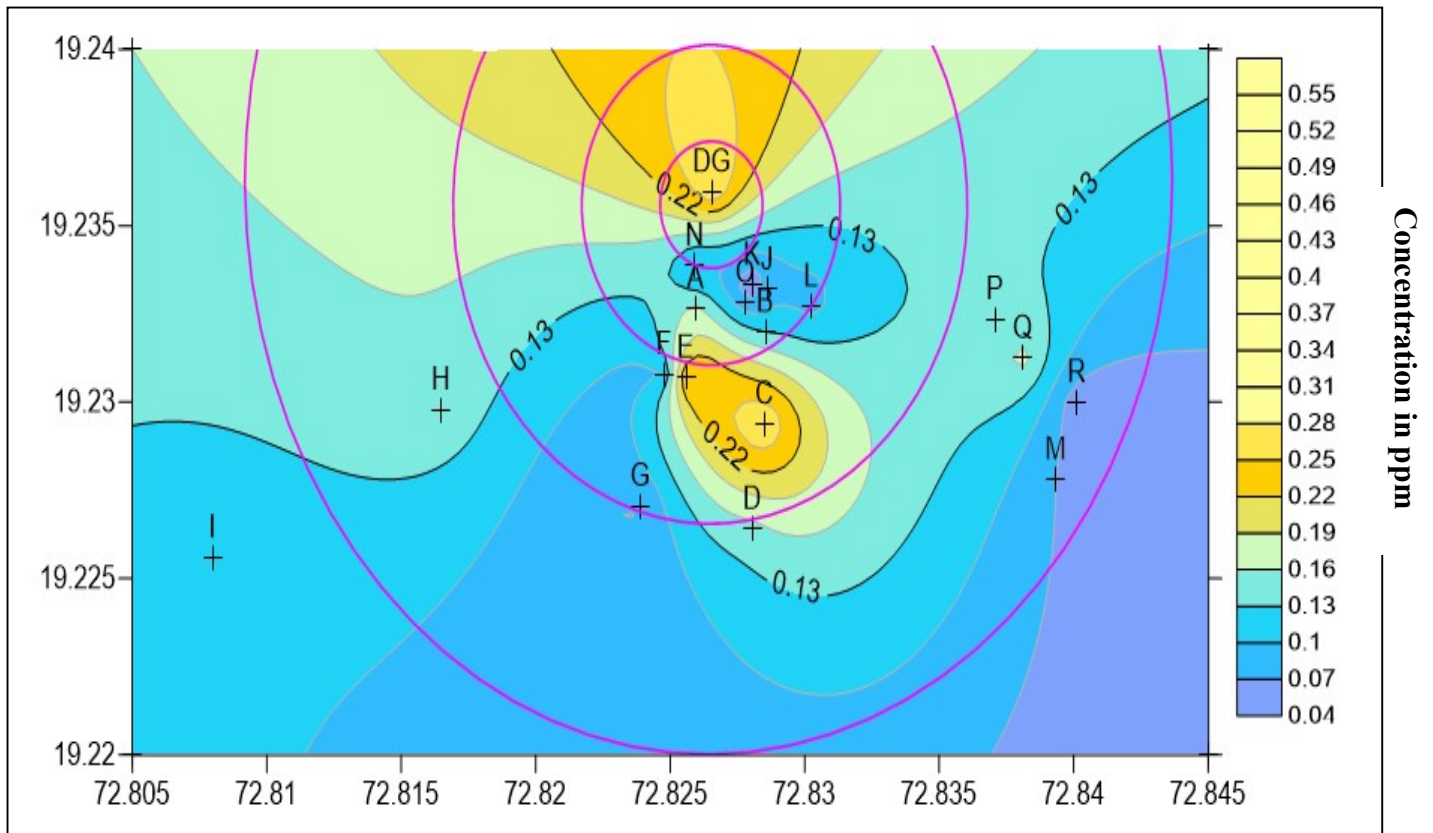
Figure 3.13 c: Contour Map of H$_2$S Concentrations during Winter Season (Site Gorai)

A : Malgudi Hotel; B : Maxus Mall; C : Suvidya School; D : Gorai Bridge; E : Dr.Pillai Academy;F : Pepsi Ground; G : Gorai 2; H ; Ferry Point 1; I : Ferry Point 2; J : Chinmay Society; K : Sonchafa Nursery; L : Gorai Depot; M : New MHB Colony; N : Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

The 2nd peak was observed at Suvidya School located at 1 km of concentration 0.28 ppm, this location is exactly opposite to the dumping ground. The emissions from closure site can be the reason of the concentration.

A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.14 a: Contour Map of CH4 Concentrations during Pre Monsoon Season (Site Gorai)

The 2nd peak observed at Gorai -2 of concentration 40 ppm of CH_4. There are due to the possibilities of 2 reasons i.e. due to sewerage lines passing through in this area and the fish market waste operating in this area.

A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

**Figure 3.14 b: Contour Map of CH4 Concentrations during Post Monsoon Season (Site Gorai)**

The 2nd peak was observed at Pillai Academy with concentration 25.73 ppm of CH_4. The concentration can be attributed to same reasons as stated in 3.13 b.
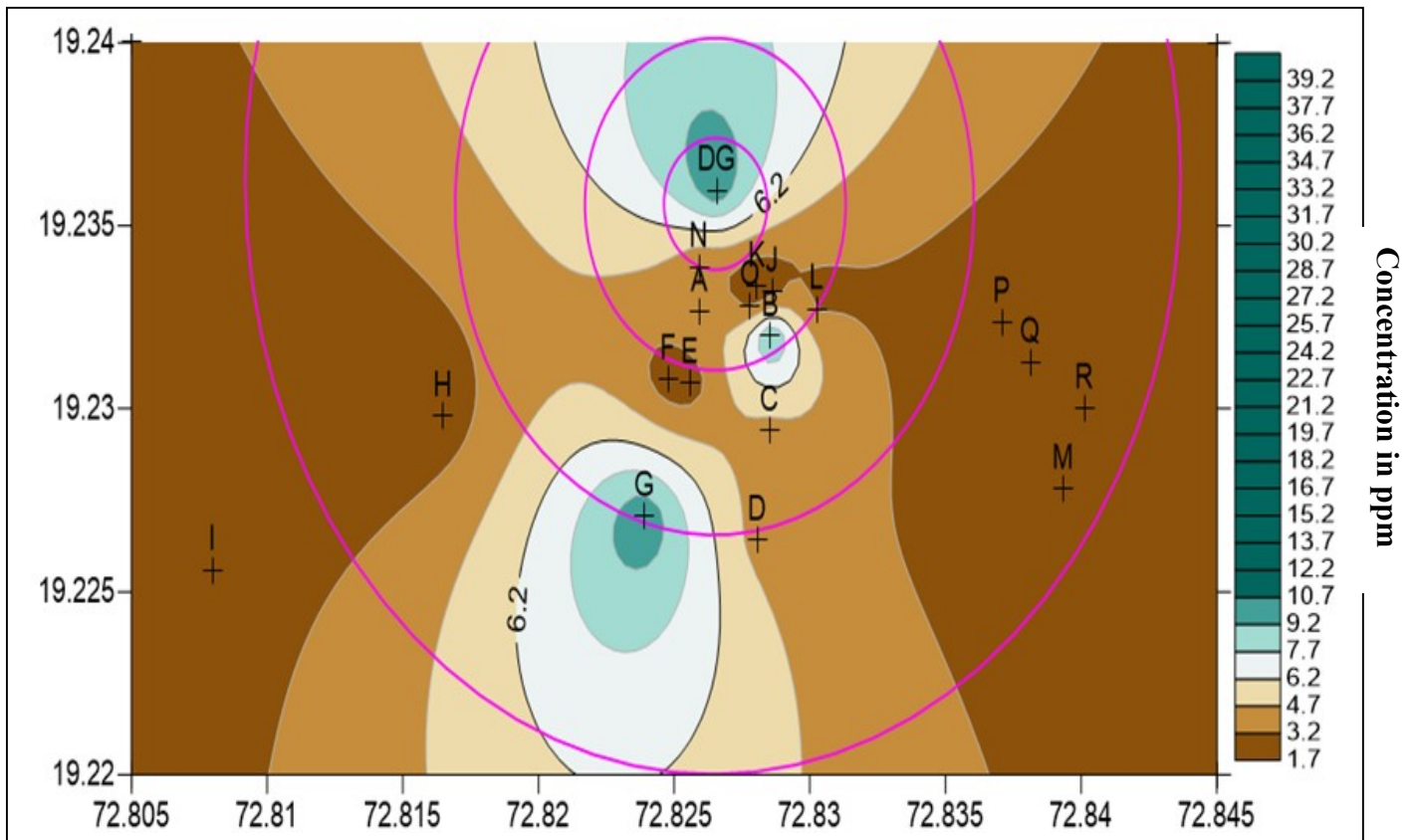
Figure 3.14 c: Contour Map of CH₄ Concentrations during Winter Season
(Site Gorai)

A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

The 2nd peak observed at a distance of 500 m at location at Maxus Mall location with the concentration of 9.8 ppm and reason explained in 3.12 a. The 3rd peak was observed at Gorai 2 location and the concentration was 10.61 ppm. This concentration can be attributed to same reasons as stated in 3.14 a.

A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr. Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.15 a: Contour Map of NH₃ Concentrations during Winter Season
(Site Gorai)

The 2nd peak was observed at Pillai Academy of concentration 0.34 ppm and reason is stated in 3.13 b. The 3rd peak observed at a distance of 3km at the location of Ferry point with concentration of 0.299 ppm. This concentration might be due the creek effect.
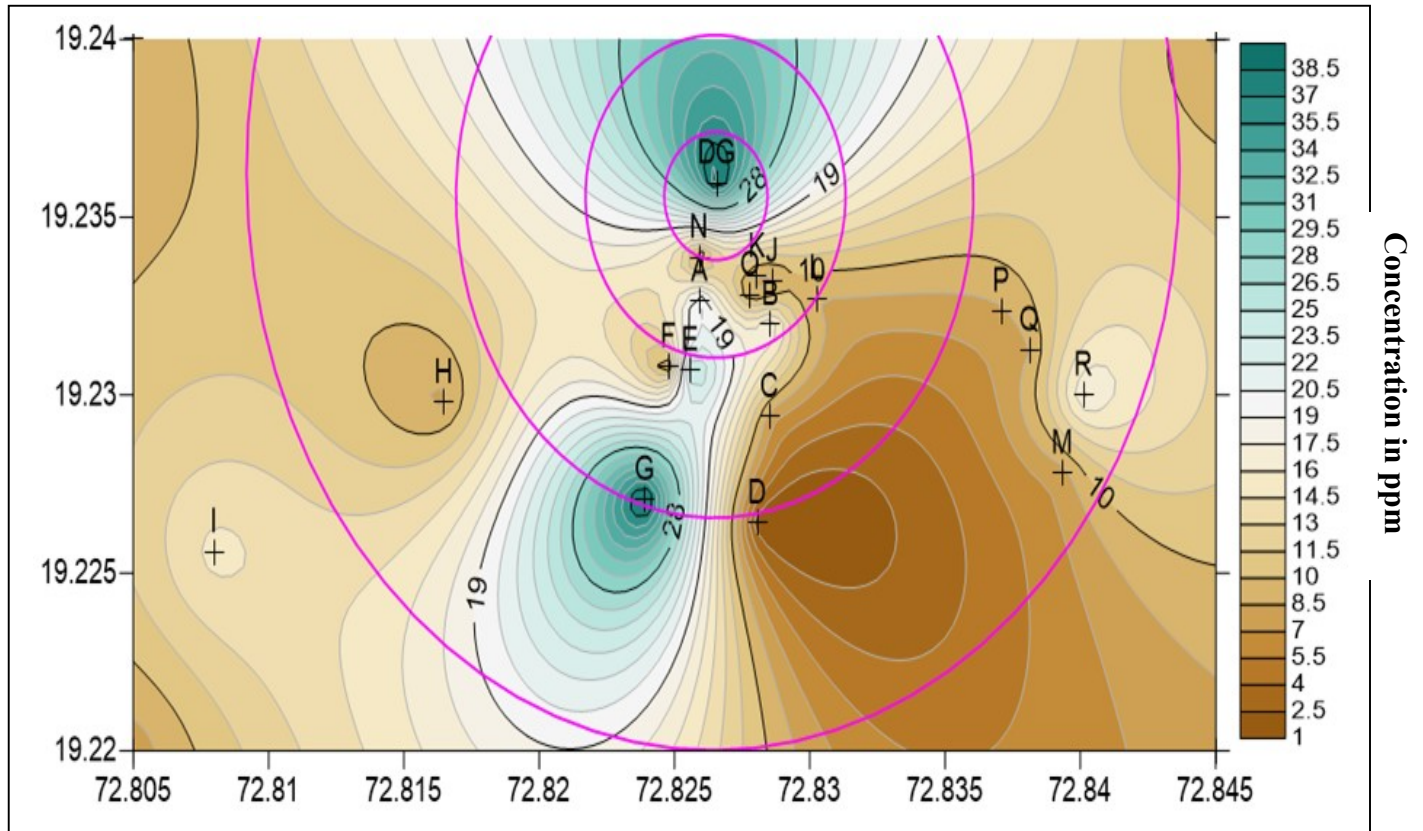
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.16 a: Contour Map of Mercaptan Concentrations during Pre Monsoon Season
(Site Gorai)

The 2nd peak observed at Gorai 2 with concentration of 70.5 ppb at a distance of 1km and the reason is stated in 3.14 a.
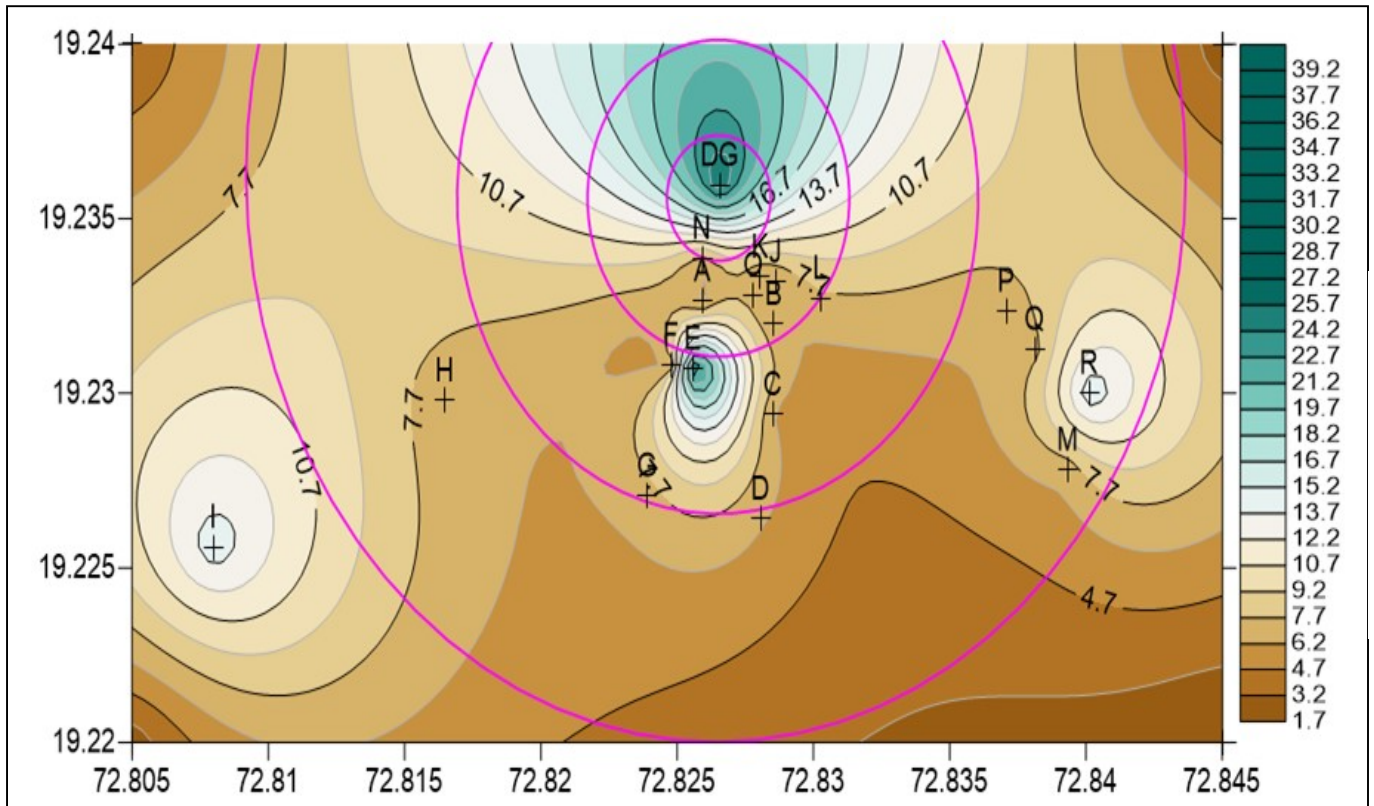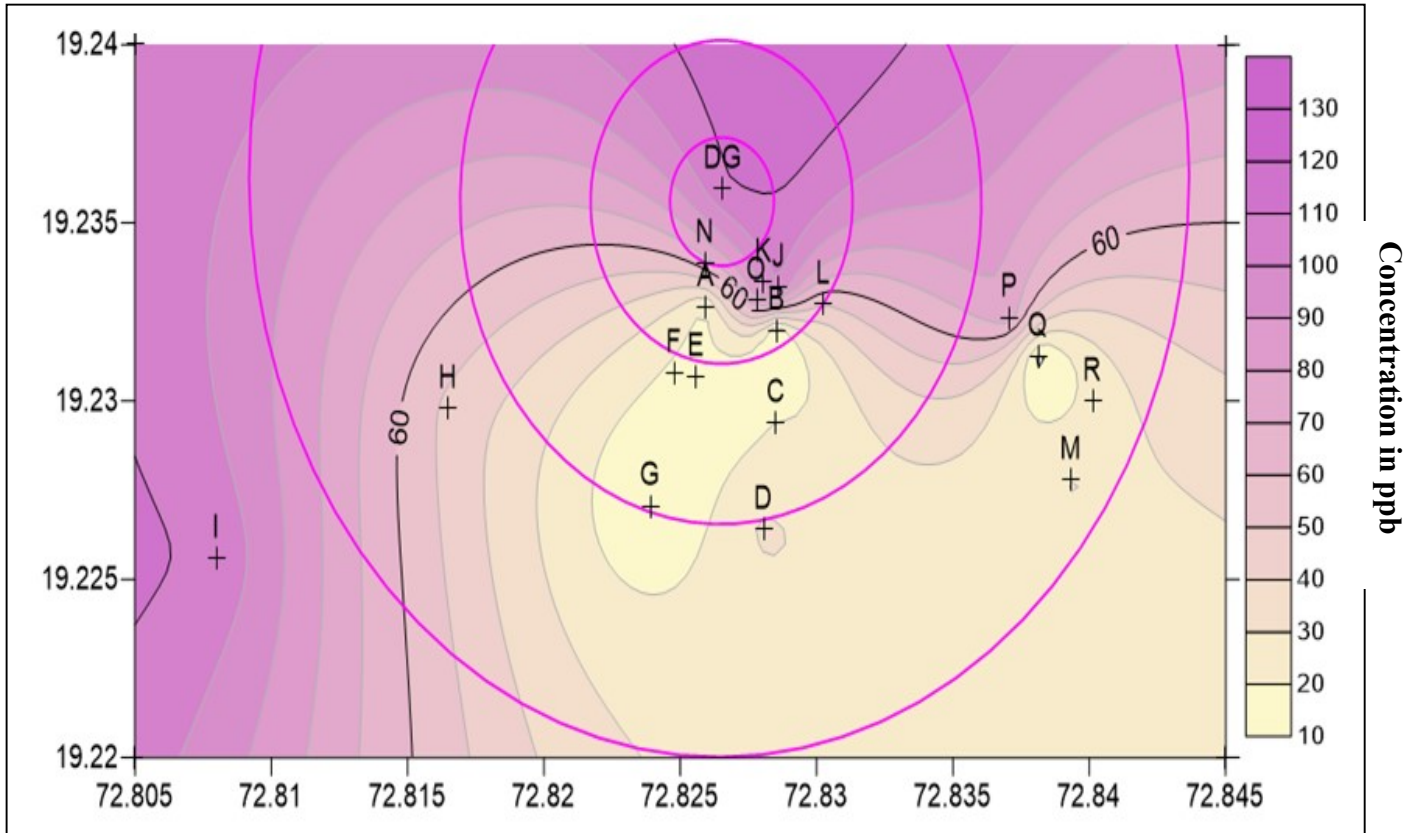
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.16 b: Contour Map of Mercaptan Concentrations during Post Monsoon Season (Site Gorai)

At 1 km. distance Gokhale college location shows 77.04 ppb concentration of Mercaptan in post monsoon season. The concentration can be attributed the adjoining nullah flowing close by this site.
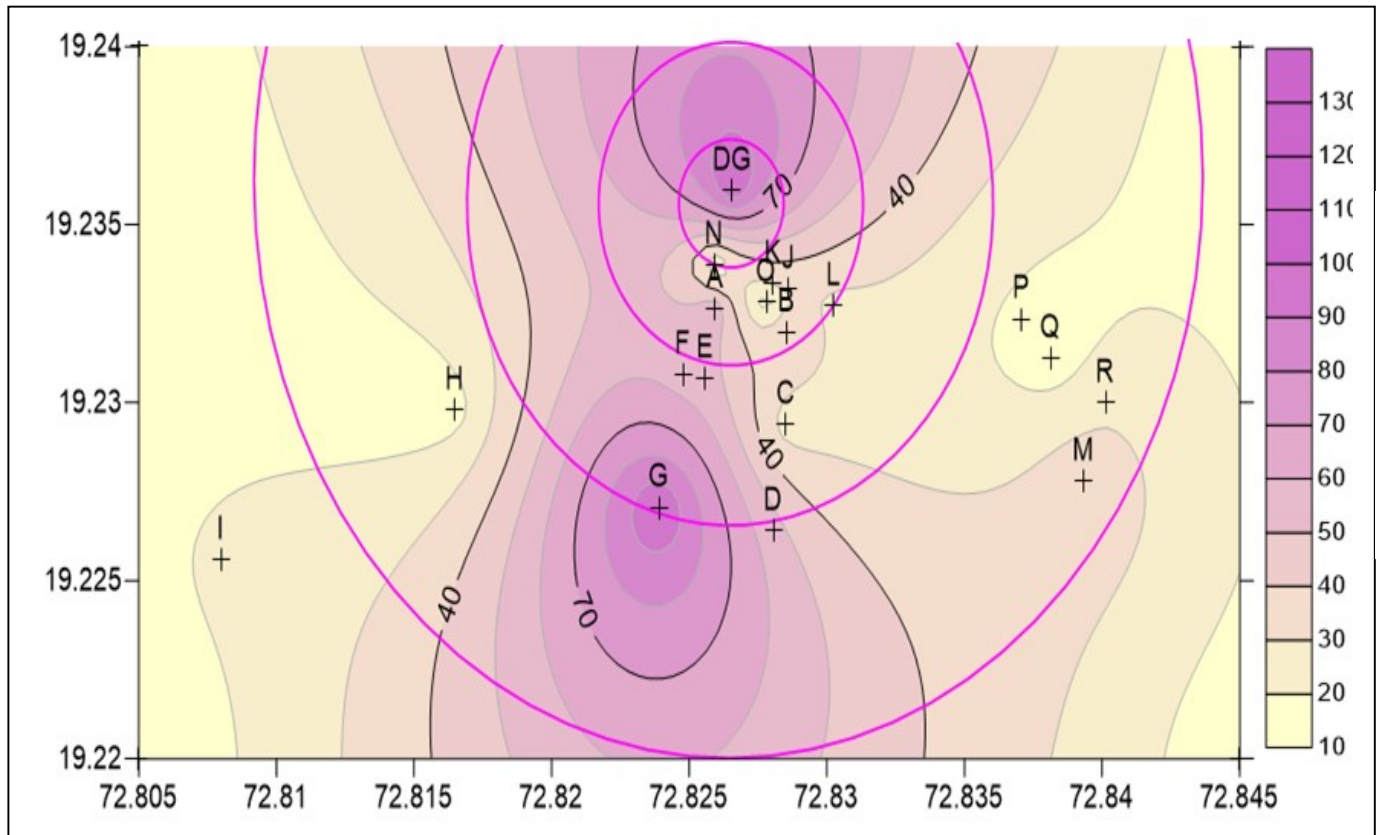
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.16 c: Contour Map of Mercaptan Concentrations during Winter Season (Site Gorai)

The 2nd peak was observed at the Gorai 2 location shows 53.87 ppb concentration and can be attributed to same reasons as stated in 3.14 a.
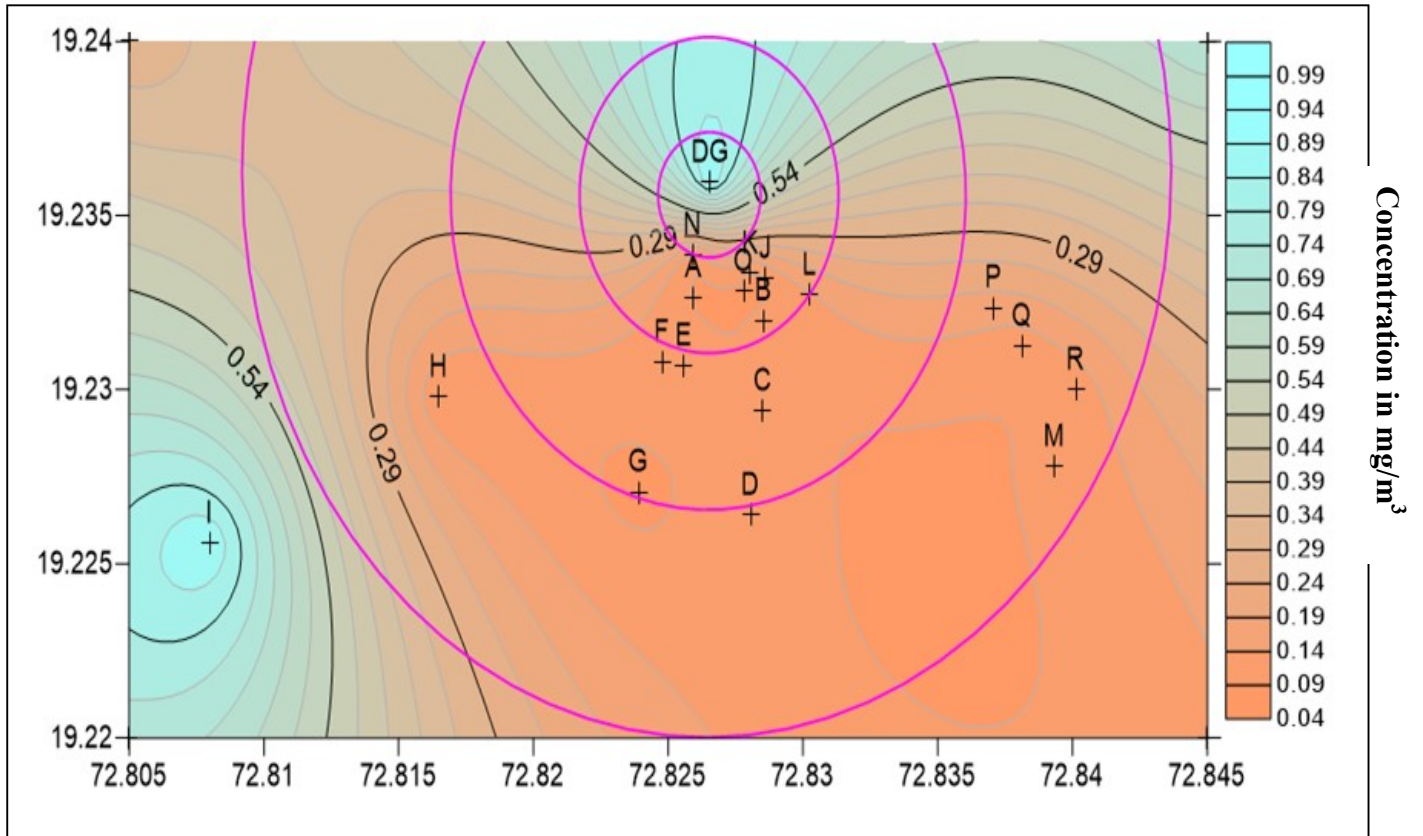
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.17a: Contour Map of PM Concentrations during Pre Monsoon Season
(Site Gorai)

The 2nd peak was observed at a location of in the direction of Uttan Village side having concentration of 0.922 mg /m^3. This can be attributed to the effect of creek.
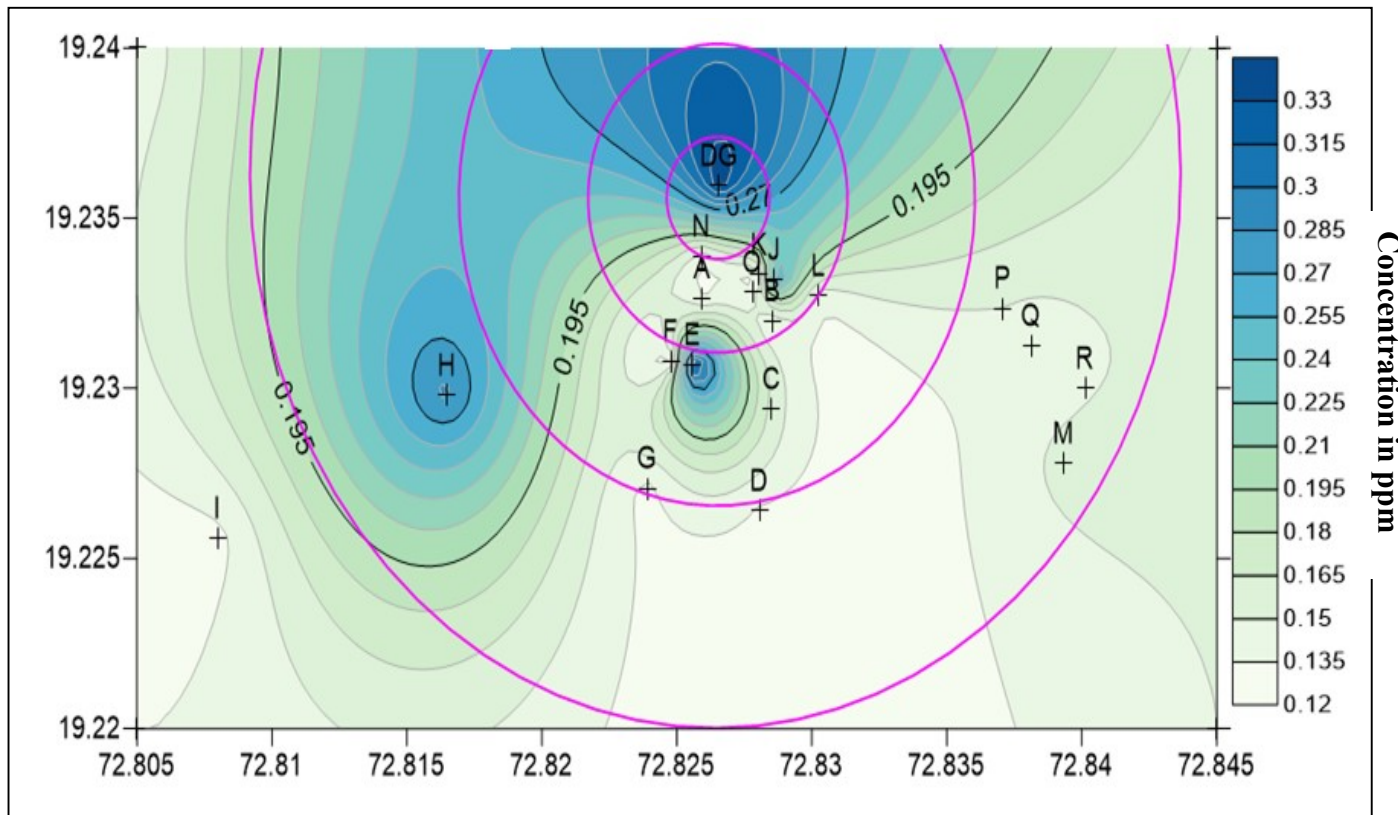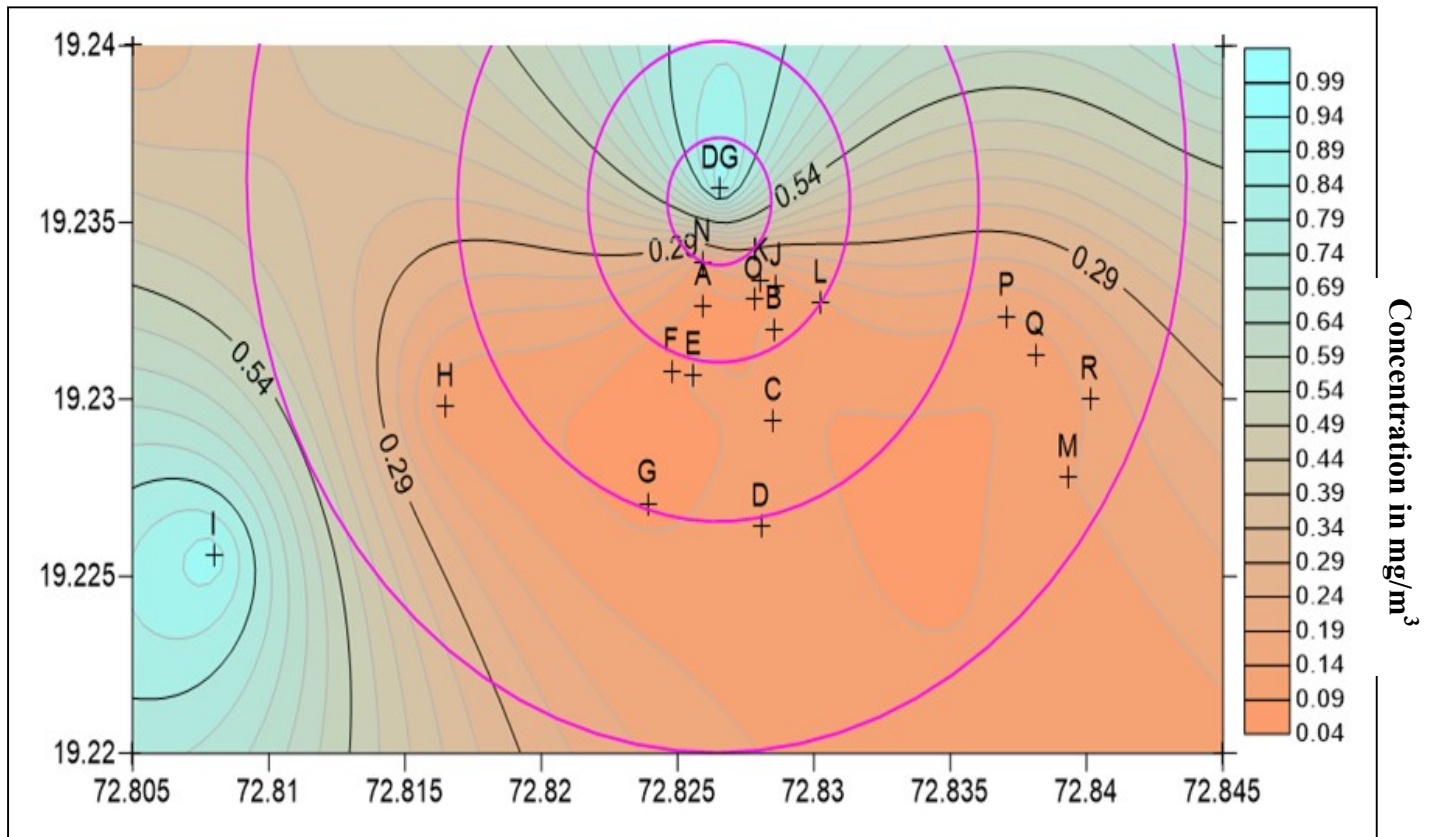
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.17 b: Contour Map of PM Concentrations during Post Monsoon Season (Site Gorai)

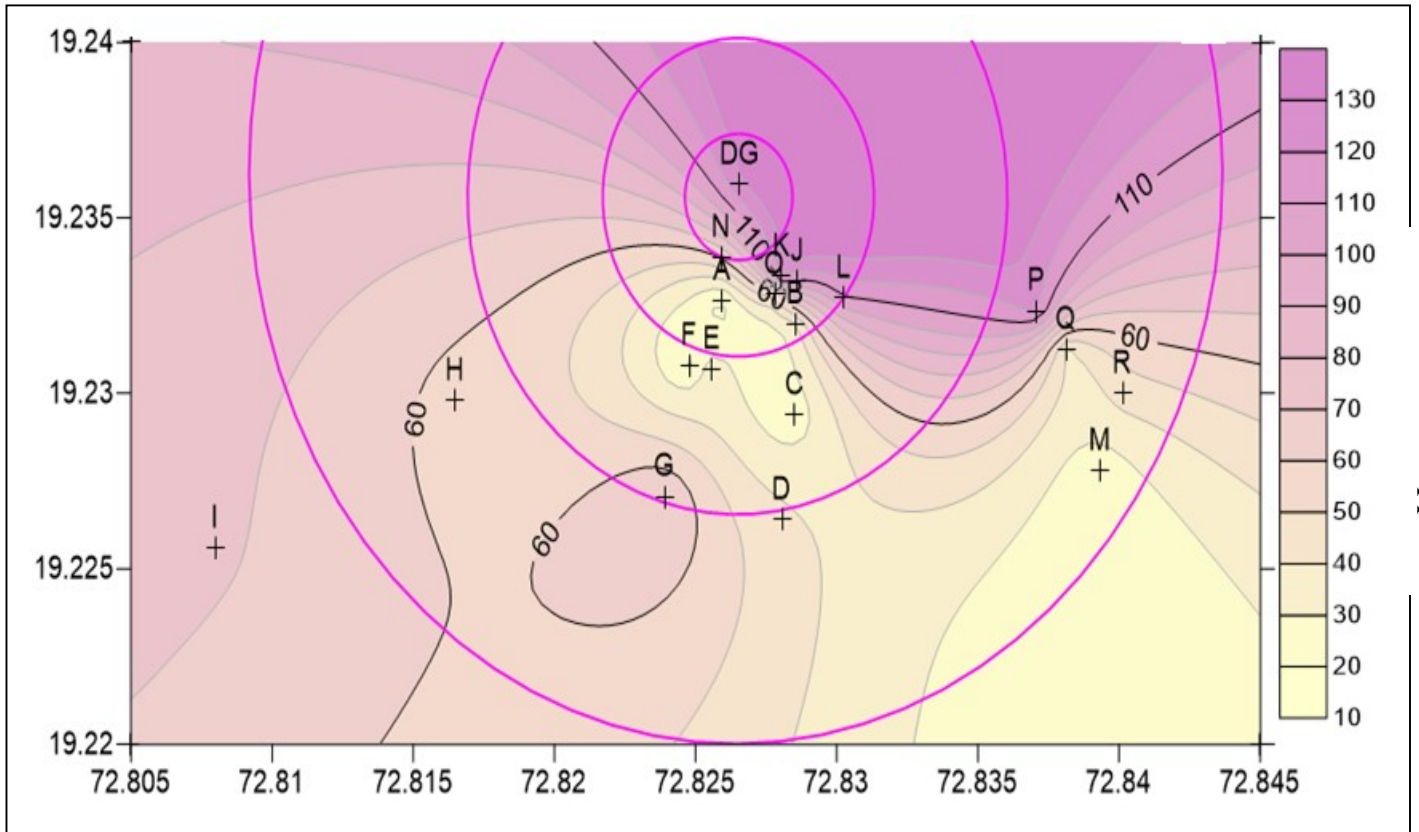The concentration observed same at the location observed in earlier contour and the reason is stated in 3.17 a.
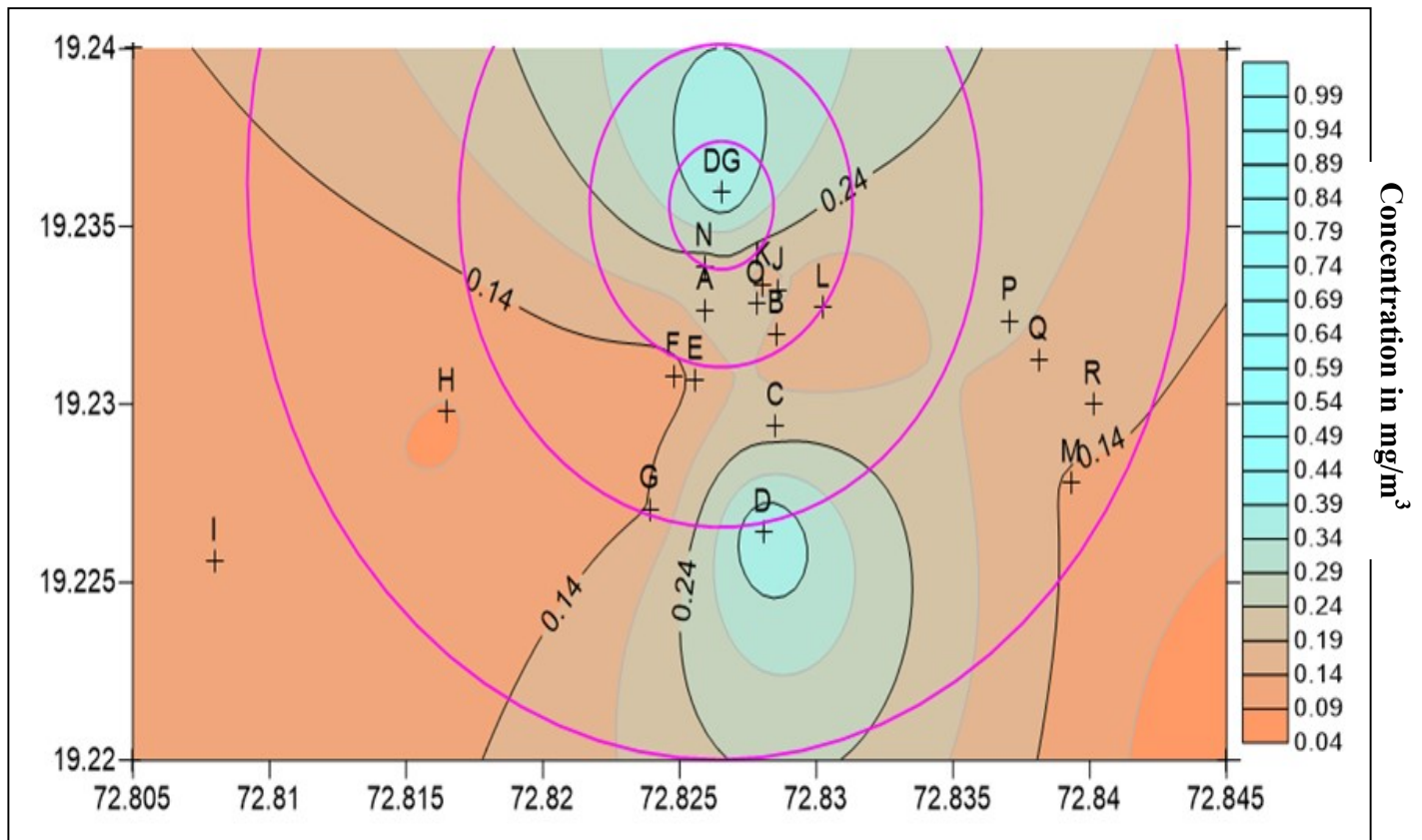
A: Malgudi Hotel; B: Maxus Mall; C: Suvidya School; D: Gorai Bridge; E: Dr.Pillai Academy; F: Pepsi Ground; G: Gorai 2; H; Ferry Point 1; I: Ferry Point 2; J: Chinmay Society; K: Sonchafa Nursery; L: Gorai Depot; M: New MHB Colony; N: Closure Point; O: Shanti Dhan; P: Gokhale College; Q: MHB Colony; R: Borivali Fire Station; DG: Gorai Dumping Ground

Figure 3.17c: Contour Map of PM Concentrations during Winter Season
**(Site Gorai)**

The 2nd peak was observed at Gorai Bridge location with the concentration of 0.398 mg /m3 and the reason could be the heavy traffic converging on nearby bridge.

3.3 Measurements and Assessment at Diva Khardi Dumping Ground

The measurements of concentration of the odorous compounds H_2S, CH_4, NH_3, CH_4S, DMS and VOC and Particulate Matter were carried out over a days at various distances in the vicinity of the Diva Khardi Dumping Ground. The seasonal variation of measurement parameters for pre monsoon, post monsoon and winter are presented **Table 3.9, 3.10, 3.11**andare depicted in **Figure 3.18**.

Table 3. 9: Diva Khardi Pre Monsoon Season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H_2S ppm	CH_4 ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	Salvi Nagar 2 (S)	200m	34.5	66.1	E/W	1.5	ND	0.17	12.2	0.09	12.42	ND	0.06	0.063	0.072
	National School (S)	500m	35	65.4	W/E	1.8	ND	0.19	ND	0.21	5.41	54.48	0.07	0.076	0.1
	Sudama Residency (S	1km	34.5	67.6	E/W	2.9	ND	0.2	ND	0.14	20	398.4	0.05	0.056	0.076
	Rainbow School (S)	3km	32.8	70.3	W/E	2.9	ND	0.13	1.33	0.2	39.15	701.7	0.06	0.067	0.084
Day 2	Salvi Nagar 1 (Ne)	200m	34.2	66.6	E/W	17	ND	0.34	ND	0.34	17.21	774.3	0.12	0.127	0.179
	Ekvira Chawl (N)	500m	35.1	58.4	E/W	7.9	ND	0.26	ND	0.63	10.96	648.9	0.13	0.123	0.168
	Gaondevi Apartments (N)	1km	35.2	60.2	W/E	12	0.8	0.29	ND	0.46	51.22	540.6	0.1	0.112	0.136
	Diva School (N)	3km	34.8	59.6	S/N	7.6	0.6	0.49	ND	0.68	39.32	97.87	0.13	0.139	0.202
Day 3	Sumit Plaza (N)	200m	34	62	W/E	11	ND	0.48	ND	0.27	16.3	12.2	0.08	0.085	0.112
	Aadarsh Gurukul (NE)	500m	33.3	60.8	N/S	15	0.6	0.47	ND	0.39	40.23	637.8	0.09	0.094	0.107
	Global School (NE)	1km	34.2	57.1	S/N	16	0.49	0.45	ND	0.35	28.01	520.7	0.09	0.099	0.117
	Bedekar Nagar(NE)	3km	34.7	62	N/S	16	ND	0.43	ND	0.43	37.01	155	0.1	0.079	0.124
Day 4	Sudama Greens (SW)	500m	29.4	70.5	W/E	10	0.36	0.45	ND	0.03	35.27	373.3	0.08	0.088	0.111
	Om Residency (SW)	1km	31.1	67	E/W	13	0.61	0.39	ND	0.53	50.32	144.6	0.09	0.095	0.14
	Saraswati School (SE)	3km	30.2	72.4	E/W	9.7	ND	0.48	ND	0.35	41.95	502.1	0.1	0.103	0.142
Day 5	Mumbra Hospital (SW)	3km	31.5	53.8	N/S	2.5	ND	0.13	1.22	5.58	26.31	ND	0.13	0.147	0.276
	Mumbra Police stn.(SW)	3km	31.4	54.6	N/S	1.4	ND	0.65	10.1	0.5	28.29	ND	0.19	0.213	0.286
	Patil School (SW)	3km	30.2	58.8	N/S	1.1	ND	0.41	3.75	0.56	26.77	ND	0.17	0.196	0.374
	Global Park (SW)	3km	29.5	54.8	N/S	3.2	0.2	0.34	4.1	0.54	34.19	ND	0.22	0.247	0.481
	Kalsekar College (SW)	3km	29.4	56.5	S/N	4	0.4	0.16	2.06	0.29	43.94	ND	0.28	0.322	0.618

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

Table3.10: Diva Khardi Post Monsoon Season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H$_2$S ppm	CH$_4$ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m^3	PM2.5 mg/m^3	PM10 mg/m^3
Day 1	Salvi Nagar	200m	38.1	28.4	N/S	6.84	0.12	0.17	ND	ND	18.41	ND	0.033	0.037	0.09
	Adarsh Gurukul	500m	38	29.4	NW/SE	3.6	0.11	0.12	ND	ND	14.26	ND	0.053	0.062	0.222
	Ekvira Chawl	500m	38.6	28.9	N/S	6.84	0.15	0.11	ND	ND	12.65	ND	0.053	0.071	0.301
	Gaonevi Apartments	1km	39.3	27.4	SW/NE	5.04	0.16	0.14	ND	ND	15.28	107.43	0.049	0.059	0.181
	Global School	1km	38	29.8	E/W	4.68	0.06	0.19	ND	ND	12.62	ND	0.053	0.064	0.209
Day 2	Sabegaon	200m	38	27.5	NE/SW	5.04	1.17	0.23	8.18	ND	143.16	158.02	0.096	0.153	0.878
	National School	500m	38.2	30.7	NW/SE	4.32	ND	0.17	ND	0.58	10.98	ND	0.039	0.05	0.217
	Sudama Residency	1km	35.9	33.4	NE/SW	3.96	0.23	0.27	ND	ND	20.02	ND	0.021	0.024	0.061
	Om Residency	1km	37.3	32.8	W/E	2.88	ND	0.22	ND	2.97	50.93	ND	0.062	0.078	0.369
	Rainbow School	3km	36.3	31.5	W/E	7.92	ND	0.21	ND	ND	70.47	ND	0.088	0.101	0.439
Day 3	Sumit Plaza	200m	36.4	34.1	W/E	3.6	0.04	0.11	ND	2.49	1.53	87.65	0.057	0.065	0.17
	Aadarsh Ground	500m	35	34.8	SE/NW	2.88	ND	0.05	ND	4.36	8.12	71.32	0.043	0.049	0.134
	Post Office	3km	36.2	34.4	E/W	2.16	ND	0.07	4.87	2.12	39.04	0.7	0.332	0.446	2.703
	Diva School	3km	37.4	32.5	SW/NE	2.52	ND	0.09	1.02	1.91	10.11	73.74	0.113	0.141	0.659
	Saraswati School	3km	36.5	34.2	NW/SE	2.52	ND	0.17	ND	1.18	5.8	ND	0.043	0.049	0.126
Day 4	Mumbra Hospital	3km	32	52.6	S/N	1.44	ND	0.33	5.39	0.61	16.77	ND	0.13	0.147	0.27
	Mumbra Police Stn.	3km	31.1	55	N/S	1.8	0.8	0.18	11.95	0.34	46.06	ND	0.189	0.21	0.271
	Patil School	3km	30.4	58.8	N/S	1.8	0.7	0.3	3.2	0.11	11.3	ND	0.172	0.193	0.374
	Global Park	3km	30	56.2	N/S	2.88	0.28	0.2	14.83	0.65	26.53	ND	0.148	0.158	0.214
	Kalsekar College	3km	30	56.3	S/N	2.88	0.4	0.65	3.57	0.16	22.16	ND	0.282	0.32	0.617

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

Table3.11: Diva Khardi Winter Season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H₂S ppm	CH₄ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	Ekvira Chawl	200m	30.6	33.3	S/N	3.24	ND	0.14	ND	0.41	18.76	73.5	0.061	0.07	0.257
	Sumit Plaza	500m	31.7	31.3	SW/NE	9	ND	0.02	ND	ND	16.88	ND	0.056	0.063	0.155
	Gaondevi Apartments	1km	31.9	31.8	NW/SE	3.24	ND	ND	ND	0.13	11.18	93.51	0.078	0.101	0.452
	Diva Post Office	3km	32.2	30.6	SW/NE	1.8	ND	0.04	6.97	0.13	30.69	ND	0.282	0.362	2.471
	Diva High School	3km	32.8	32.1	NW/SE	3.24	2.15	ND	ND	ND	27.35	ND	0.128	0.154	0.684
Day 2	Salvi Nagar 1	200m	31.3	23.5	N/S	5.04	0.89	0.28	ND	ND	69.79	491.21	0.057	0.067	0.287
	Aadarsh Gurukul	500m	32.2	24.6	N/S	5.04	1.01	0.07	ND	ND	139.99	489.92	0.041	0.047	0.133
	Global English School	1km	31.6	24.4	NW/SE	5.4	1.12	0.07	ND	ND	71.45	345.48	0.045	0.051	0.16
	Bedekar Nagar	3km	30.5	24.9	SE/NW	3.6	1.67	0.17	ND	ND	144.54	264.13	0.068	0.084	0.4
Day 3	Salvi Nagar 2	200	31.8	27.4	N/S	8.28	1.14	0.08	ND	ND	42.7	190.99	0.062	0.07	0.196
	Sudama Greens	500	31.8	26.4	NW/SE	4.68	1.35	0.14	ND	ND	42.46	289.69	0.05	0.055	0.11
	Om Residency	1km	32.3	28	NW/SE	3.24	1.62	0.1	ND	ND	30.56	ND	0.06	0.066	0.15
	Saraswati School	3km	31.6	26.2	NE/SW	3.6	1.02	0.14	0.04	ND	15.82	ND	0.052	0.056	0.113
Day 4	National School	500m	27.5	39.1	NE/SW	2.16	1.96	0.05	26.11	1.52	39.42	180.91	0.512	0.638	1.272
	Sudama Regency	1km	27.7	37.6	E/W	2.88	1.56	0.43	ND	0.82	65.31	154.53	0.203	0.225	0.348
	Rainbow English School	3km	28.2	38	NW/SE	1.8	1.62	0.16	ND	0.73	13.61	76.67	0.137	0.154	0.32
Day 5	Mumbra Hospital	3km	29.3	35.1	NE/SW	1.08	1.16	0.23	3.03	0.68	70.46	83.76	0.121	0.136	0.361
	Mumbra Police Station	3km	29.7	34.3	N/S	1.08	1.38	0.09	1.79	0.27	88.07	23.74	0.099	0.108	0.238
	Global Park	3km	29.6	33.8	N/S	1.08	1.24	0.18	2.35	0.26	41.69	40.93	0.163	0.188	0.555
	Kalsekar College	3km	30.4	33.8	S/N	1.44	1.03	0.13	ND	0.33	57.62	ND	0.174	0.212	0.797
	Sakharam Patil School	3km	30	34.7	N/S	1.8	1.07	0.19	3.08	0.64	62.86	41.44	0.134	0.155	0.499

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

The overall measurements for all seasons for Diva Khardi Dumping Ground site is presented in **Table 3.12**and depicted in **Figure 3.19.**

Table 3.12: Range and average concentrations of pollutants at three seasons

Name of the Parameter	VOC (ppm)		H₂S (ppm)		CH₄ (ppm)		NH₃ (ppm)	
Range/Average	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
Pre Monsoon	0 - 0.8	0.19	0 - 0.65	0.33	0 - 12.18	1.65	0 - 5.58	0.60
Post Monsoon	0 - 1.17	0.20	0 - 0.65	0.19	0 - 14.83	2.52	0 - 34.12	2.86
Winter	0 - 2.15	1.09	0 - 0.43	0.13	0 - 26.11	2.07	0 - 1.52	0.28

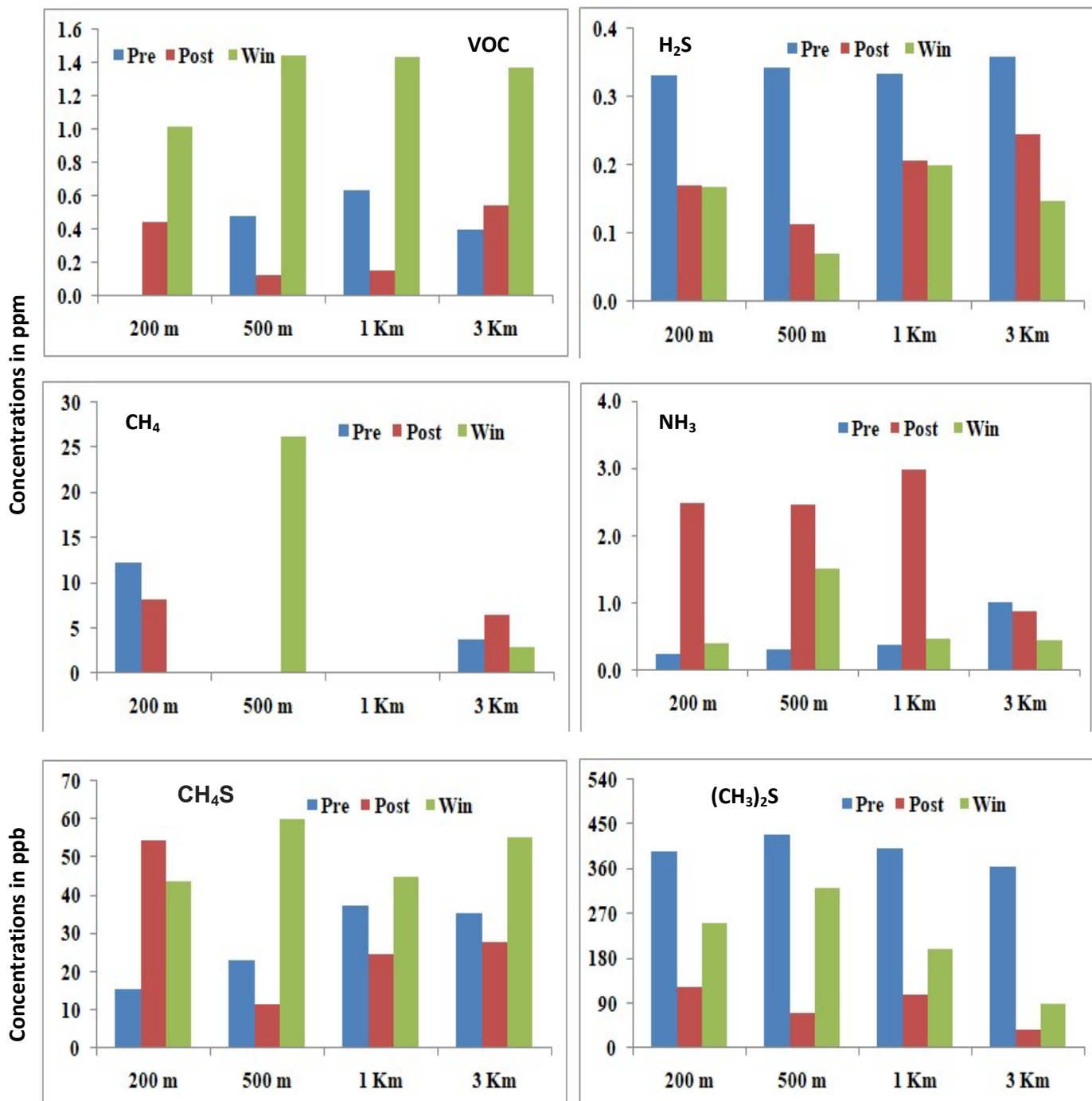# Diva Khardi Dumping Ground

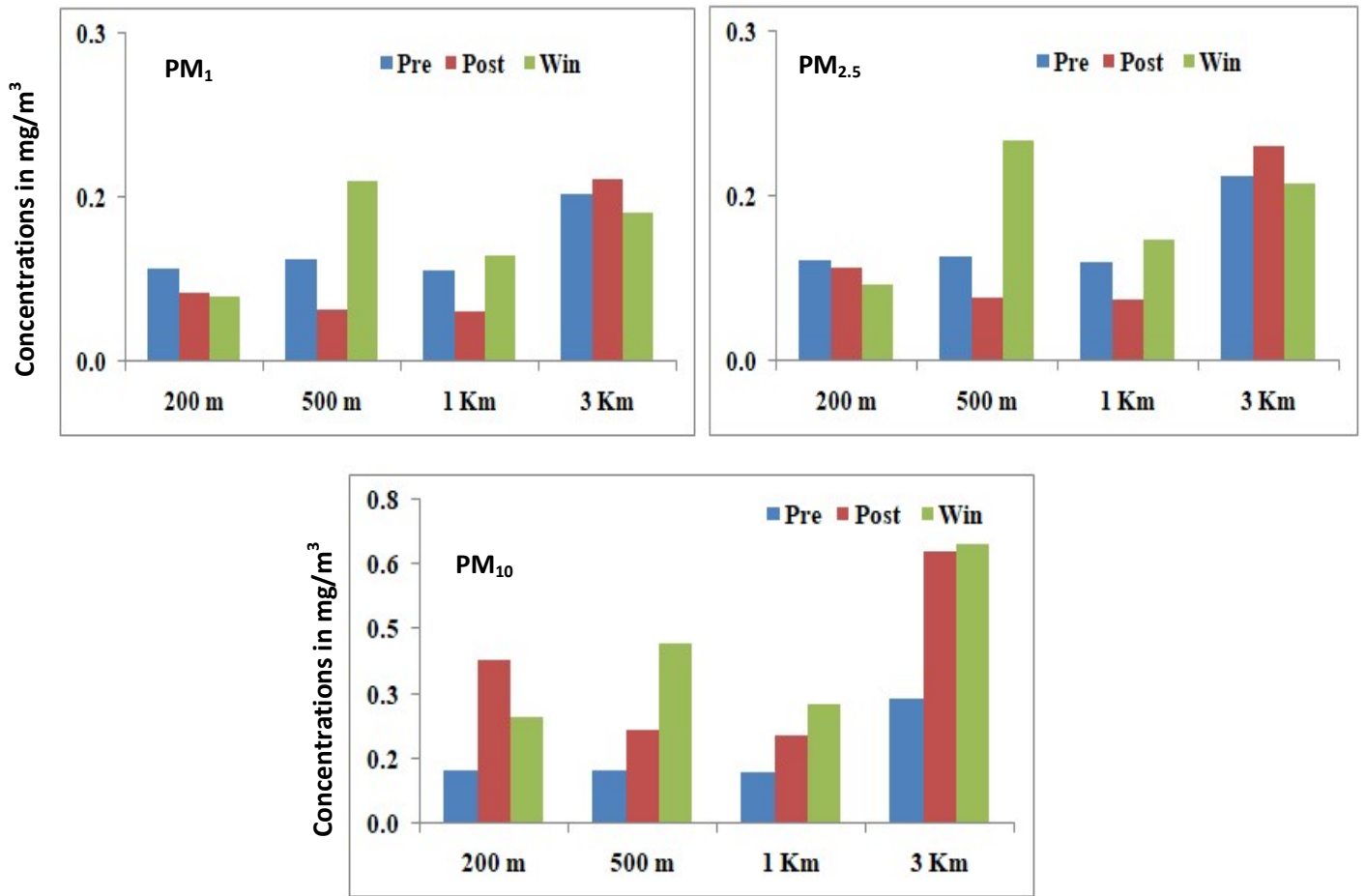
Figure 3.18: Three seasons concentrations

Figure 3.18 (Contd..) : Three seasons concentrations
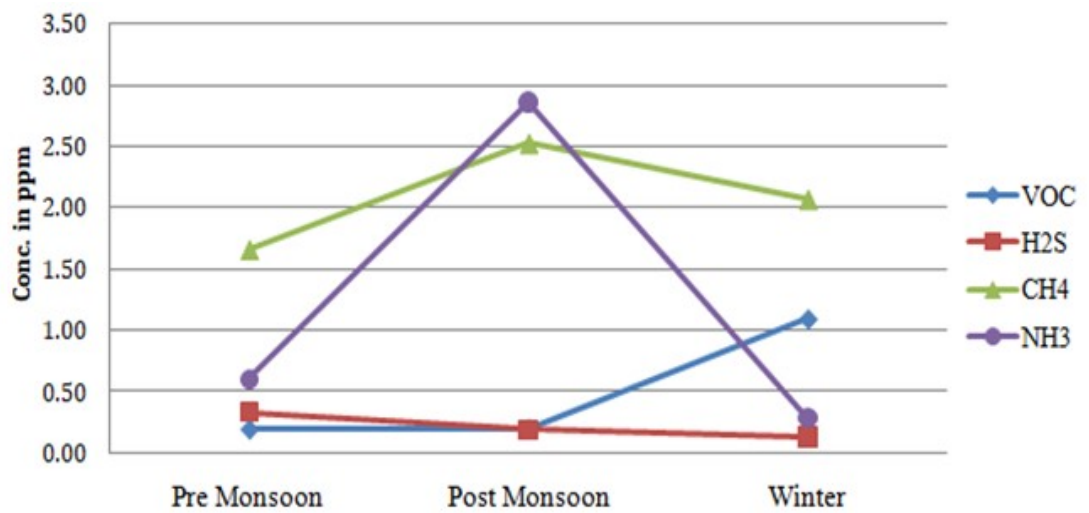
Figure 3.19: Three seasons average concentrations

3.3.1 Observations for three seasons

The VOC in winter at Diva-Khardi shows almost steady concentration at all distances of the level of about 1.4 ppm which obviously in a Pre and Post Monsoon time produces less than half concentration between 500 mtr to 3 Km it seems to be decreased considerably to 0.2 ppm to 0.4 ppm.

H_2S shows significant concentration at all distances probably due to the site is surrounded by marshy land and creek which generates H_2S. It was reported that the creek is carrying some industrial effluent making it more prevalent of significant amount of H_2S concentration which almost half level less than 0.2 ppm in Post Monsoon and Winter season.

In case of CH_4, it is almost nonexistence till about 1 Km except at 200 mtr in Pre and Post monsoon seasons and some diffused concentration at about 3 Km is observed suddenly. High concentration of about 25 ppm is observed in Winter season at 500 mtr is probably due to accumulated impact in Winter which may be emanation of methane by surrounding marshy land and it appears that it gets stabilized till about at distance about 3 Kms.

The NH_3 concentration is seen to be equally diffused at all distances in all seasons because of the property of steady diffusion of NH_3.

With regards to CH_4S and $(CH_3)_2S$ there appears to be permanent impact of these gases due to degradation of waste, marshy land, creek water, mixed industrial waste in Mumbra creek. The levels of at all times are under uniform influence as per seasonal climate impact.

The PM concentration of 1 to 10 are shown the fall of values during post monsoon, the Winter values are unusually seen higher than Pre & Post Monsoon time at all distances indicating their non-dispersal due to cold climate in Winter. It is very distinctly seen that during all seasons the PM concentration is higher at 3 Km which may be due to wind sweeps in one direction as one side of the site is intercepted by the mountain. All PM levels are many times higher at all distance also invite an action. The concentrations of the parameters at this site are above permissible level. The only assumption considered is the site almost surrounded by marshy land and polluted creek water which are contributory factor. The hazardous impacts of these parameters can be as referred in ***Chapter 4 Section 4.3***.

3.3.2 Expression of Measurements and Diffusion through Contour Maps -Diva Khardi

The contour maps as shown in **Figure 3.20 to 3.25** for each of the parameters and season are showed inconformity with the trends of measurements at Diva- Khardi site. The contours of the graphical assessment and closely signify the concentration of every parameter at <u>any given place within </u>the range of measurement. Some abruption can be seen in every map of either increased or abrupt decrease of concentration at places or otherwise steady decrease of concentration as one goes away from the site the aberration seen to be change due to wind direction and meteorological parameters.

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza;DG: Dumping Ground

Figure 3.20 b: Contour Map of VOC Concentrations during Post Monsoon Season (Site: Diva Khardi)

The 2nd peak was observed at Sabe Gaon (Salvi Nagar 1) with concentration of 1.17 ppm. The location is at 200 m distance and exactly opposite the dumping site and hence the peak. The 3rd peak was observed at a location of Mumbra Police Station area with the concentration 0.8 ppm. This might be the effect of Thane creek which is exactly opposite to this location.
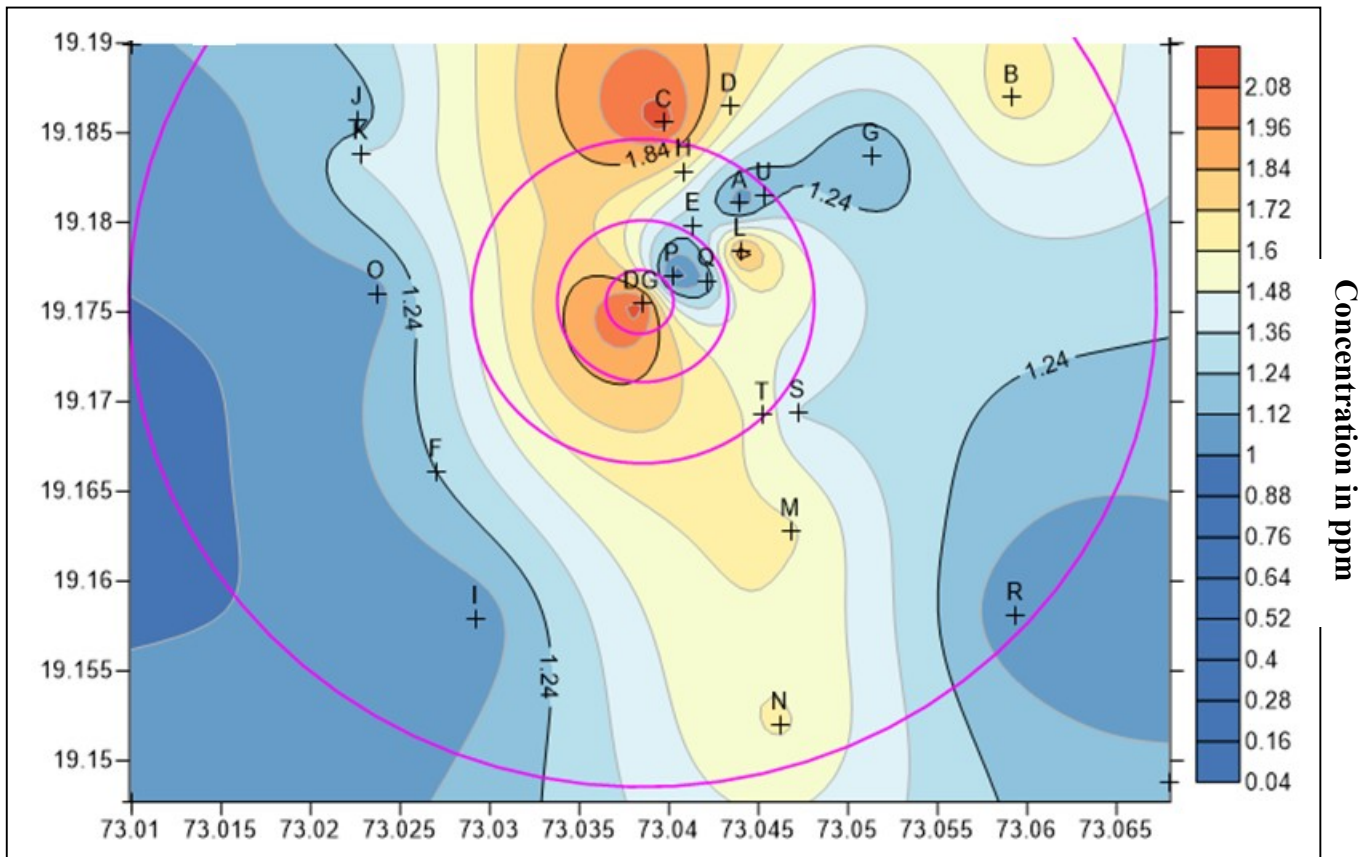
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station; L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.20 c: Contour Map of VOC Concentrations during Winter Season (Site: Diva Khardi)

The 2nd peak was observed at Diva-Khardi High School area at 3 km. shows concentration 2.15 ppm which may be due to heavy traffic in this nearby station area. The 3rd peak was observed at Bedekar Nagar with the concentration of 1.67 ppm. The area is surrounded by marshy land with sewage water and solid waste which could act as additional source.

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.21 a: Contour Map of H₂S Concentrations during Pre Monsoon Season
(Site: Diva Khardi)

The 2nd peak was observed at the location of Mumbra Police Station with concentration of 0.65 ppm. The reason could be as stated in 3.20 b. The 3rd peak was observed at Sarswati School at a distance of 3km showing concentration 0.48 ppm. The reason may be due to the waste dumping.

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station; L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.21 b: Contour Map of H$_2$S Concentrations during Post Monsoon Season (Site: Diva Khardi)

The 2nd peak was observed at the location at Kalsekar College with the concentration of 0.65 ppm. The reason might be the emissions coming from garbage transporting vehicles continuously plying from this area. .

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.21c: Contour Map of H₂S Concentrations during Winter Season (Site: Diva Khardi)

At Sudama Regency, the concentration observed is 0.43 ppm at 1 km distance. Salvi Nagar at 200 mtr. distance, the concentration observed is 0.28 ppm.

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

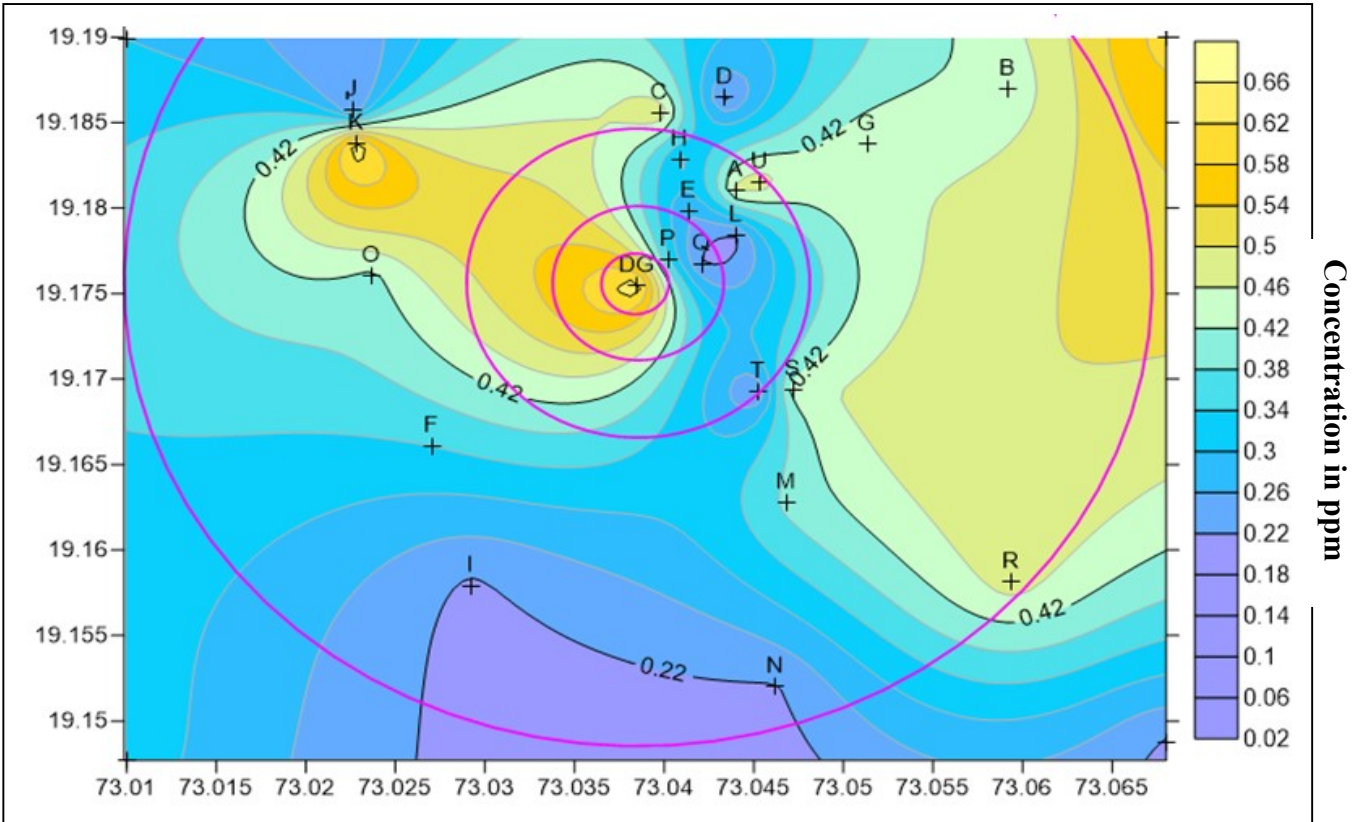**Figure 3.22 a: Contour Map of NH$_3$ Concentrations during Pre Monsoon Season (Site: Diva Khardi)**

The 2nd peak was observed with the concentration 5.58 ppm at the location of Mumbra Hospital. The reason might be the Thane creek close to the dumping site.

A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.22 c: Contour Map of NH$_3$ Concentrations during Winter Season
(Site: Diva Khardi)

The 2nd Peak was observed at National School area with the concentration of 1.52 ppm. The school location is exactly opposite to the dumping site at 200 m which could be the reason.
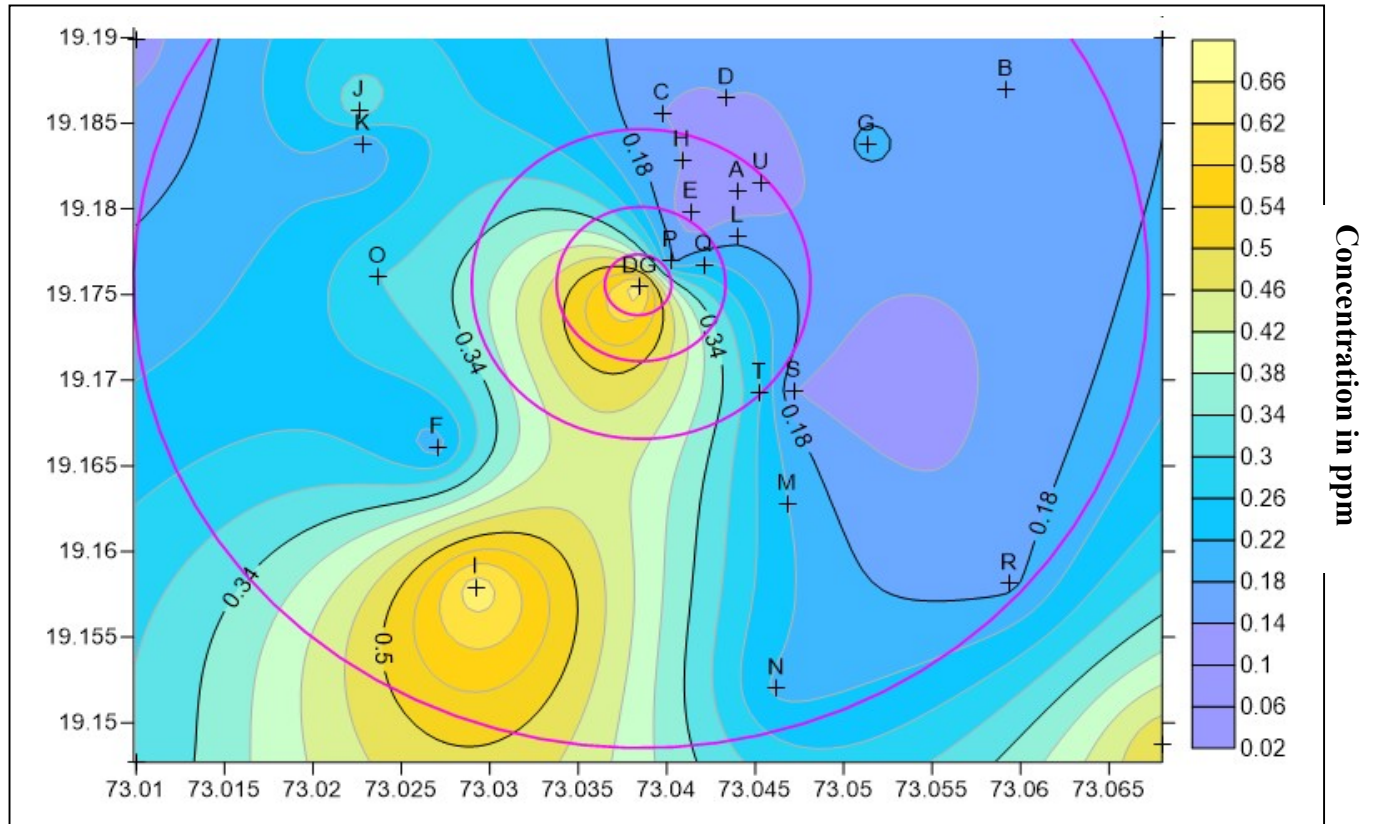
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.23 a: Contour Map of Mercaptan Concentrations during Pre Monsoon Season (Site: Diva Khardi)

The second peak was observed at Goandevi Apartment location with the concentration 51.22 ppb. The concentration can be attributed to the nullah flowing adjacent to the apartment carrying sewage and solid waste.
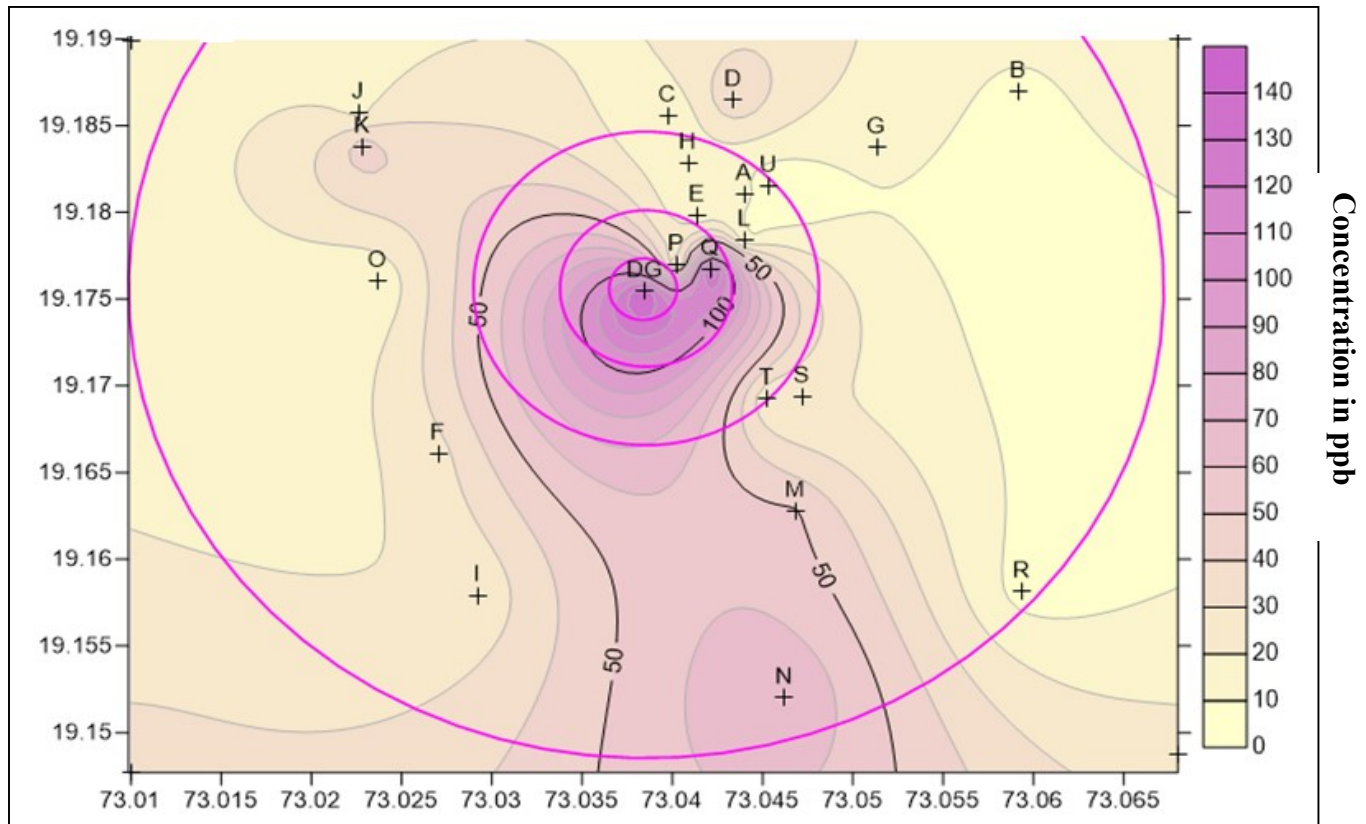
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.23 b: Contour Map of Mercaptan Concentrations during Post Monsoon Season (Site: Diva Khardi)

The 2nd peak was observed at 3km distance at a location of Rainbow School area with the concentration 70.47 ppb. The reason can be the garbage vehicles are continuously passing through this nearby road and also the old waste lying behind this location.
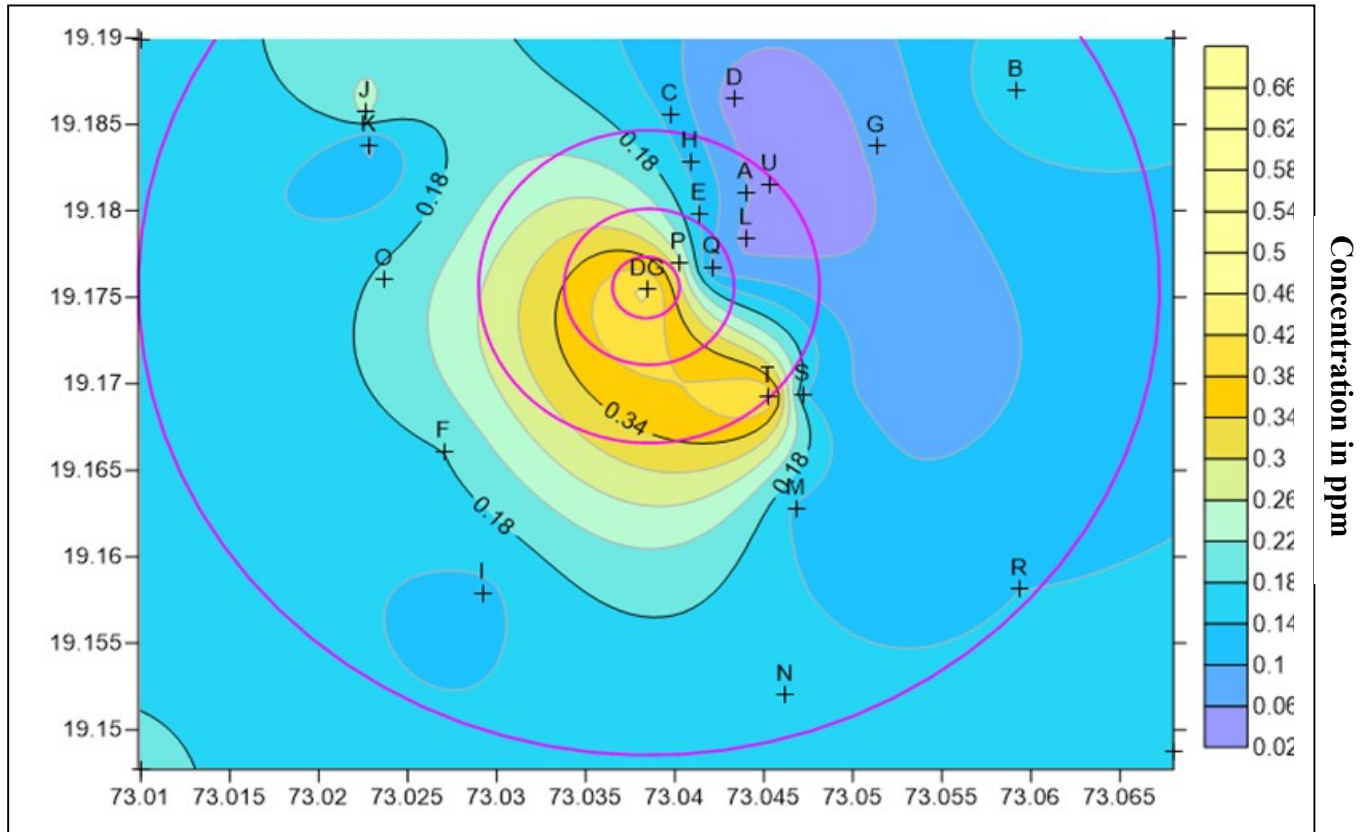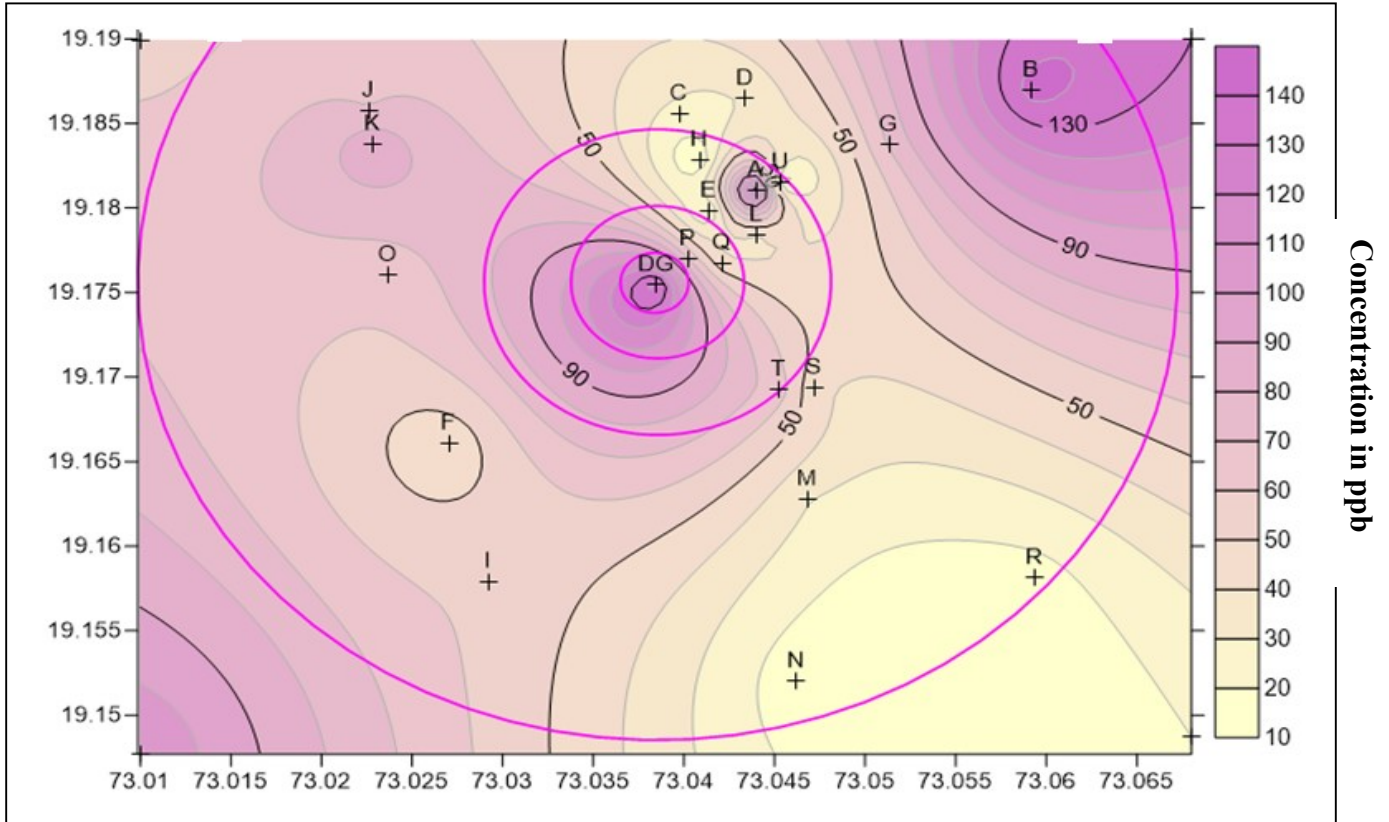
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.23 c: Contour Map of Mercaptan Concentrations during Winter Season (Site: Diva Khardi)

The 2nd peak was observed at Bedekar Nagar area with the concentration of 144. 54 ppb and reason stated in 3.20 c. The 3rd peak was observed at Mumbra Police station 88.07 ppb and reason is as explained in 3.20 b.
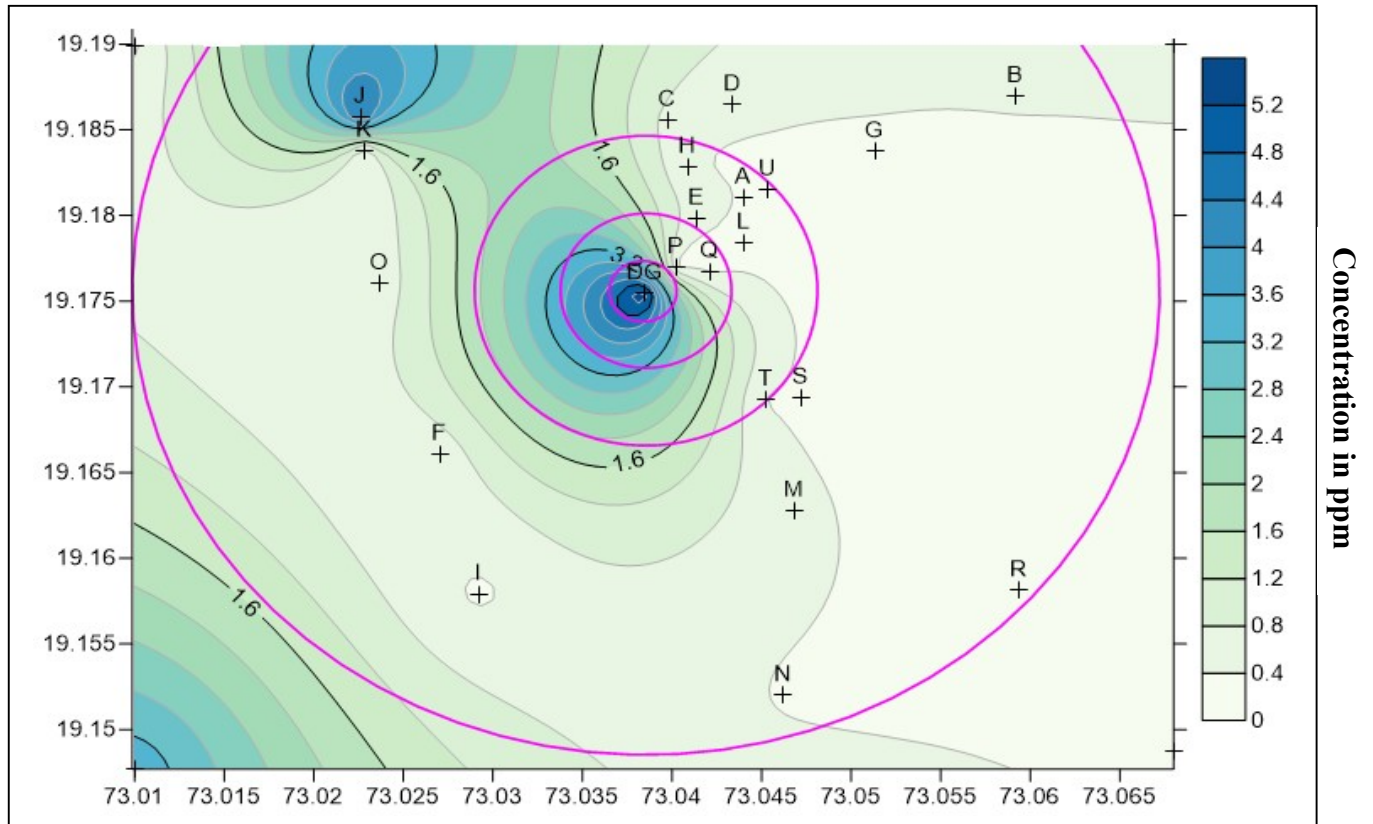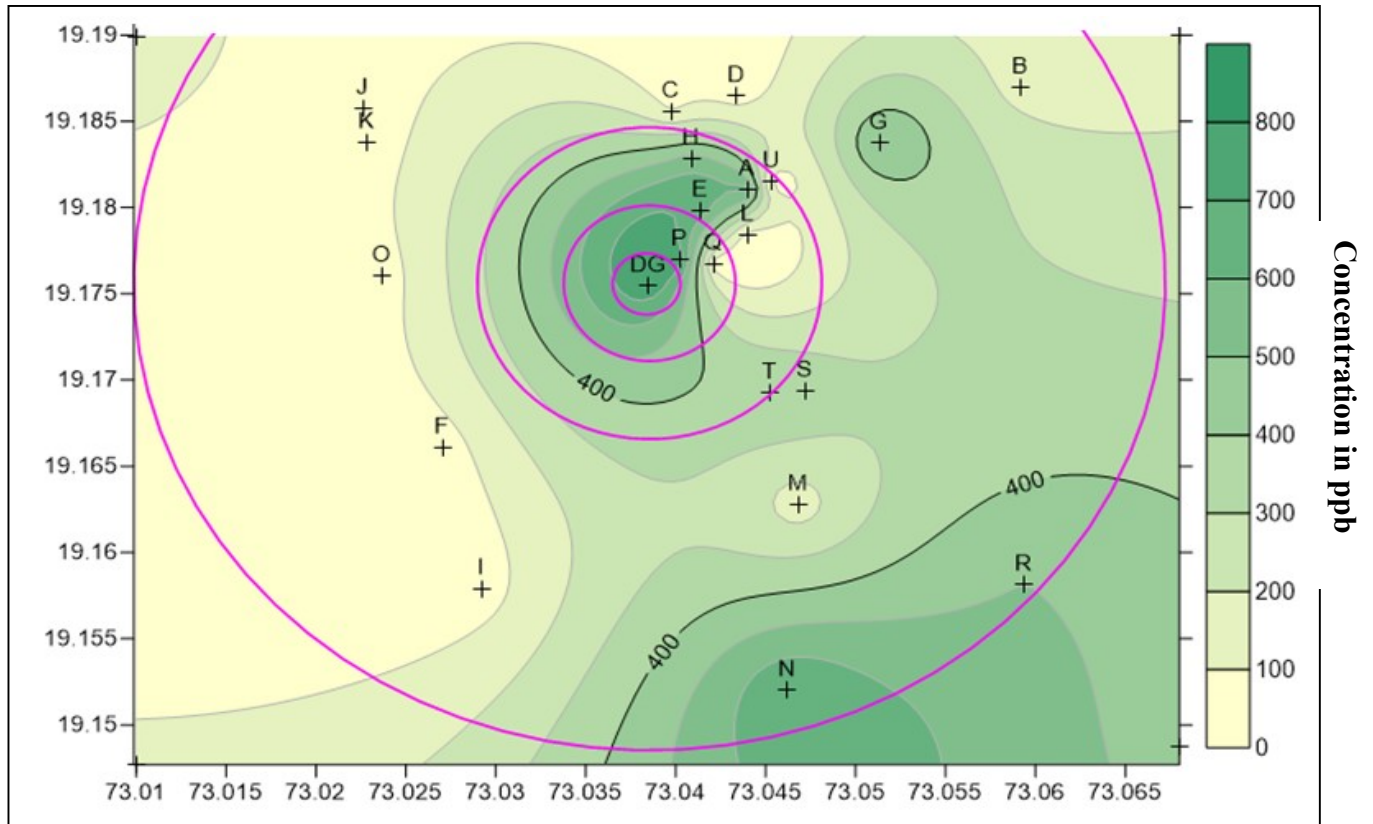
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.24 a: Contour Map of DMS Concentrations during Pre Monsoon Season (Site: Diva Khardi)

The 2nd Peak was observed at Global School area and concentration of 520.7 ppb. The area is surrounded by sewage water coming from nearby apartments and this might be one of the reasons to contribution in the concentration of DMS.
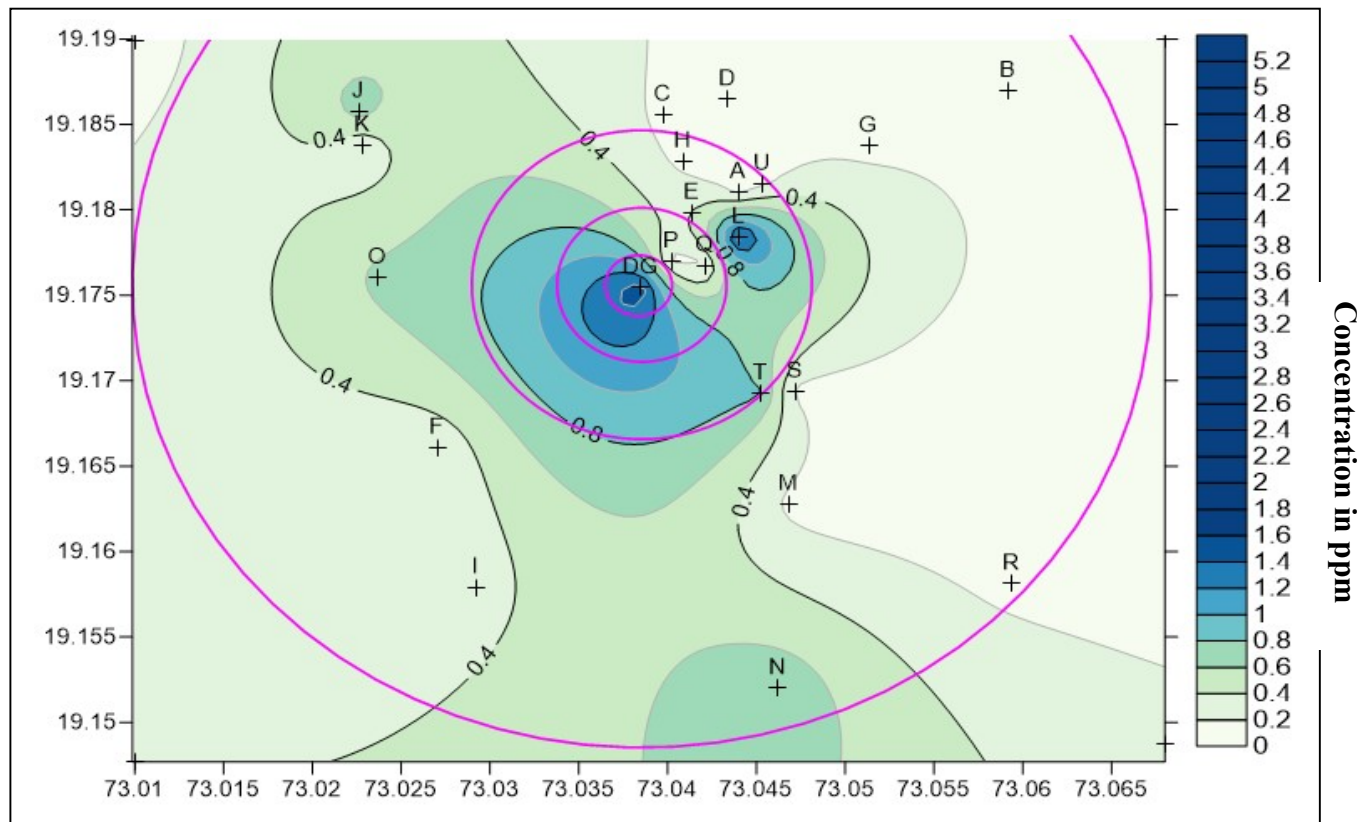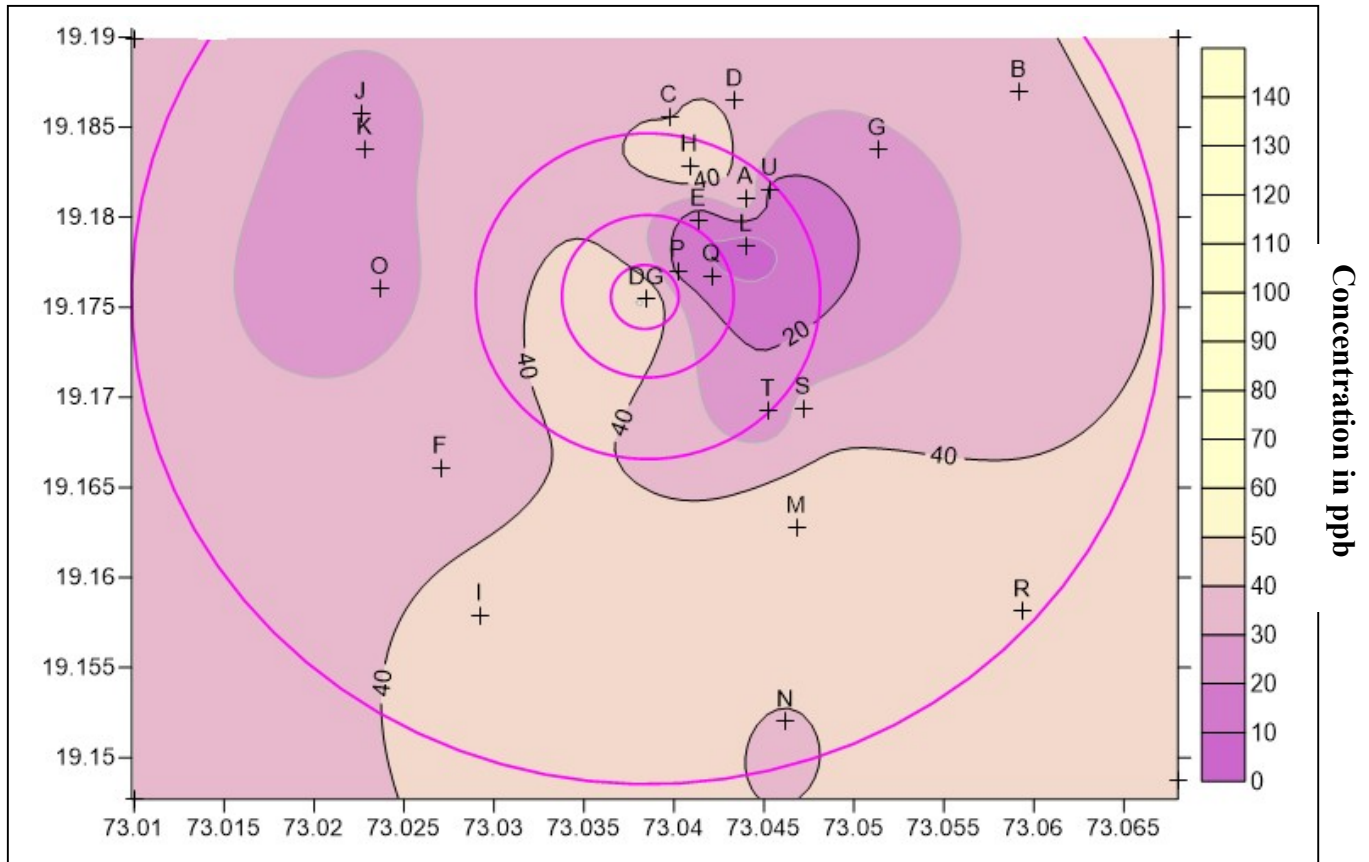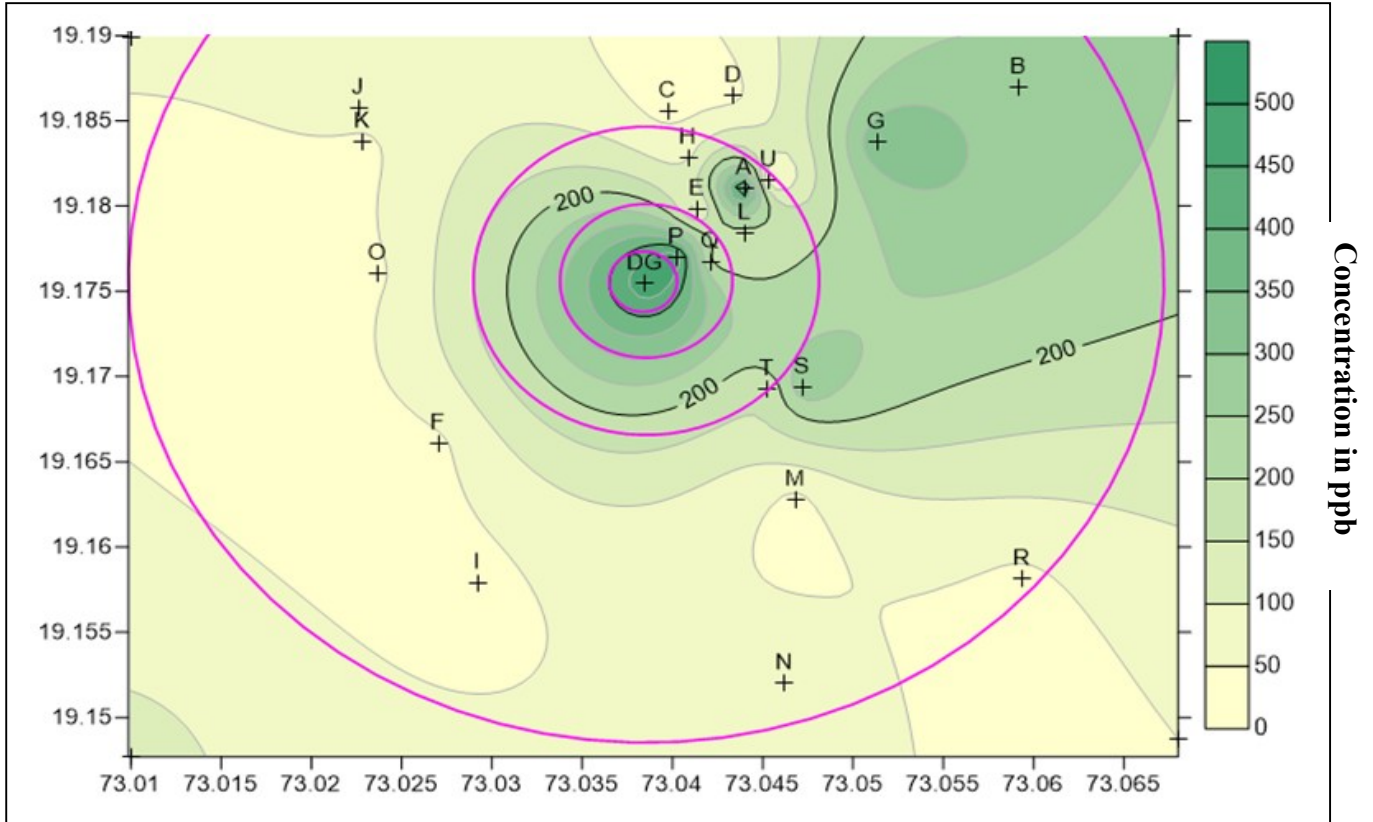
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.24 c: Contour Map of DMS Concentrations during Winter Season

In this season 2nd and 3rd peaks were observed at the locations Bedekar Nagar and Global School area with concentrations observed 264.13 ppb and 345.48 ppb respectively and the reasons are as explained in 3.20c and 3.24a.
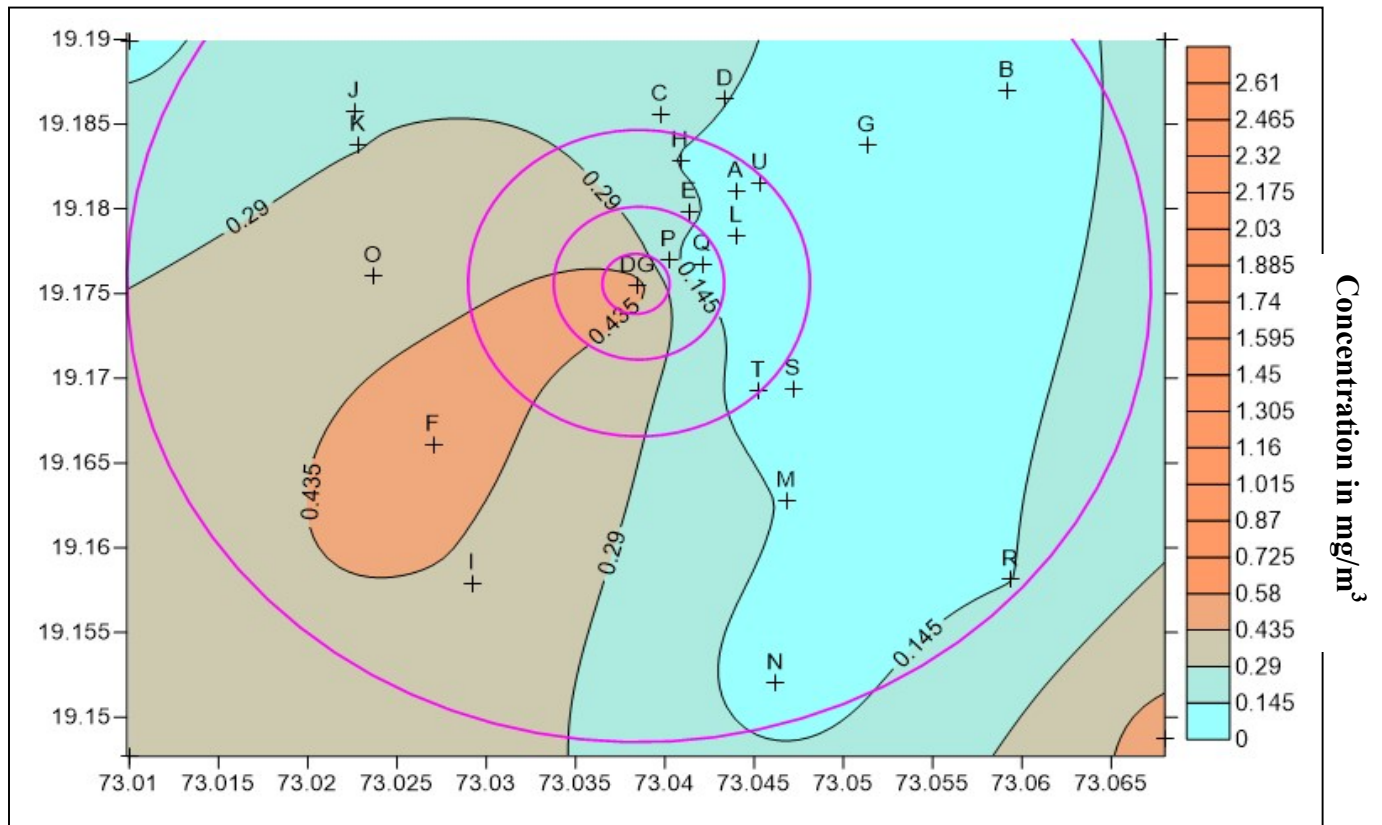
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.25 a: Contour Map of PM Concentrations during Pre Monsoon Season (Site: Diva Khardi)

The 2nd peak was observed at 3 km. at location Global Park with the concentration of 0.481 mg/m^3. This may be due to continuous vehicular traffic towards Shilphata Road and Mumbra city.
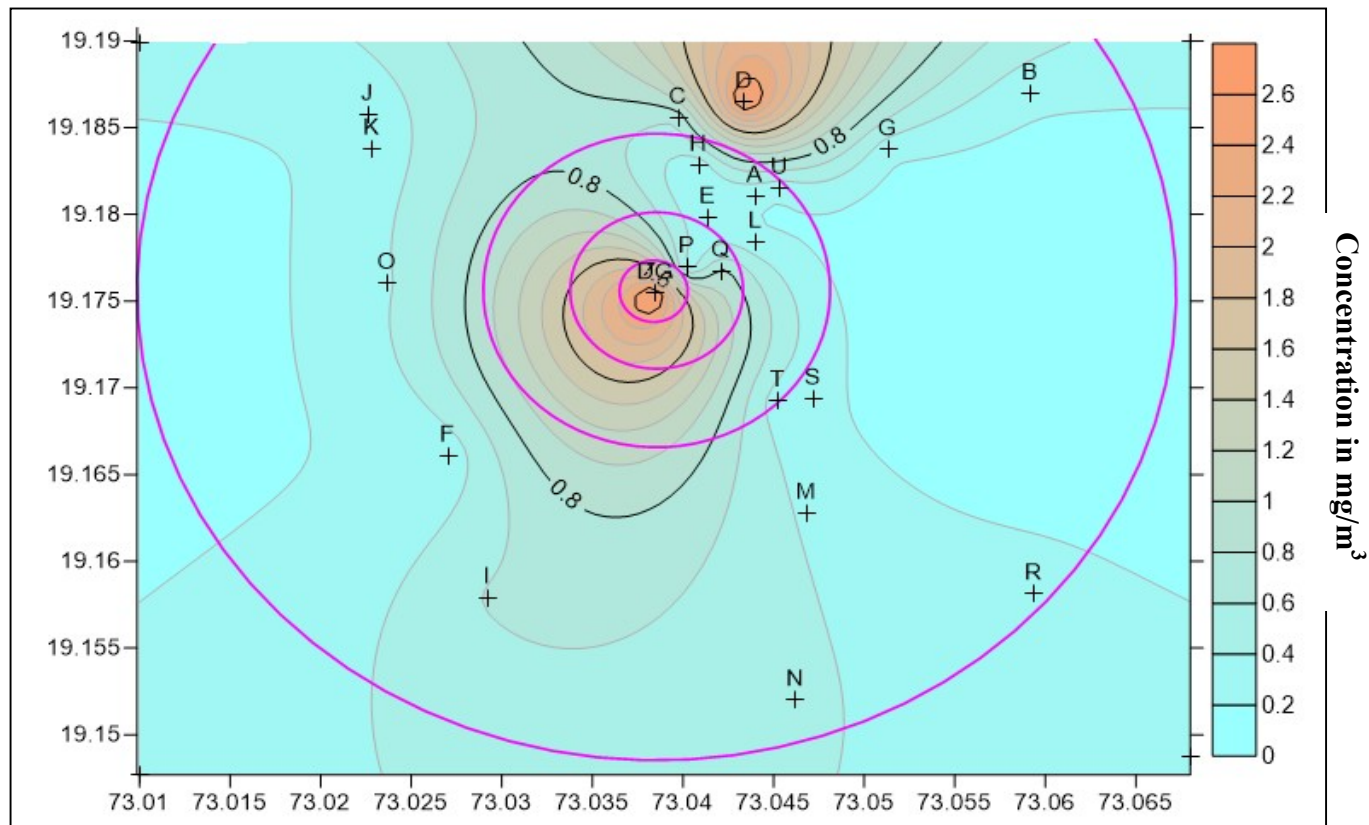
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.25 b: Contour Map of PM Concentrations during Post Monsoon Season (Site: Diva Khardi)

The 2nd peak was observed at Diva Post Office location at the distance of 3km and concentration was observed to be 2.703 mg/m3. This location is nearest to the Diva Station and junction point of the vehicles; this may be the reason for the concentration observed at this location.
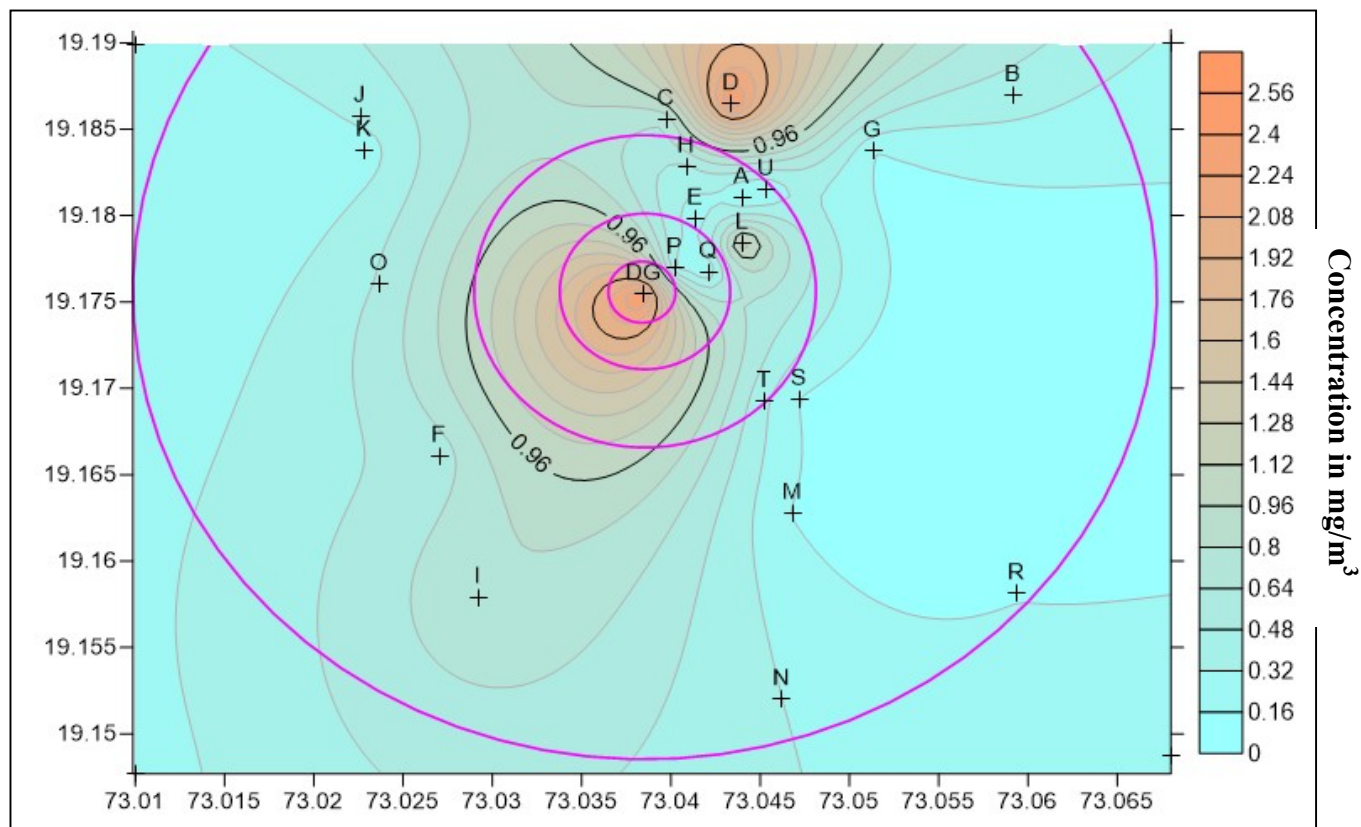
A: Aadarsh Gurukul; B: Bedekar Nagar; C: Diva high School; D: Diva Post Office; E: Ekvira Chawl; F: Global Park; G: Global School; H: Goandevi; I: Kalsekar College; J: Mumbra Hospital; K: Mumbra Police Station;L: National School; M: Om Residency; N: Rainbow School; O: Sakharram Patil Vidya Mandir; P: Salvi Nagar 1; Q: Salvi Nagar2; R: Saraswati School; S: Sudama Greens; T: Sudama Regency; U: Sumit Plaza; DG: Dumping Ground

Figure 3.25 c: Contour Map of PM Concentrations during Winter Season (Site: Diva Khardi)

In winter season at the same location the 2nd peak was observed with the concentration of 1.272 mg/m3 and this could be as stated in 3.24 b.

3.4 Measurements and Assessment at Turbhe Waste Processing Facility

The measurements of concentration of the odorous compounds H_2S, CH_4, NH_3, CH_4S, DMS and VOC and Particulate Matter were carried out over a days at various distances in the vicinity of the Turbhe Waste Processing Facility. The seasonal variation of measurement parameters for pre monsoon, post monsoon and winter are presented **Table 3.13, 3.14 and 3.15**andare depicted in **Figure 3.26**.

Table: 3.13: Turbhe Waste Processing Facility Pre Monsoon Season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H_2S ppm	CH_4 ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	ND Samata Vidyalaya (W)	200m	39.1	52.3	S/N	8.6	ND	0.51	ND	ND	61.49	ND	0.19	0.205	0.28
	Shivshakti Nagar (W)	500m	38.6	49.6	NE/SW	7.9	ND	0.16	ND	0.53	51.24	ND	0.16	0.172	0.206
	Shalimar Stop (N)	1km	38.2	50.4	S/N	4.7	ND	0.14	ND	0.25	82.24	ND	0.15	0.163	0.175
	Khairane Gaon (NW)	3km	38.9	48	E/W	3.2	ND	0.25	ND	ND	43.9	ND	0.15	0.165	0.199
Day 2	W.P.F Gate (E)	200m	37	49.4	N/S	5.4	ND	0.12	5.84	ND	63.27	ND	0.2	0.206	0.292
	BASF (E)	500m	39.5	46	SW/NE	6.8	ND	0.27	ND	ND	89.09	ND	0.17	0.175	0.208
	Haribaba Sadhu Marg (SW)	1km	37.5	43.5	SE/NW	5.4	ND	0.16	ND	ND	48.17	ND	0.15	0.152	0.169
	Jui Nagar Municipal School (S)	3km	39.2	45.8	W/E	3.2	ND	0.16	ND	ND	51.89	ND	0.16	0.158	0.202
Day 3	Road next to WPF (N)	200m	37.2	46.8	N/S	2.9	ND	0.16	ND	ND	49.85	ND	0.16	0.162	0.218
	Parsik Hill (E)	500m	39.1	45.1	SW	4	ND	0.15	ND	ND	40.12	ND	0.17	0.172	0.229
	Turbhe Naka (S)	1km	39.5	45.5	SE	2.5	ND	0.14	ND	ND	83.62	ND	0.33	0.351	0.645
Day 4	WPF	200m	37.8	43.4	NE	4.3	ND	0.15	ND	ND	85.5	ND	0.18	0.186	0.274
	Yashraj Biotech (N)	500m	40.9	37.1	SW	3.6	0.5	0.16	ND	ND	61.36	ND	0.23	0.233	0.346
	Sky Industries (NE)	500m	40.7	37.7	SE	3.2	ND	0.18	ND	ND	99.11	ND	0.18	0.186	0.256
	Global Lab (S)	1km	40.5	38.7	W/E	3.6	ND	0.1	ND	ND	61.46	ND	0.15	0.154	0.18
	Savita Chemicals (NW)	1km	41.4	38.6	N/S	3.2	ND	0.16	ND	ND	54.86	ND	0.18	0.186	0.234
	Wasan Toyota (N)	1km	41.2	36.7	NE	4	ND	0.15	ND	ND	26.12	ND	0.17	0.171	0.222
Day 5	Prabhat Dairy (W)	1km	31.4	56.9	S	1.4	ND	0.09	ND	ND	28.77	ND	0.32	0.307	0.429
	Head Post Office Vashi (S)	3km	31.7	60.6	SW	2.2	ND	0.14	ND	ND	31.3	ND	0.47	0.483	0.822
	Shiravne Gaon (S)	3km	31.8	58.2	SE	1.4	ND	0.12	ND	ND	32.75	ND	0.36	0.365	0.528

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

Table: 3.14: Turbhe Waste Processing Facility Post Monsoon Season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H$_2$S ppm	CH$_4$ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m^3	PM2.5 mg/m^3	PM10 mg/m^3
Day 1	Samata School	200m	38.3	51.6	S/N	3.24	ND	0.28	ND	ND	68.46	ND	0.119	0.14	0.184
	Shivshakti Nagar	500m	38	50.7	NE/SW	2.88	ND	0.11	ND	0.29	45.95	ND	0.071	0.084	0.131
	Shalimar Stop	1km	37.5	49.7	N/S	3.96	ND	0.13	ND	0.03	73.17	ND	0.119	0.14	0.205
	Khairane Gaon	3km	36.2	49.6	E/W	3.24	ND	0.14	ND	ND	35.47	ND	0.106	0.128	0.188
Day 2	WPF Gate	200m	36.6	50	NE/SW	3.6	ND	0.15	ND	ND	74.43	ND	0.194	0.197	0.254
	BASF	500m	38.4	45.6	NW/SE	5.04	ND	0.15	ND	ND	62.35	ND	0.229	0.233	0.271
	Haribaba Sadhu Marg	1km	37.1	45.7	SW/NE	4.32	ND	0.15	ND	ND	38.07	ND	0.168	0.171	0.221
	Jui Nagar Municipal School	3km	36.9	50	E/W	1.8	ND	0.15	ND	ND	49.69	ND	0.198	0.185	0.282
Day 3	Road next to WPF	200m	36.6	46.3	E/W	3.96	ND	0.21	ND	ND	66.14	ND	0.184	0.188	0.233
	Parasik Hill	500m	37	45	S/N	3.24	ND	0.16	ND	ND	46.85	ND	0.194	0.199	0.264
	Turbhe Naka	1km	37	44.5	SW/NE	11.16	ND	0.18	ND	ND	55.75	ND	0.403	0.428	0.843
	Indira Nagar	1km	37.3	43.5	S/N	3.6	ND	0.14	ND	ND	62.72	ND	0.254	0.262	0.367
Day 4	WPF	200m	37.2	39.1	N/S	3.24	ND	0.12	ND	ND	44.44	ND	0.25	0.258	0.334
	Yashraj Biotech	500m	39.4	36.6	SW/NE	2.52	ND	0.16	ND	ND	40.17	ND	0.177	0.182	0.224
	Sky Industries	500m	37.9	38.9	SE/NW	5.76	ND	0.13	ND	ND	104.42	ND	0.243	0.251	0.349
	Global Lab	1km	39.3	37.2	W/E	4.32	ND	0.2	ND	ND	37.84	ND	0.244	0.253	0.419
	Savita Chemicals	1km	38.6	37.4	NW/SE	2.88	ND	0.13	ND	ND	55.41	ND	0.154	0.158	0.199
	Wasan Toyota	1km	38.7	36.4	S/N	2.52	ND	0.19	ND	ND	109.37	ND	0.168	0.173	0.217
Day 5	Prabhat Dairy	1km	31.4	56.9	E/W	1.44	ND	0.09	ND	ND	28.77	ND	0.299	0.307	0.429
	Vashi Post Office	3km	31.7	60.6	W/E	2.16	ND	0.14	ND	ND	31.3	ND	0.465	0.483	0.822
	Shiravne Gaon	3km	31.8	58.2	N/S	1.44	ND	0.12	ND	ND	32.73	ND	0.356	0.365	0.528

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

Table3.15: Turbhe Waste Processing FacilityWinter season

	Location	Distance in m	Temp °c	Humidity RH	WD	WS m/s	VOC ppm	H₂S ppm	CH₄ ppm	NH3 ppm	MER ppb	DMS ppb	PM1 mg/m³	PM2.5 mg/m³	PM10 mg/m³
Day 1	WPF Gate	200m	32.9	38	W/E	1.8	0.38	0.09	ND	ND	26.28	78.7	0.083	0.091	0.195
	BASF	500m	33.9	37.1	E/W	2.88	0.49	0.2	2.9	0.03	21.05	ND	0.09	0.101	0.235
	Parsik Hill	500m	34.9	32.2	NW/SE	3.24	0.86	ND	ND	ND	52.86	374.97	0.088	0.107	0.388
	Indira Nagar	1km	34.3	35.8	N/S	3.96	0.57	0.02	ND	ND	30.52	ND	0.079	0.089	0.26
Day 2	WPF Gate	200m	34.8	37.7	SW/NE	1.44	1.66	0.04	0.77	ND	24.71	ND	0.226	0.287	1.874
	Yashraj Biotech	500m	34.8	38.3	SE/NW	2.88	1.86	0.03	30.59	ND	10.94	152.75	0.087	0.099	0.242
	Sky Industries	500m	35	37.6	E/W	2.88	1.75	0.11	3.41	ND	19.5	316.69	0.092	0.107	0.268
	Shalimar	1km	33.9	37.8	SE/NW	3.24	1.38	0.08	2.71	ND	64.47	337.65	0.115	0.14	0.422
Day 3	Samata H.School	200m	35.1	36.2	SE/NW	2.16	1.45	0.12	1.09	ND	59.93	158.87	0.104	0.112	0.253
	Wasan Toyota	1km	33.6	37.2	SE/NW	2.16	1.2	0.14	0.64	0.41	44.32	24.39	0.09	0.098	0.19
	Savita Chemicals	1km	34.7	36.4	N/S	2.88	1.43	0.14	0.22	0.3	42.15	20.05	0.111	0.121	0.298
	Khairane Gaon	3km	33.1	35.6	E/W	6.12	1.26	0.23	0.03	0.09	45.06	13.46	0.104	0.111	0.198
Day 4	Hari Baba Sadhu Marg	1km	30.8	41.1	SW/NE	1.44	1.55	0.09	8.58	0.47	22.74	126.32	0.161	0.177	0.413
	Turbhe Naka	1km	31.2	39.4	N/S	1.44	1.69	0.25	4.44	0.52	23.79	76.9	0.162	0.18	0.378
	Shiravane Gaon	3km	30.7	42.5	NW/SE	3.24	1.49	0.09	3.6	0.07	21	77.44	0.161	0.193	0.581
	Jui Nagar MNC School	3km	30.7	42.6	W/E	1.44	1.41	0.3	2.66	0.38	26.19	32.01	0.123	0.133	0.267
Day 5	Shivshakti Nagar	500m	30.2	41.1	N/S	1.8	1.61	0.06	26.2	0.12	35.53	58.89	0.202	0.221	0.401
	Global Lab	1km	31.5	39.8	E/W	2.88	1.9	0.05	8.52	0.11	31.92	93.56	0.172	0.201	0.506
	Prabhat Dairy	1km	30.4	40.4	W/E	2.16	1.64	0.06	3.34	0.24	51.38	36.72	0.147	0.184	0.438
	Vashi Post Office	3km	31.2	44	S/N	2.88	1.38	0.06	5.48	0.13	24.95	145.72	0.126	0.139	0.225

WD –Wind Direction, WS- Wind Speed, MER – Mercaptan, DMS- Dimethyl Sulphide

The overall measurements for all seasons for Turbhe Waste Processing Facility is presented in **Table 3.16** and depicted in **Figure 3.27.**

Table 3.16: Range and Average Concentrations of Pollutants at three seasons

Name of the Parameter	VOC (ppm)		H₂S (ppm)		CH₄ (ppm)		NH₃ (ppm)	
Range/Average	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
Pre Monsoon	0 - 0.5	0.03	0 - 0.51	0.16	0	0	0 - 0.53	0.04
Post Monsoon	0	0	0 - 0.28	0.15	0	0	0 - 0.29	0.02
Winter	0 - 1.9	1.26	0 - 0.3	0.10	0 - 30.59	5.04	0 - 0.47	0.12

Turbhe Waste Processing Facility (WPF)
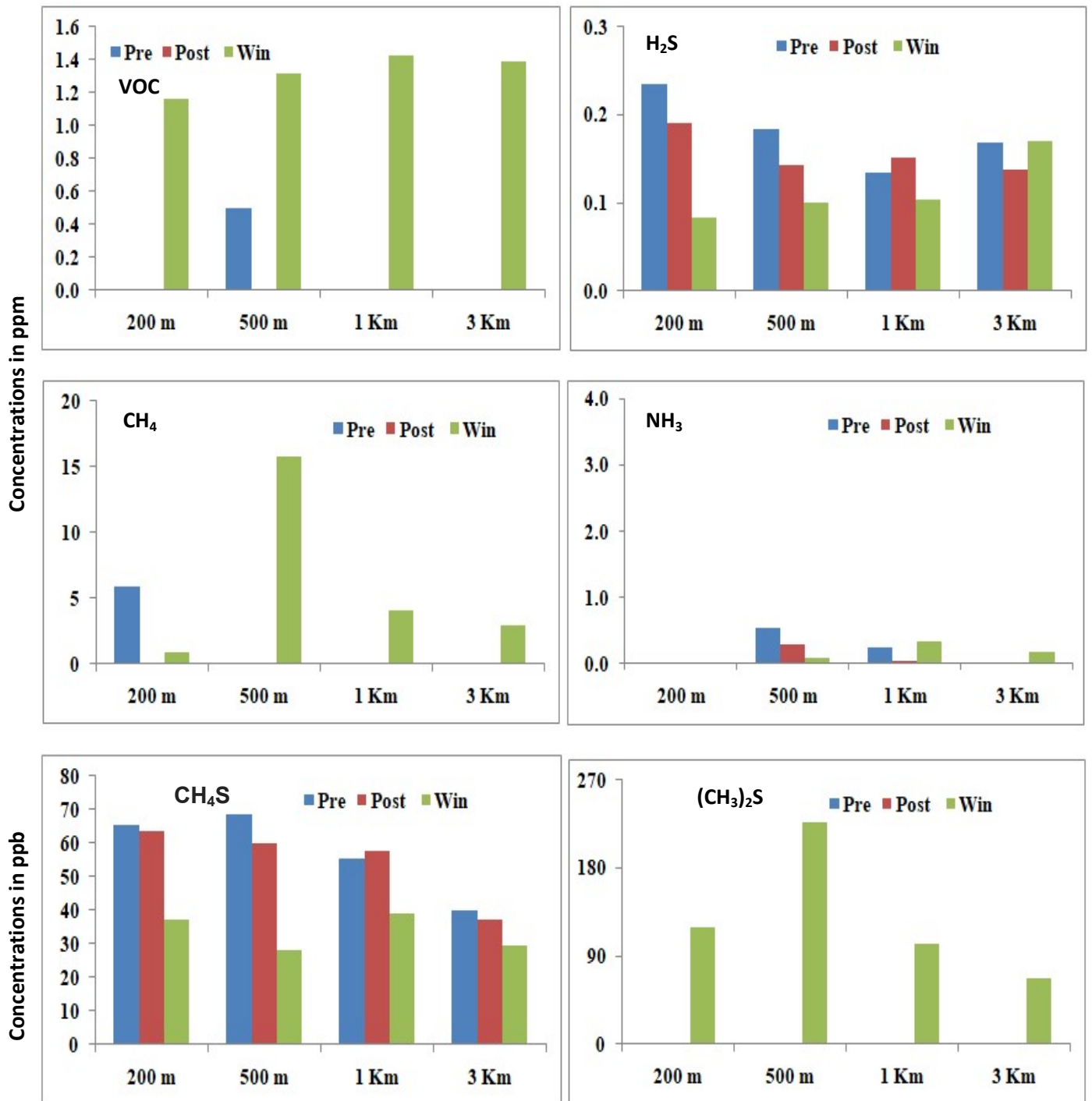
Figure 3.26: Three seasons concentrations
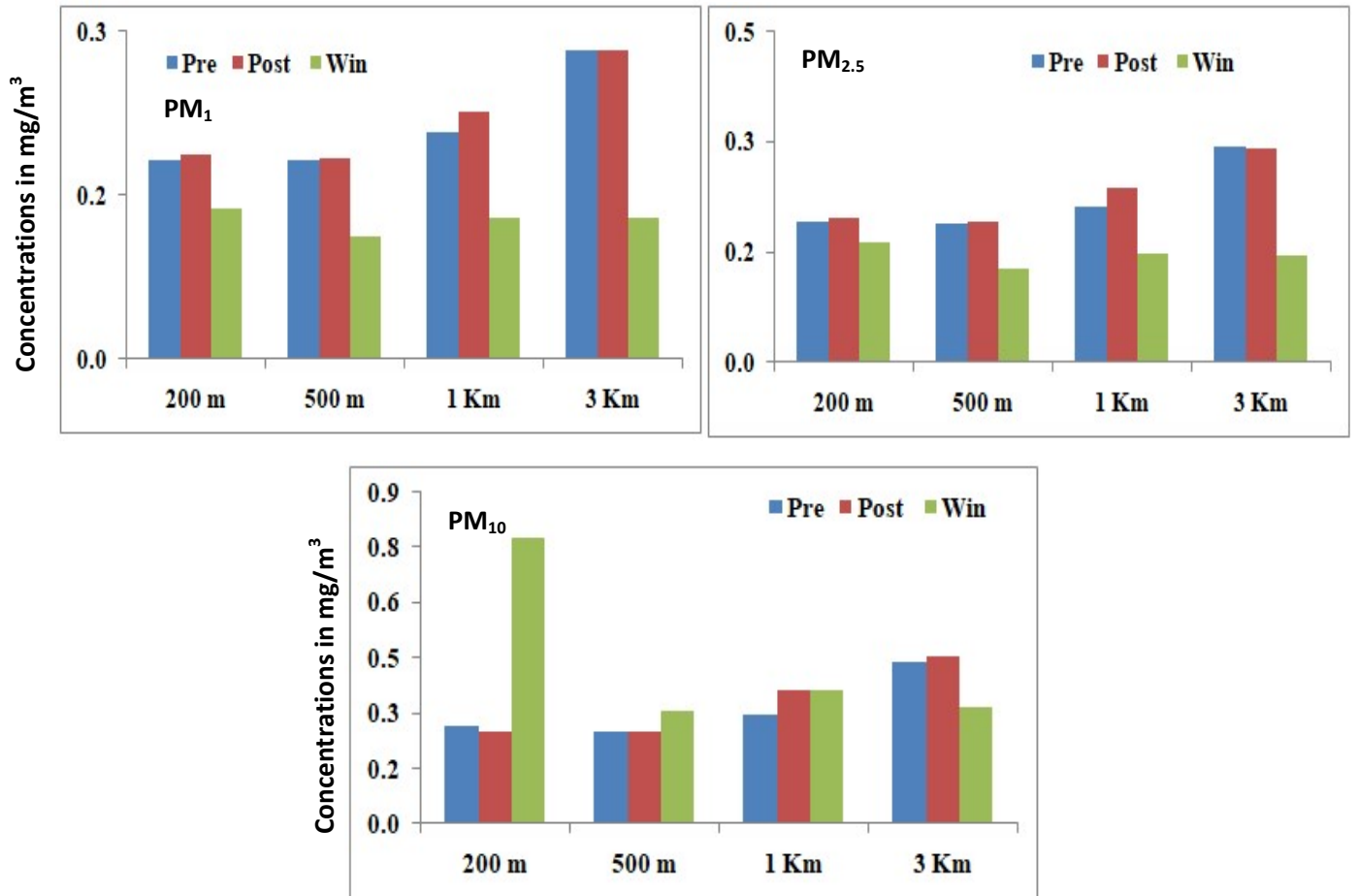
Figure 3.26 (Contd..) : Three seasons concentrations
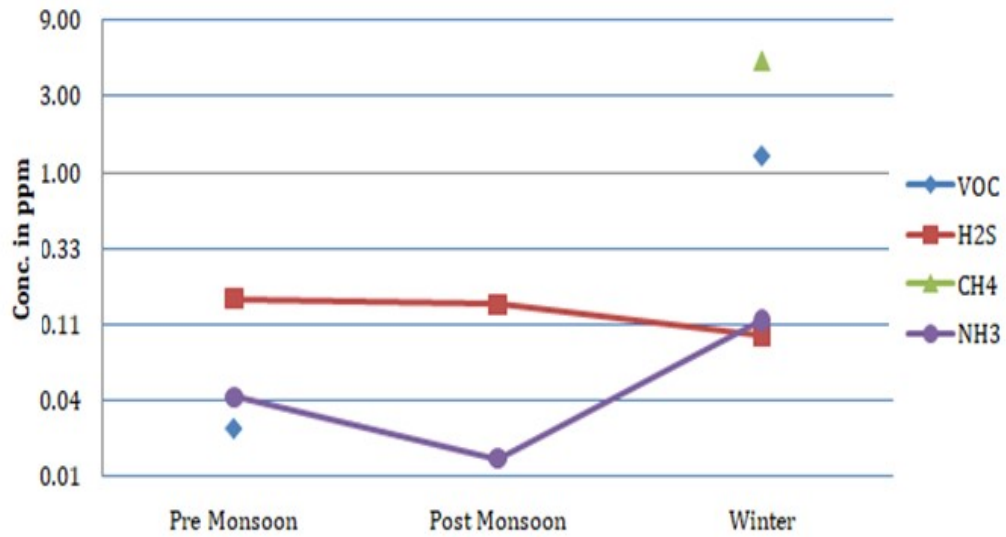
Figure 3.27: Three seasons average concentration

3.4.1 Observations for three seasons

It is a waste processing facility situated in a hilly area and by the side of chemical and pharmaceutical industrial area. It is good to see that there are no generation of VOC at the site except the marginal concentration at 500 mtr. from processing facility, whereas in Winter season there is some catch up of VOC of about 1.4 ppm up to 3 Km area, but it was again Winter impact due to non-dispersal of VOC and at a distance of 1 Km and 3 Km the concentrations are more due to impact from surrounding industries.

The H_2S concentration for all seasons is ranging from 0.1 ppm to 0.2 ppm at 200 mtr this is almost uniformly at all seasons. In all seasons, NH_3 is almost negligible.

The CH_4 concentration is almost non visible as the waste is subjected to full processed. The winter shows concentration of 15 ppm at about 500 mtrs which sharply falls from 1 Km to 3 Km to less than 5 ppm. The CH_4S concentration is in all seasons is higher range with respect to odour detection threshold value and is between 30 ppb to 65 ppb. Therefore, CH_4S generation is almost in steady state may be because of pulverisation of waste resulting into increase in surface area and the waste heap some time accumulated due to exceeding capacity at the processing facility.

DMS isnot be seen in Post and Pre Monsoon, whereas accumulation is seen from level 90 ppb to 250 ppb which falls to 90 ppb about 3 Km. The concentration certainly makes the site as a smelling site at the processing spot, but may not be as dangerous with respect to health impact.

As regards to PM_1 and $PM_{2.5}$ concentration at Turbhe site it is quite significant with respect to permissible value and always between 0.2 mg/cum to 0.3 mg/cum which is about 10 to 20 times higher than the permissible limit. Whereas, PM_{10} concentration is much larger i.e. 0.3 mg/cum to 0.5 mg/cum and extremely high at 200 mtr in Winter close to 0.85 mg/cum, therefore the site is adversely affecting with respect to public health.

VOC, DMS, $CH_4$and PM are showing higher than permissible levels and hence hazardous as reported ***Chapter 4 Section 4.3*** and require to be controlled during processing, as it can be harmful to the workers and residential population.

3.4.2 Expression of Measurements and Diffusion through Contour Maps -Turbhe WPF

The contour maps as shown in **Figure 3.28 to 3.34** for each parameter and season showed are inconformity with the trends of measurements at Turbhe Waste Processing Facility site. The contours of the graphical assessment and closely signify the concentration of every parameter at <u>any given place within</u> the range of measurement. Some abruption can be seen in every map of either increased or abrupt decrease of concentration at places or otherwise steady decrease of concentration

as one goes away from the site the aberration is seen change due to wind direction and meteorological parameters.
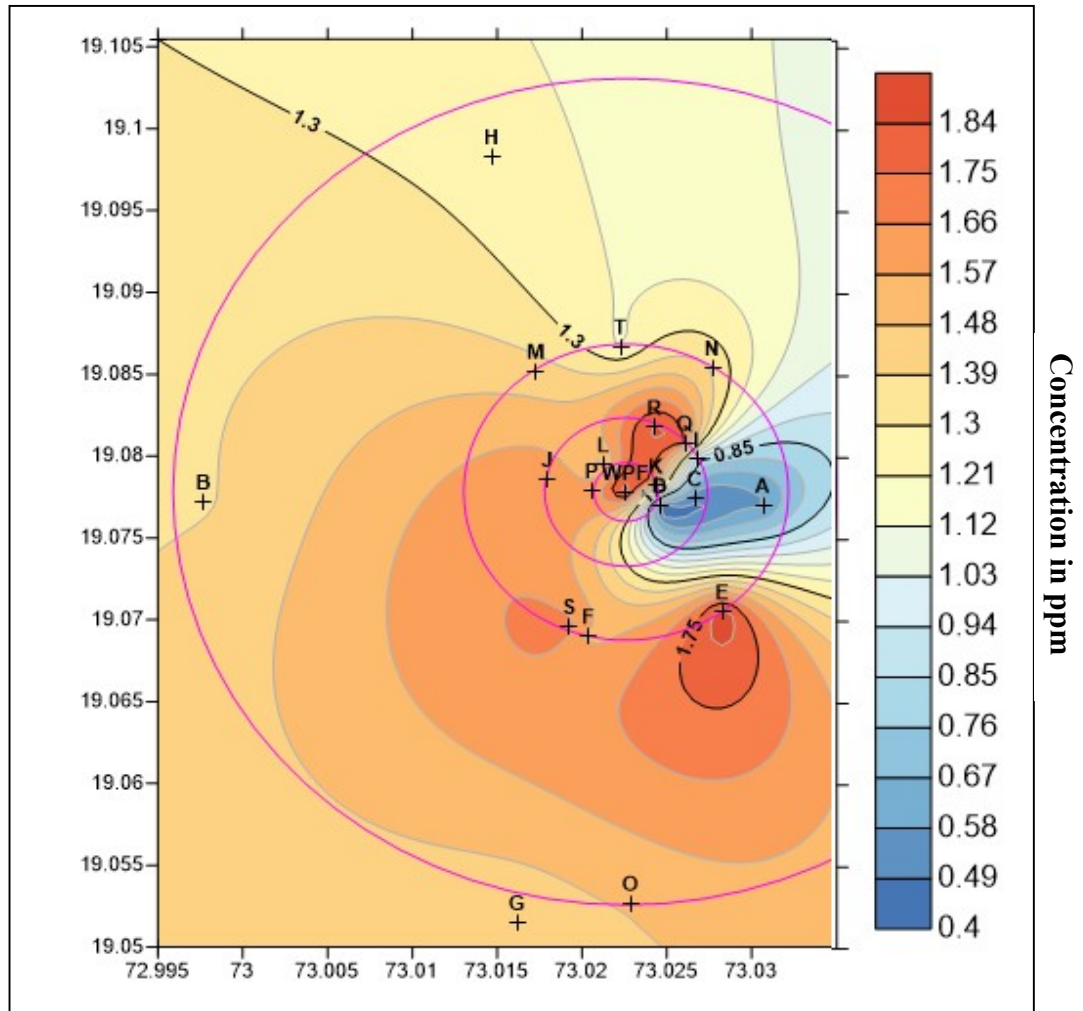
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

**Figure 3.28c: Contour Map of VOC Concentrations during Winter Season
(Site: Turbhe WPF)**

The 2nd and 3rd peak with concentration of 1.69 ppm and 1.55 ppm at Turbhe naka and Haribaba Sadhu Marg respectively could be attributed due to heavy traffic in this area.
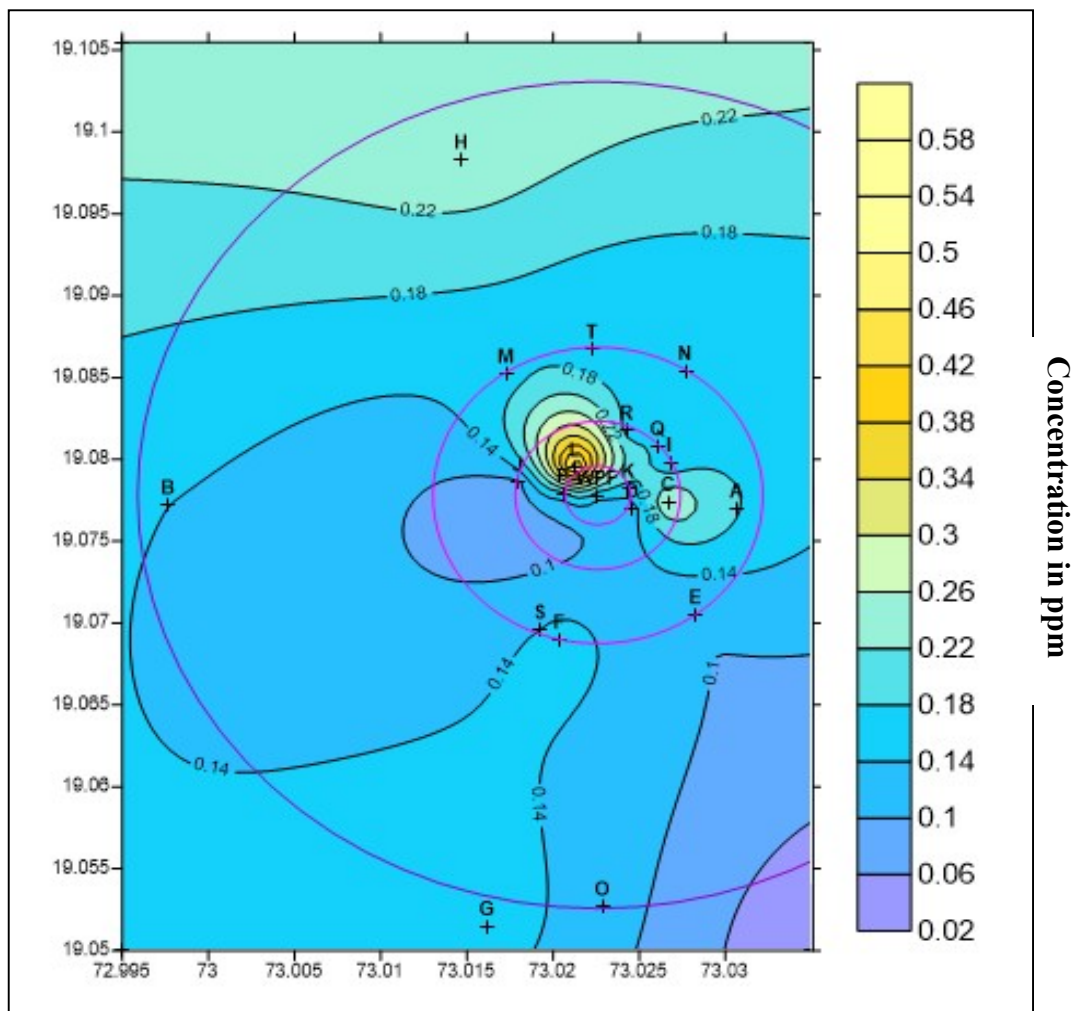
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.29a: Contour Map of H₂S Concentrations during Pre Monsoon Season (Site: Turbhe WPF)
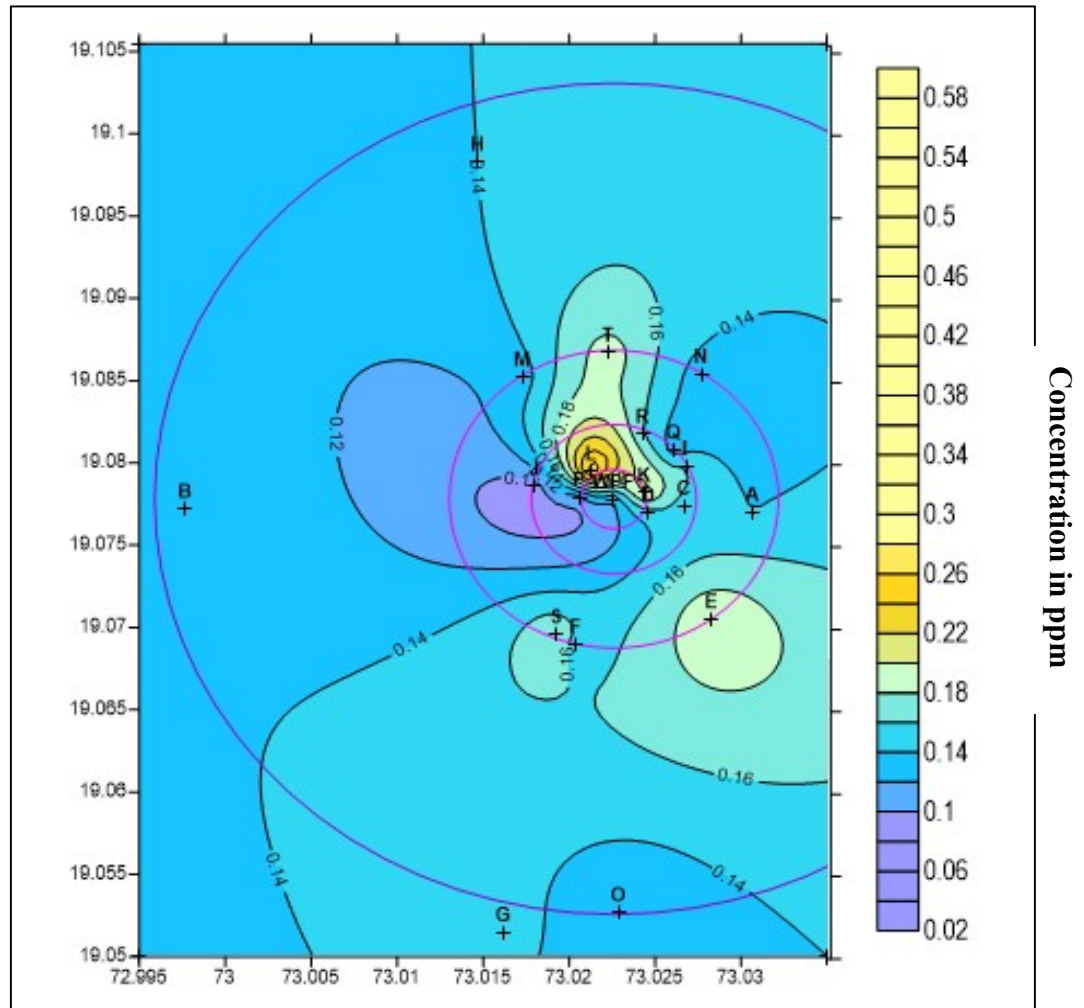
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.29b: Contour Map of H₂S Concentrations during Post Monsoon Season (Site: Turbhe WPF)

The 2ⁿᵈ and 3ʳᵈ peaks were observed at locations Turbhe Naka and Global Lab with concentration of 0.18 ppm and 0.2 ppm, the reasons are as stated in 3.28 c.

A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.29 c: Contour Map of H₂S Concentrations during Winter Season
(Site: Turbhe WPF)

The 2nd peak was observed at a 3 km distance at location of Khairane Village with the concentration of 0.23 ppm. The 3rd peak was observed at Juinagar Municipal School with the concentration 0.3 ppm. The reasons might be that the sewerage lines and public toilet are located at these respective points.
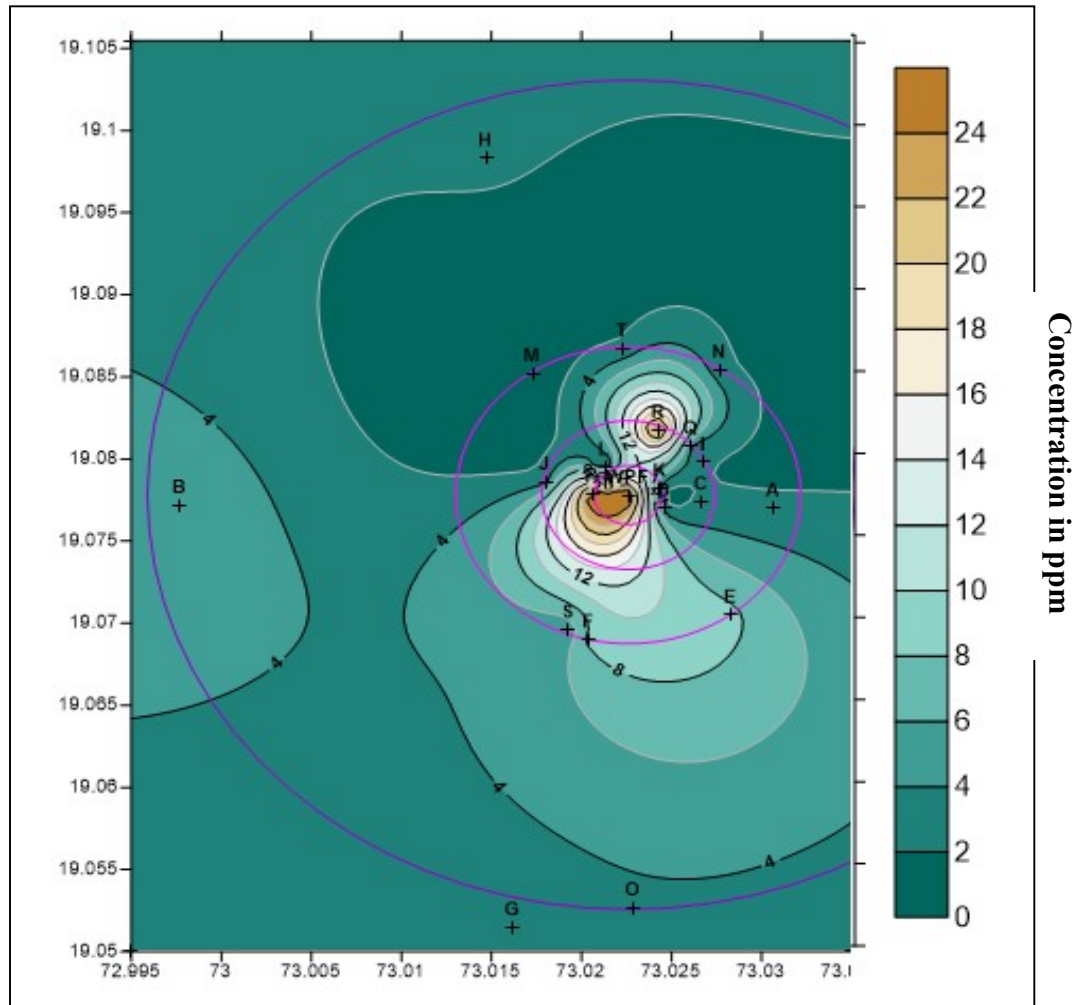
Figure 3.30c: Contour Map of CH₄ Concentrations during Winter Season (Site: Turbhe WPF)

A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.30c: Contour Map of CH₄ Concentrations during Winter Season (Site: Turbhe WPF)

The 2nd peak was observed at location of the Head Post Office of Vashi and concentration was observed to be 5.48 ppm and reason may be the adjacent nallah flowing in this area carrying the sewage and solid waste.
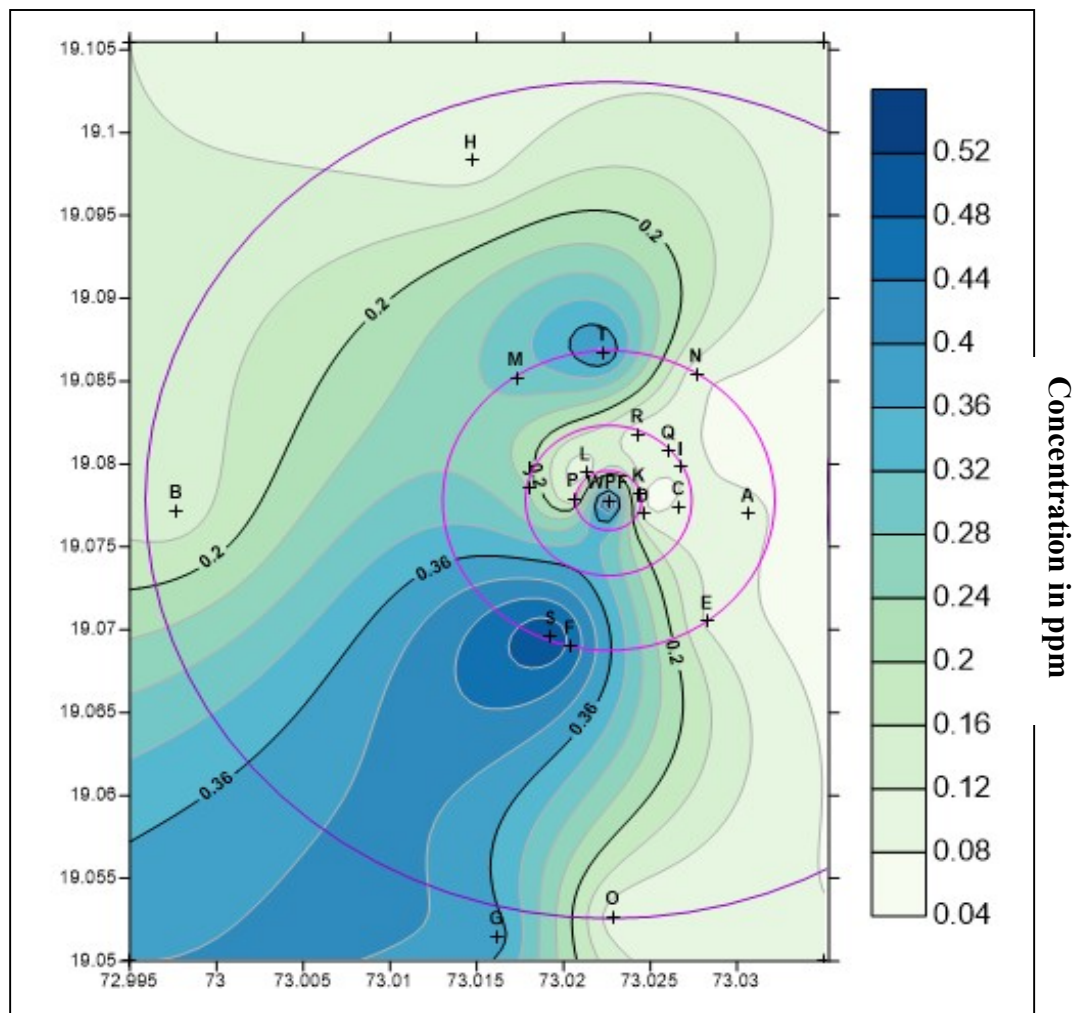
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF;
E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.31c: Contour Map of NH₃ Concentrations during Winter Season
(Site: Turbhe WPF)

The 2nd peak was observed at 1 km distance at Wasan Toyato with the concentration of 0.64 ppm which is midst of industries causing emissions in these areas. The 3rd peak with range of 0.38 to 0.52 at the locations Hari Baba Sadhu Marg, Turbhe Naka and Jui Nagar Municipal School the reasons could be as explained in 3.28c and 3.29c.
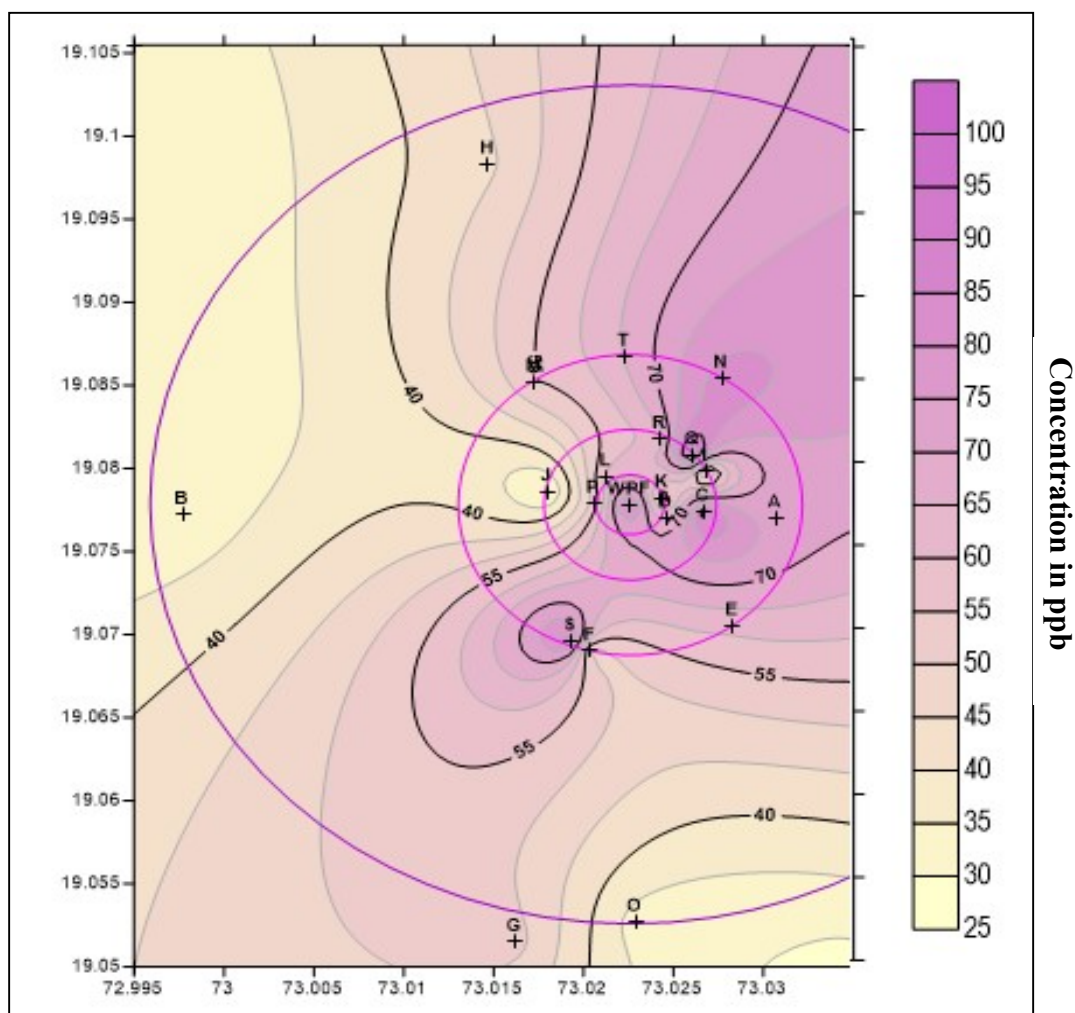
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF;
E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H:
Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi
School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q:
Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe
WPF

**Figure 3.32 a: Contour Map of Mercaptan Concentrations during Pre Monsoon Season
(Site: Turbhe WPF)**
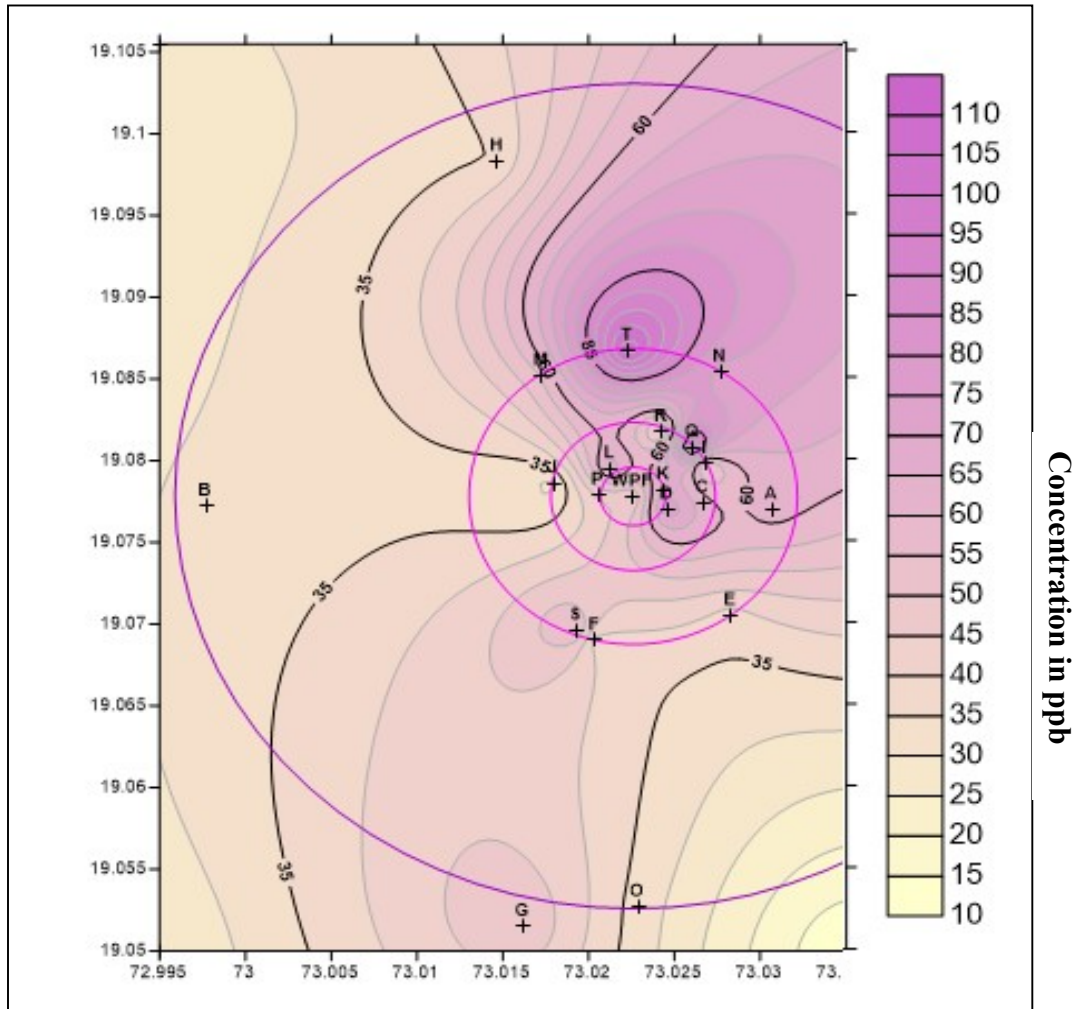
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

**Figure 3.32 b: Contour Map of Mercaptan Concentrations during Post Monsoon Season (Site: Turbhe WPF)**

The 2nd peak was observed at Wasan Toyato industry location with concentration 109.77 ppb and the reason could be as stated in 3.31c.
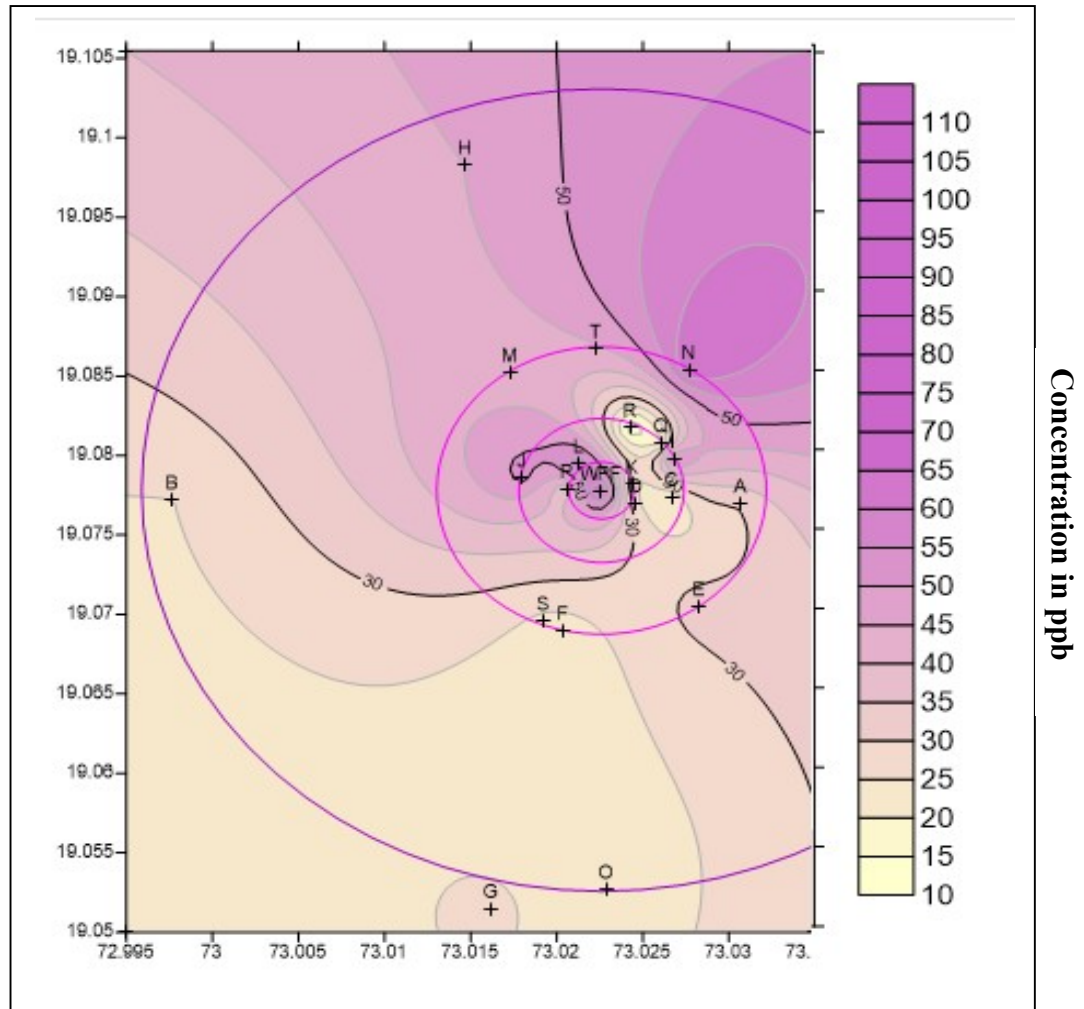
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.32c: Contour Map of Mercaptan Concentrations during Winter Season (Site: Turbhe WPF)

The concentrations were observed towards north direction and this may be the wind direction changes in the season. The 2nd peak was observed at near location at Shalimar stop with concentration 64.47 ppb. The area surrounded by the chemical industries and the emissions from the gases might be the reason of the gases concentration.
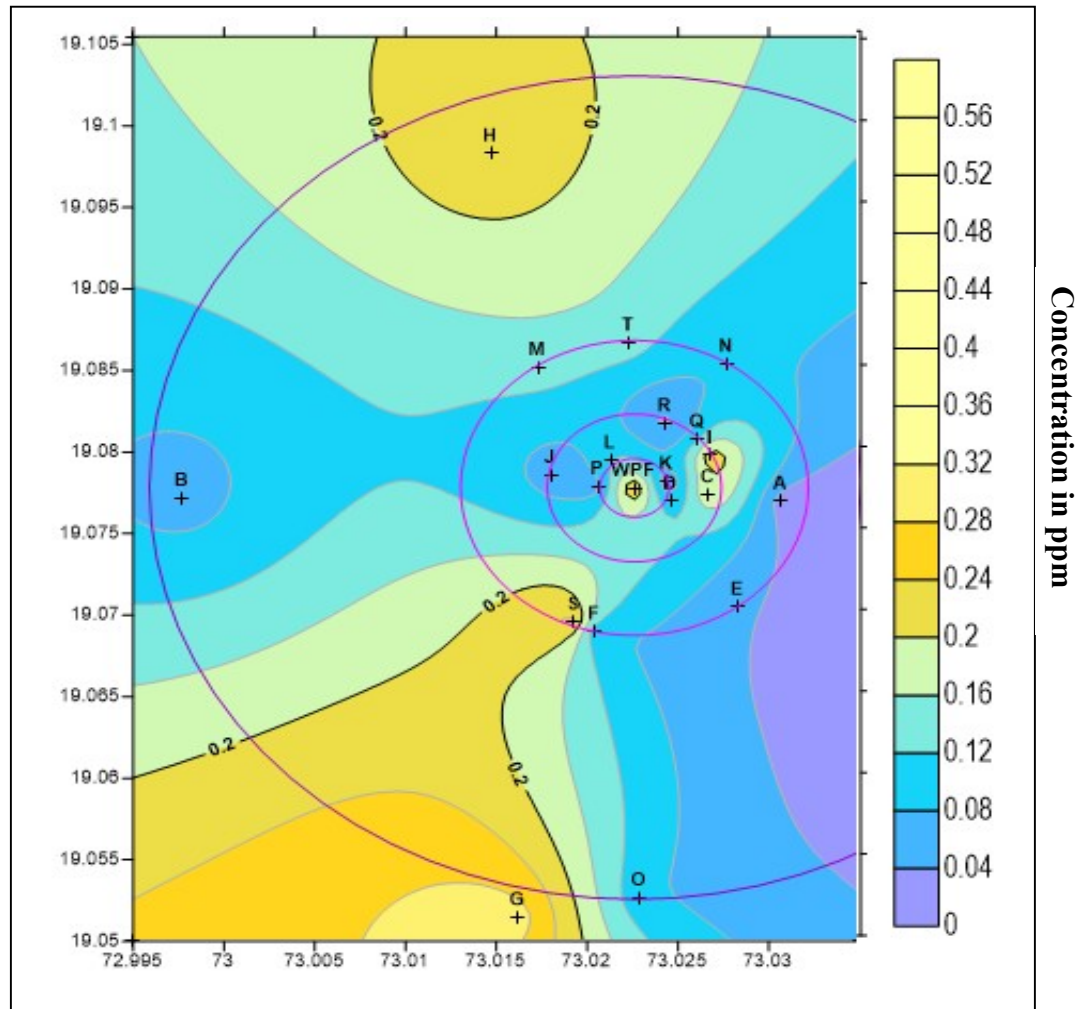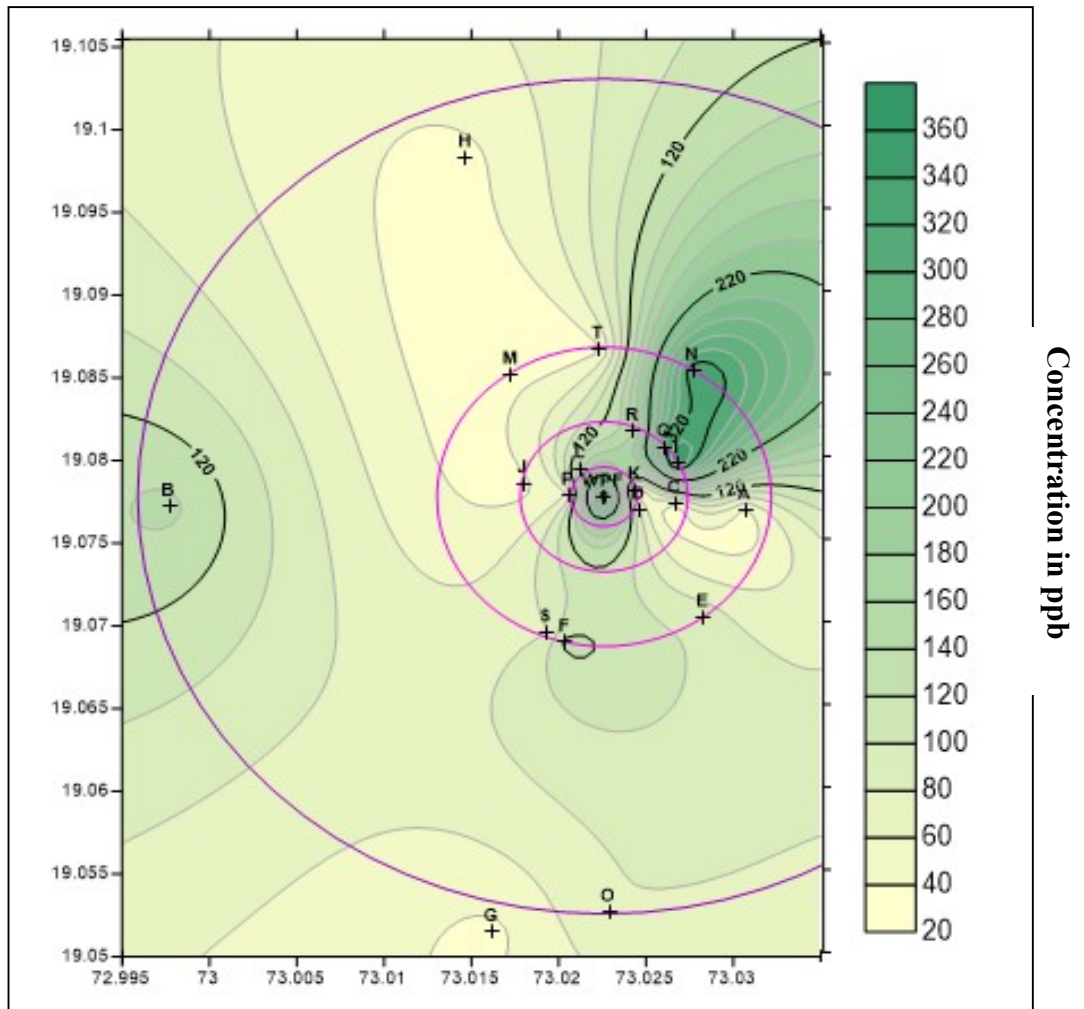
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.33c: Contour Map of DMS Concentrations during Winter Season (Site: Turbhe WPF)

The 2nd Peak was observed at location Hari Baba Sadhu Marg with concentration 126.32 ppb and the reason could be as explain in 3.28 c. The 3rd peak was observed at a 3 km distance at Vashi Post Office location with the concentration of 145.72 ppb and could be due to as explained in 3.30 c.
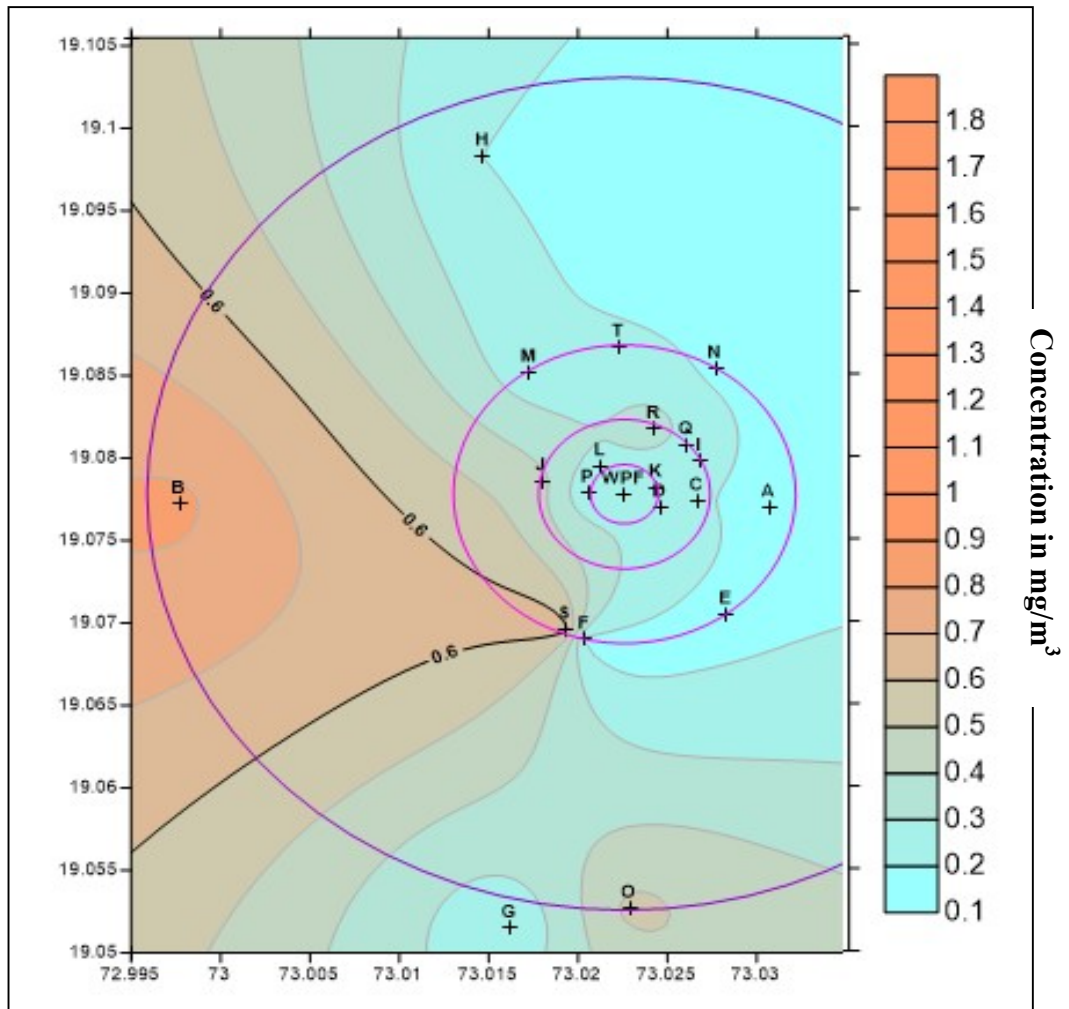
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF;
E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

**Figure 3.34a: Contour Map of PM Concentrations during Pre Monsoon Season (Site: Turbhe WPF)**

The 2nd and 3rd peaks at Head post Office and Shiravane Gaon at a distance of 3 km. with concentrations 0.822 mg/m^3 and 0.528 mg/m^3 respectively can be attributed to continuous vehicular traffic at both the locations.
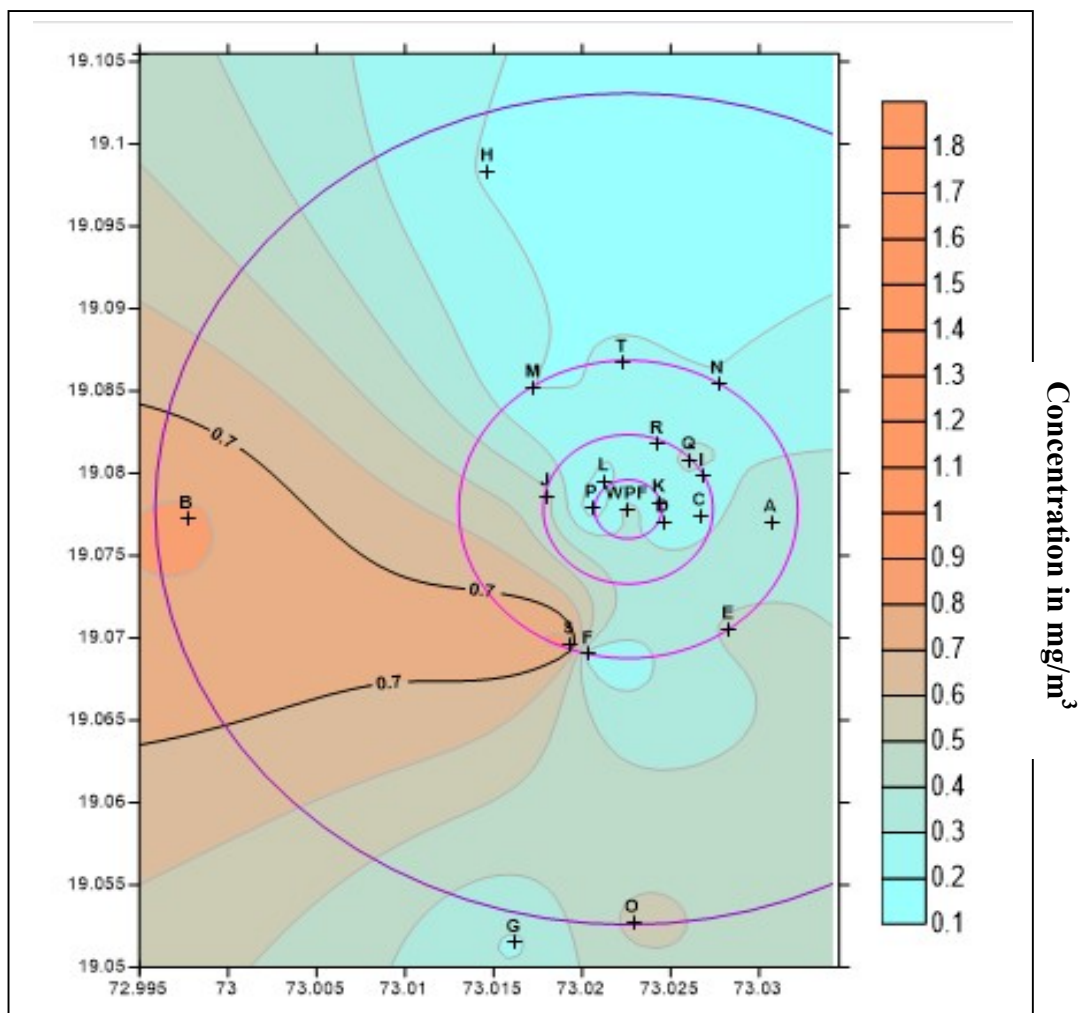
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF; E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H: Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q: Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe WPF

Figure 3.34b: Contour Map of PM Concentrations during Post Monsoon Season (Site: Turbhe WPF)

The peaks at Washi P.O and Shiravane Gaon with 0.82 and 0.52 mg/mc at 3 km distance are again due to impact of heavy traffic.
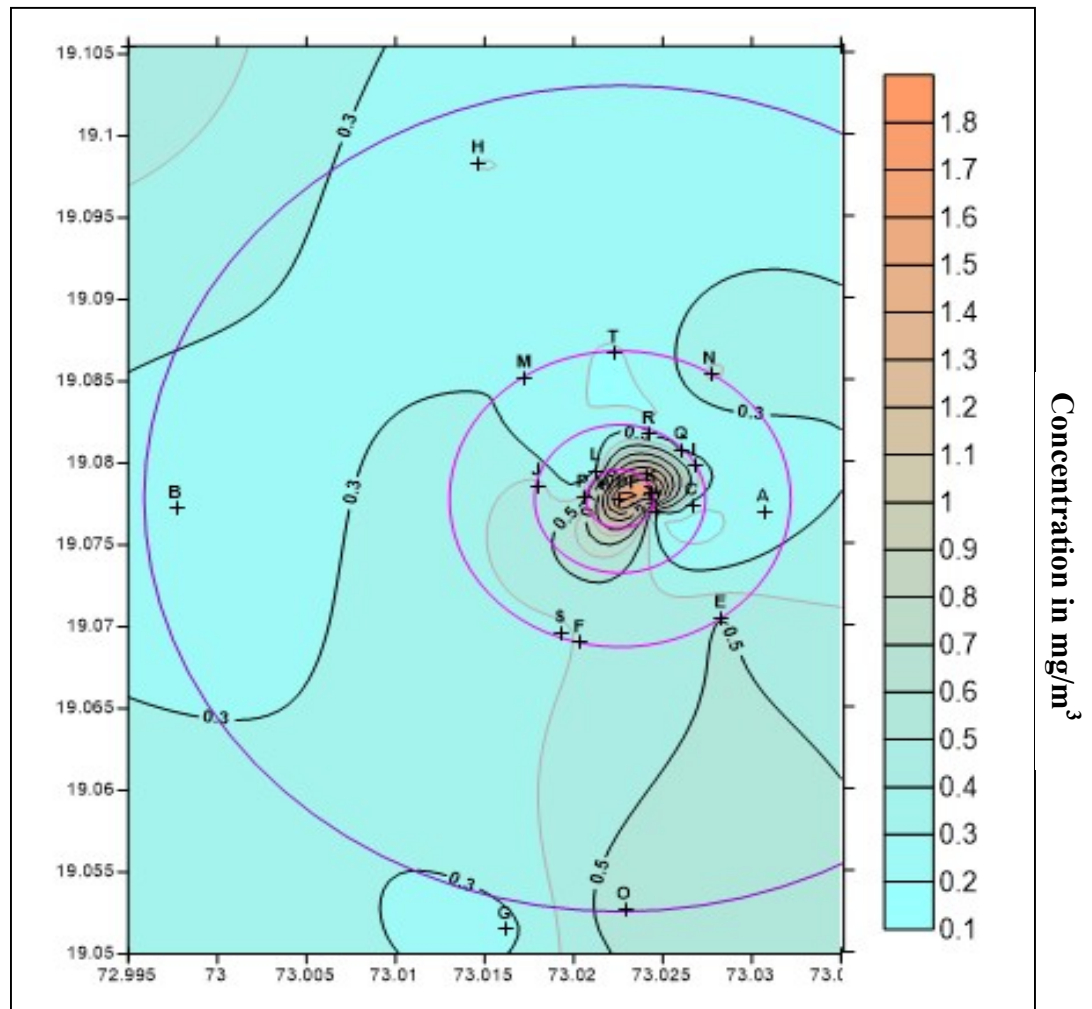
A: Indira Nagar; B: Head Post Office Vashi; C: BASF Industry; D: Entrance of WPF;
E: Global Lab MIDC Main Rd; F: Haribaba Sadhu Marg; G: Jui Nagar Municipal School; H:
Khairane Village/Bonkode; I: Parsik Hill B.; J: Prabhat Diary; K: Road for WPU; L: Samata Hindi
School; M: Savita Chemicals Stop; N: Shalimar Stop; O: Shirvane Gaon; P: Shivshakti Nagar; Q:
Sky Industries Ltd; R: Yashraj Biotechnology; S: Turbhe Naka; T: Wason Toyota; WPF: Turbhe
WPF

**Figure 3.34 c: Contour Map of PM Concentrations during Winter Season
(Site: Turbhe WPF)**

3.5 AERMOD Simulation Modelling

It is interesting to report herein that various workers have even derived the Emission Factor for any given dumping site by designing the section of dump of solid waste of specified dimensions. **Ngwabie, et al [21]** derived Emission Factor for greenhouse gas emissions from Municipal Solid Waste dumpsites in Cameroon, Similarly Estimated ammonia emissions factor for anthropogenic non-agricultural sources[22]. We applied this into the dispersion model called AERMOD by considering admeasuring of 50 m X 50 m site at Deonar and deriving emission estimation around minimum 632 µg/m^3 in 1st hour from our measurements of methane for pre monsoon, the dispersal model has been drawn and represented by following **Figure 3.35**
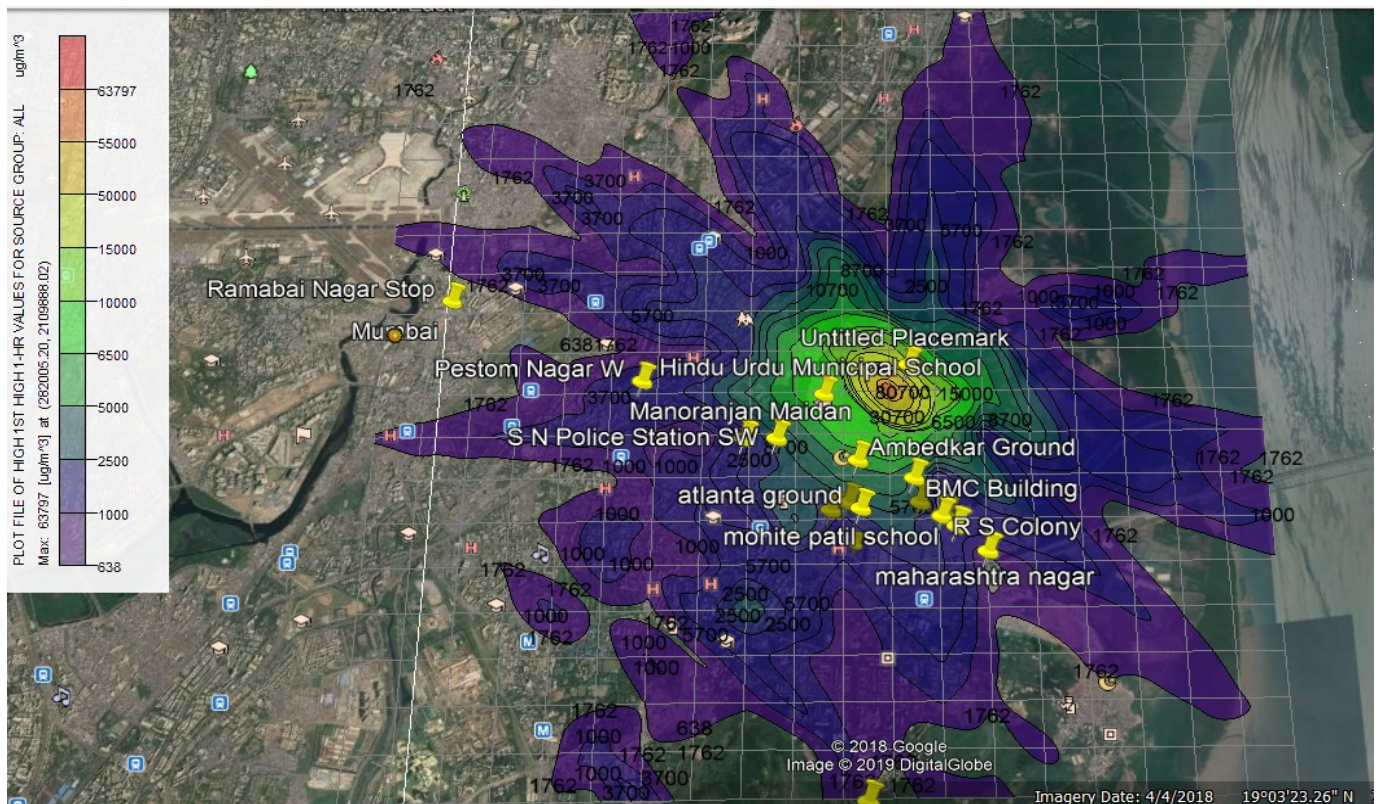
Figure 3.35: Represents the methane gas emission at Deonar dumping at pre monsoon

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CHAPTER 4
Odour Perception Survey Analysis

Odour perception studies were carried out at all 4 dumping sites. The sample sizes of respondents at respective site were Deonar- 315, Gorai- 280, Diva-Khardi -458 and Turbhe- 522 persons. They were analysed for subjected questions based on odour perception studies in the way of questionnaire survey. The focus was to collect the minimum responses of about 60-70 persons at each distance of respective sites to have equal comparison. The Age Group selected was 20 to 50. The percentages shown are derived from the responses of the people, who have been responded for the study and residing near to the site at various distances. The responses received have been scrutinized and comparable have been recorded. The Female responses were in the ranges of 20% to 40% except Diva-Khardi site, as against Male responses and therefore the comparative analysis have not been made separately in the report. The response of each person was categories into 4 groups of levels of odour as: -"No Smell", "Moderate Smell", "Significant Smell" and "Strong Smell".

4.1 Recording of Odour Perception

1) Deonar Dumping Ground: The observations of odour perception of total responses from public and its percentages are reported in **Table 4.1** and the same has been represented in **Figure 4.1.**

Table 4.1: The Observations of Odour Perception by Public Across Distance

Distance	Strong Smell	% Res.	Significant Smell	% Res.	Moderate Smell	% Res.	No Smell	% Res.	Total
200 m	50	71.43	19	27.14	1	1.43	0	0.00	70
500 m	56	70.00	24	30.00	0	0.00	0	0.00	80
1km	80	88.89	4	4.44	3	3.33	3	3.33	90
3 km	47	62.67	25	33.33	3	4.00	0	0.00	75
Total	234		71		7		3		**315**
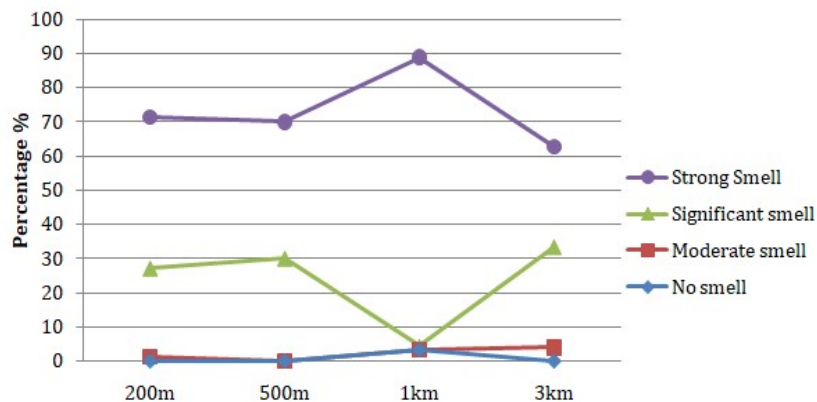
Figure 4.1: Odour Perception across distance

During the survey it was observed that the people residing close to the dumping site i.e. 200 m, are reluctant to give their observations on the survey sheet stating that they are acclimatised to the situation and do not get smell. From the responses received, it is concluded that majority of people gets significant or strong smell at all distances indicating they undergo odour nuisance. The East and North-East sides are not accessible due to creek and thick mangroves. The survey of that area could not be made and incidentally there is no housing at that side.

2) Gorai Dumping Ground: The South West & North West, North East Sides were not accessible due to Creek and Mangroves, the survey could not be made and incidentally there is no residential colony there. The observations of odour perception responses and its percentage population are reported in **Table 4.2**and the same has been represented in **Figure 4.2**.

Table 4.2: The Observations of Odour Perception by Public Across

Distance	Strong Smell	% Res.	Significant Smell	% Res.	Moderate Smell	% Res.	No Smell	% Res.	Total
200 m	15	24.11	12	10.71	18	12.50	57	52.68	102
500 m	1	1.89	0	0.00	12	22.64	50	75.47	63
1km	0	0.00	5	5.62	18	20.22	66	74.16	89
3 km	0	0.00	0	0.00	2	7.69	24	92.31	26
Total	28		17		46		189		280
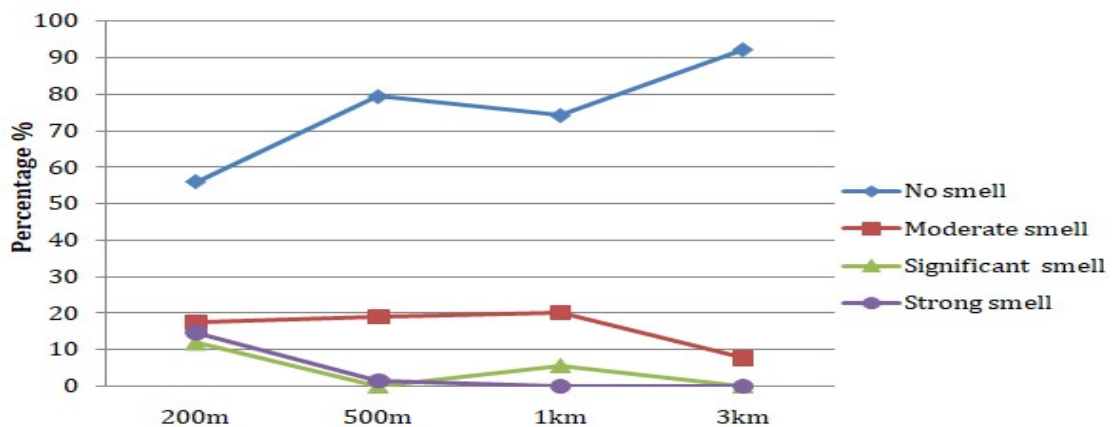
Figure 4.2: Odour Perception across distance

It was observed that majority of people residing are strongly disagree of odour nuisance at all distances from the dumping site, however people residing in Chinmay Society at 200 m complained about odour nuisance during evening time. This might be due to change in wind direction and effect of nearby creek.

3) Diva-Khardi Dumping Ground: The observations of odour perception of total responses of sample size and its percentage are as reported in **Table 4.3**and the same has been represented in **Figure 4.3**.

Table 4.3: The Observations of Odour Perception by Public across Distance

Distance	Strong Smell	% Res.	Significant Smell	% Res.	Moderate Smell	% Res.	No Smell	% Res.	Total
200 m	62	49.60	49	39.20	12	9.60	2	1.60	125
500 m	65	49.24	56	42.42	6	4.55	5	3.79	132
1km	66	46.81	59	41.84	8	5.67	8	5.67	141
3 km	36	60.00	24	40.00	0	0.00	0	0.00	60
Total	229		188		26		15		458
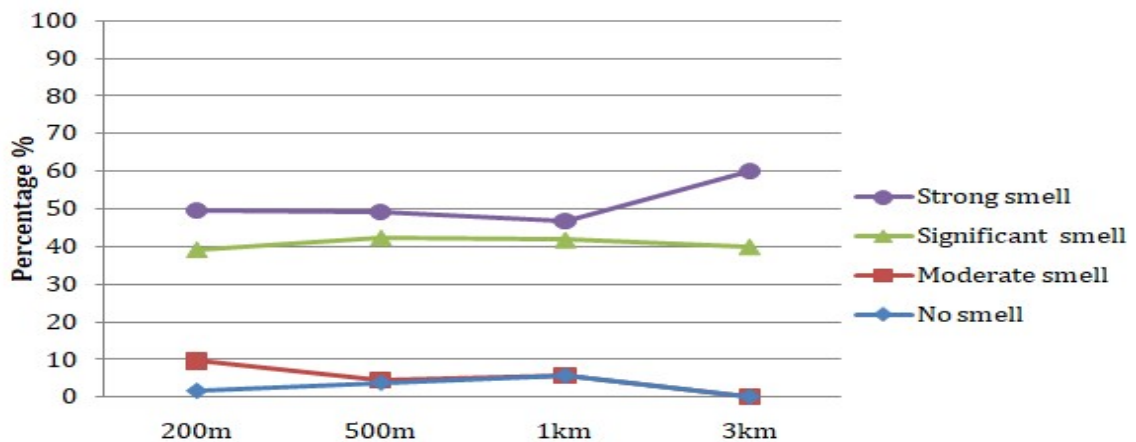
Figure 4.3: Odour Perception across distance

During the Perception Study majority of the people residing close to the dumping nearly at 200 m and 300 m distances responded and recorded that they get odour nuisance for all the time. From the responses received, it is concluded that majority of the people at every distance are strongly agree for the odour nuisance even at 3 Kms from the dumping site.

4) Navi Mumbai Turbhe, Waste Processing Facility (WPF): The observations of odour perception of total responses of sample size and its percentage are as reported in **Table 4.4**and the same has been represented in **Figure 4.4**.

Table 4.4: The Observations of Odour Perception by Public across Distance

Distance	Strong	% Res.	Significant	% Res.	Moderate	% Res.	No	% Res.	Total

	No Smell		Moderate Smell		Significant Smell		Strong Smell		
200 m	69	46.62	38	25.68	16	10.81	25	16.89	148
500 m	39	42.39	23	25.00	13	14.13	17	18.48	92
1km	89	47.34	70	37.23	10	5.32	19	10.11	188
3 km	21	22.34	39	41.49	9	9.57	25	26.60	94
Total	218		170		48		86		522
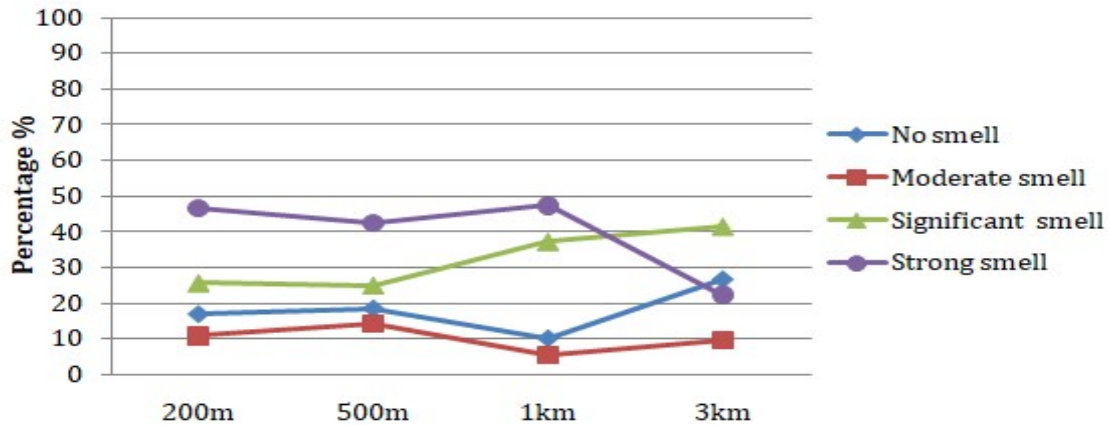
Figure 4.4: Odour Perception across distance

The Turbhe site is the Waste Processing Facility with Segregation and Composting Technology encompassed with Refuse Derived Fuel (RDF) and process remnants go to the landfill. The site is surrounded by MIDC industrial area, mainly of Chemical Industries. During the perception study most of the people at every distance strongly agree for odour nuisance. Though there is some smell from the processing facility felt intermittently, there might be major nuisance from the industrial sector mainly from Chemical Industries like BASF & Savita Chemicals and therefore, continuous assessment of industrial area required to be conducted, which is beyond the scope of this project.

4.2 Health Survey

A survey was conducted at the dumping sites and waste processing facility at Turbhe to know the health related issues like irritation, coughing, headache, nausea, vomiting, and fever from the dispensaries, clinics, doctors and types of medicines sold by the medical shops. The site-wise findings are as under:

a) **Deonar Dumping Site:** The general hospitals and clinics near the sites were visited and it was reported that nearly 30 to 40 patients approach them every month and complain about fever, skin problems, itching, cough & cold, stomach-ache, bronchitis. The medicines sold are ITMAC, MPX-625, Crocin-500, Polo-650, OZ, MPX-600 etc.

b) **Gorai Dumping Site:** After visiting the nearby hospitals and clinics at Gorai site, it is reported that 8 to 10 patients are visiting daily to the dispensaries complaining of headache, cold and

vomiting. The medicines like Saridon, Disperin, Crocin, and C-Trizen are the common remedial medicines.

c) **Diva-Khardi Dumping Site :** As reported by the clinics nearby dumping area, nearly 100 patients below age 15 and 500-700 patients from the age group 15 onwards approach for health issues like lungs problem, loose motion, headache, cough & cold, skin dieses, scabies, itching, boils etc. Most common medicines sold in this area are MPX-625M, DOLO-650, Flokonozo skin cream, ITMAC, Pain-D etc.

d) **Waste Processing Site at Turbhe :** At this treatment facility, from the nearby area approx. 60-70 patients per month approach to the clinics for the health issues like skin-diseases, respiratory problem, dizziness, viral infection, Malaria, vomiting and headache. The medicines given here are with only doctors' prescription.

From the above, it is recommended that the Health study programme based on the impacts shown above may be taken in the Second Phase of this project.

4.3 Health Impact of Gases

H_2S: According to Health and Safety Standards, this concentration for the prolong time can cause nausea, tearing of eyes, headache, loss of sleep including can become cause of bronchial constriction in some asthma patients.

CH_4: Low level exposure may not cause health effect, but prolong exposure to levels of methane in the area can reduce breath oxygen from the air which can result into slurred speech, vision problem, memory loss, nausea, omitting and headache. The prolong exposure can cause change in breathing and heart beat rate, body balance problem, numbness, unconsciousness. A prolong exposure continuous can be fatal.

NH_3: The prolong exposure of NH_3 can lead to its manifestation and can do the damages like conjunctivitis, chronicle burns, visual impairment, pain in the pharynx and chest cough and dyspnoea.

CH_4S: This gas has strong odour and can disperses central nervous system (CNS), affect respiratory centre and cause respiratory paralysis and it can cause mucous membrane diseases, nausea, omitting, headache.

$(CH_3)_2S$: This can cause bad breathe asthma and skin diseases, eye and respiratory irritations.

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CHAPTER 5

Co-relation between Gases Concentrations and the Perception

Odour affects human beings in a number of ways. Strong, unpleasant or offensive smells can interfere with a person's enjoyment, recreation, life style and behaviour. Major factors of perceived odour nuisance are:

- Duration of exposure
- Frequency of occurrence
- Tolerance, and
- Expectation of the receptor

Though foul odour may not cause direct damage to health, the toxic component of odour may cause ill health or respiratory damages. There can be secondary effects like it may cause nausea, insomnia and discomfort.

5.1 Genesis of odorous gases: That are emitted from industrial sources include both inorganic and organic gases and particulates. Many odorous compounds can also result from chemical and biological ongoing processes during decomposition which could be anaerobic or aerobic of organic matter shall largely emit compounds of sulphur and nitrogen. Some of the odorous compounds emitted from sources and their detection thresholds and measured concentrations are shown in **Table 5.1**and their comparisons with National Ambient Air Quality Standards are shown in **Table 5.2**.

5.2 Establishment of correlation between combinations of odorous gases and perception at various distances

The four odorous gases namely H_2S, NH_3, CH_4S and Mercaptan were selected for the showing the relation with the People's Perceptions (**Strong Smell**) at various distances by averaging the data analysed for all the seasons, which is presented in **Figure 5.1**.

1) Deonar Dumping Ground: The meteorological parameters including the temperature and humidity affect the concentrations at every distance. The concentrations observed of H_2S, NH_3, and CH_4S for Deonar site indicates the concentration at all distances and the perception of the people states that they are Strongly Agree for the smell. The concentrations observed at certain points viz. Shivaji Nagar Bus Depot, Hindi-Urdu BMC School, Pestom Sagar, Ramabai Nagar, Maharashtra Nagar Bus Stop, Deonar Municipal Colony, Fire Brigade colony, are showing higher concentrations might be due to Nallah or Creek, drainage or garbage heaps lying on the road.

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Table 5.1: Concentration Range Received at Dumping Sites

Gases	Odour Detection Threshold	Pre-Monsoon				Post-Monsoon				Winter			
		Deonar	Gorai	Diva Khardi	Turbhe	Deonar	Gorai	Diva Khardi	Turbhe	Deonar	Gorai	Diva Khardi	Turbhe
Ammonia (NH_3) in ppm	17	0.1-0.93	0.1-1.84	0.2-0.63	0.25-0.53	0.2-0.27	0.2-0.91	1.18-34.12	0.03-0.29	0.09 -1.4	0.04 – 0.34	0.13 – 1.52	0.03 – 0.52
Hydrogen Sulphide (H_{2S}) in ppm	0.00047	0.01-0.24	0.2-0.56	0.2-0.49	0.1-0.51	0.04-0.65	0.04 -0.35	0.05-0.27	0.09-0.28	0.06-0.26	0.04-0.28	0.03-0.43	0.02-0.25
Mercaptan (CH_4S) in ppb	0.0005 (5 ppb)	10.05-196.01	9.05-128.72	5.41-51.22	28.77-99.11	8.41-108.2	7.26-107.92	1.53-50.93	28.77-104.42	17.3 –148.32	13.27–100.38	11.18-144.54	10.94-64.47
Dimethyl Sulphide $(CH3)2S$ in ppb	0.001 (1 ppb)	170.41-999.99	0-66.09	54.48-774.33	BDL	57.04-311.83	BDL	71.32-107.43	BDL	1.99-281.52	129.23 -222..20	23.74 – 489.92	2.11-281. 52

Table5.2: Comparison with National Ambient Air Quality Standards *

Standard Particulate Matter	Standard in (mg /m^3)*	Pre-Monsoon				Post-Monsoon				Winter			
		Deonar	Gorai	Diva Khardi	Turbhe	Deonar	Gorai	Diva Khardi	Turbhe	Deonar	Gorai	Diva Khardi	Turbhe
$PM_{2.5}$µg/cum (40 annually.)	0.04 (mg /m^3)	0.03-0.791	0.036-0.205	0.056-0.322	0.152-0.822	0.028-0.139	0.035-0.213	0.024-0.446	0.084-0.483	0.050-0.255	0.070-0.151	0.047-0.638	0.089-0.287
PM_{10} µg/cum (60– annually)	0.06 (mg /m^3) *	0.04-1.34	0.075-0.891	0.072-0.618	0.169-0.822	0.074-0.549	0.048-0.922	0.061-2.703	0.131-0.843	0.114-0.720	0.087-0.398	0.11 – 1.272	0.19-1.874

*Guidelines on pollution and its control, May 2008, CPCB[23]

**National Air Quality Standards, CPCB, 18th Nov. 2009   for Industrial area[24]

 ***Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval

2) Gorai Dumping Ground: The concentrations observed of H_2S, NH_3, and CH_4S for Gorai site indicates low concentration at all distances and the perception of the people states that they are Disagree for the smell. However, the concentrations observed at certain points viz. Gorai 2 and MHB Colony are showing comparatively higher concentration might be due to Nallah or Creek. The people residing within the area of 200 mtr distance i.e. Chinmay Society, Malgudi Hotel, and Shanti Dhaan are experiencing the smell during certain hours of the day. This indicates that the Gorai site is scientifically closed and better and controlled site from the environmental point of view.

3) Diva Khardi Dumping Ground: The concentrations observed of H_2S, NH_3, and DMS for Diva Khardi site indicates High concentration at all distances and the perception of the people states that they are Strongly Agree for the smell. The concentrations observed at certain points viz. Sumit Plaza, Adarsha Gugukul, Om Residency, Diva Post Office, Diva School and Mumbra Hospital are showing higher concentration might be due to Nallah or Creek and open dumping of Garbage.

4) Turbhe Waste Processing Facility : The observed concentrations for different pollutant i.e H_2S, NH_3, and DMS for Diva Khardi site indicates moderate concentration at all distances and the perception of the people states that they are Strongly Agree for the smell. The site is surrounded by MIDC industrial area, mainly of Chemical Industries. Though there is some smell from the processing facility felt intermittently, there might be major nuisance from the industrial sector mainly from Chemical Industries like BASF & Savita Chemicals and others.

Municipal solid waste dumping sites are worst known nuisances to the residents near to the dumping sites and are always pose health hazards to entire city in addition to the continues generation of various gases and formation of Leachate also create environmental pollution and even contaminating and polluting the precious resources. The present case study is focussing upon the perception studies of odorous gasses emitted from at each dumping site measurement of concentrations and percent perception of a population at dumping sites. The odour at each site shall certainly depend upon the concentration of each gas and the composition of materials in picture and meteorological parameters.

The odour at each site and distances of the site shall always be the combined effect of odorous compounds. The **Figure 5.1a** for Deonar site indicates the strong odour is felt at all distances which is obviously seen with reducing concentration with increasing distance but there is persistent odour in more or less concentrations at the site up to the measured distance of 3 Kms. Therefore, the odour exists at the site.
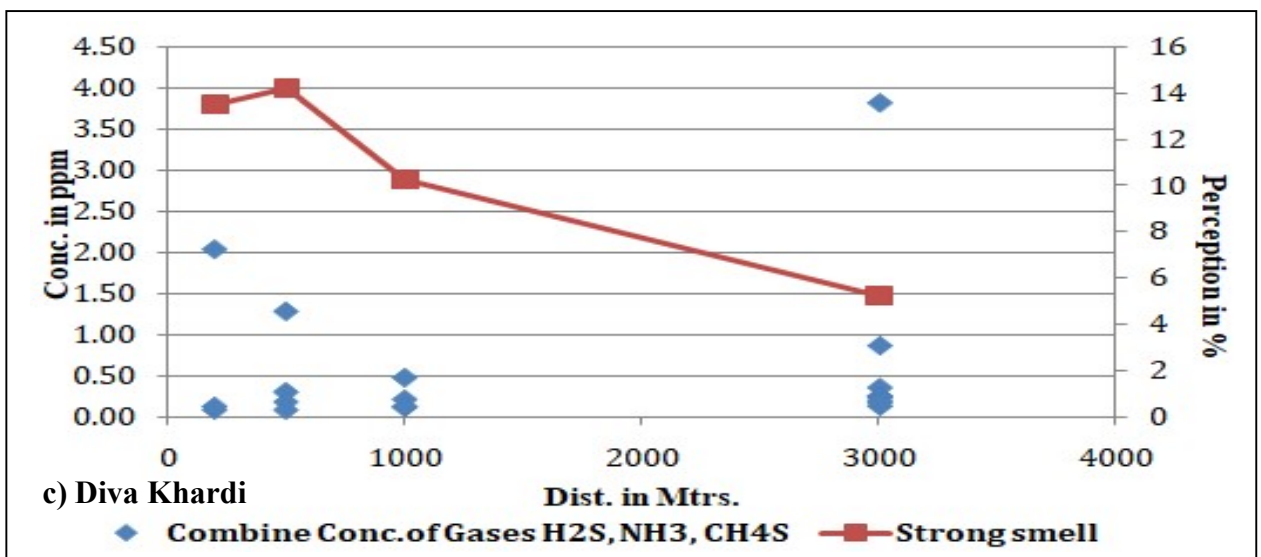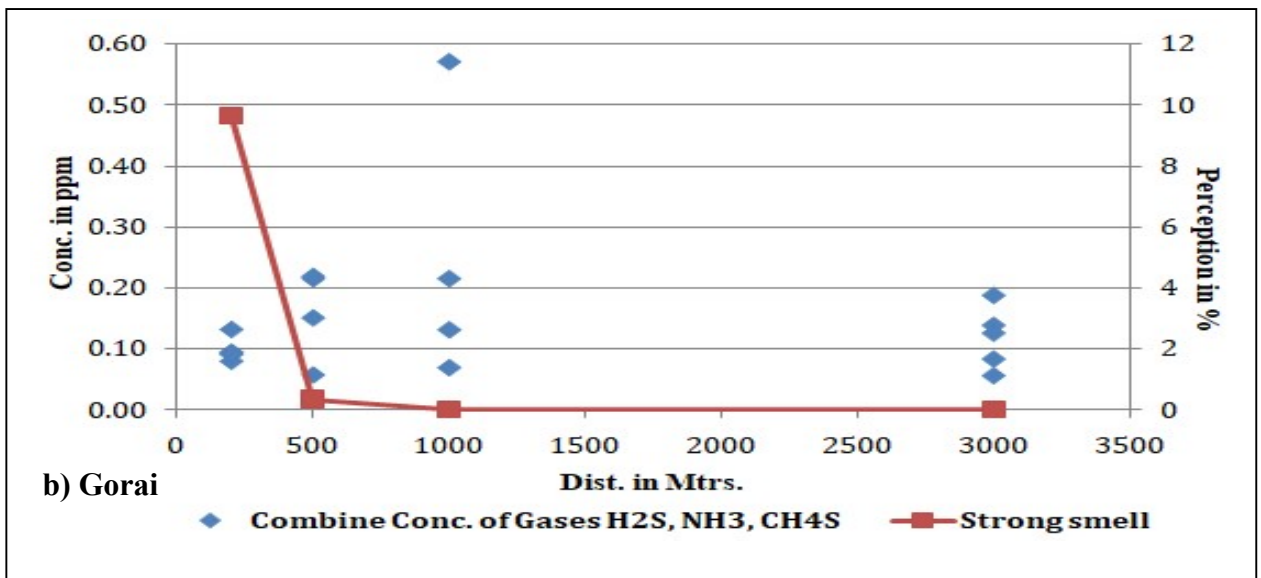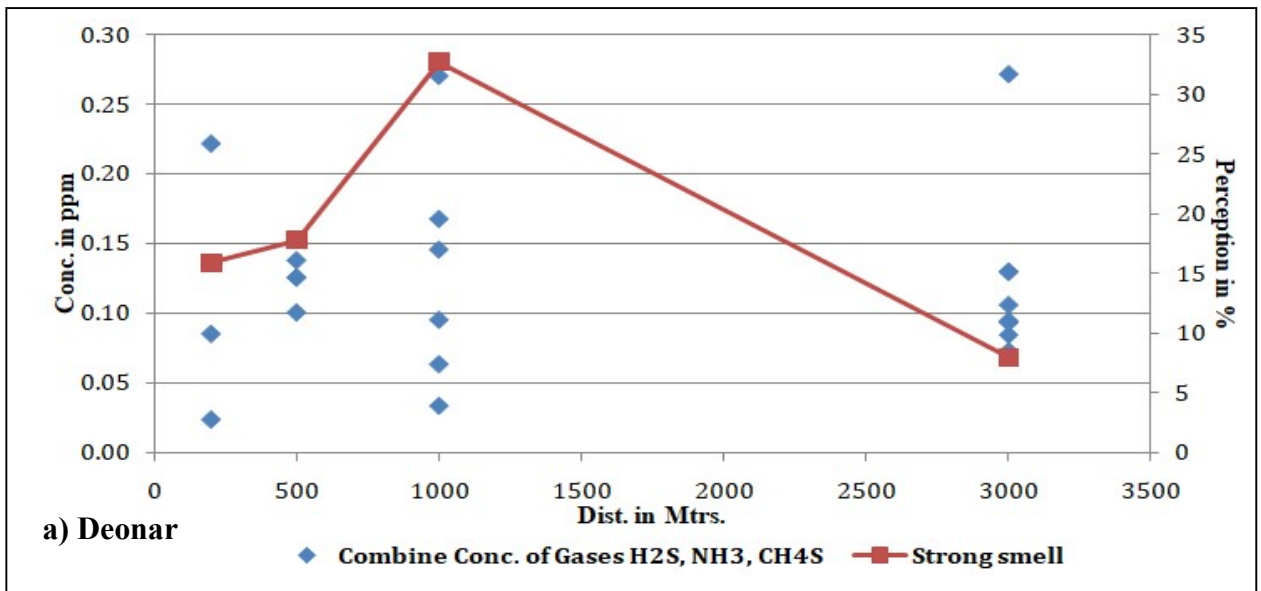
Figure 5.1: Combined Concentrations of Gases H₂S, NH₃ & CH₄S V/s Respondent Percent of Population

Figure 5.1: Combined Concentrations of Gases H_2S, NH_3 & CH_4S
V/s Respondent Percent of Population

d) Turbhe WPF
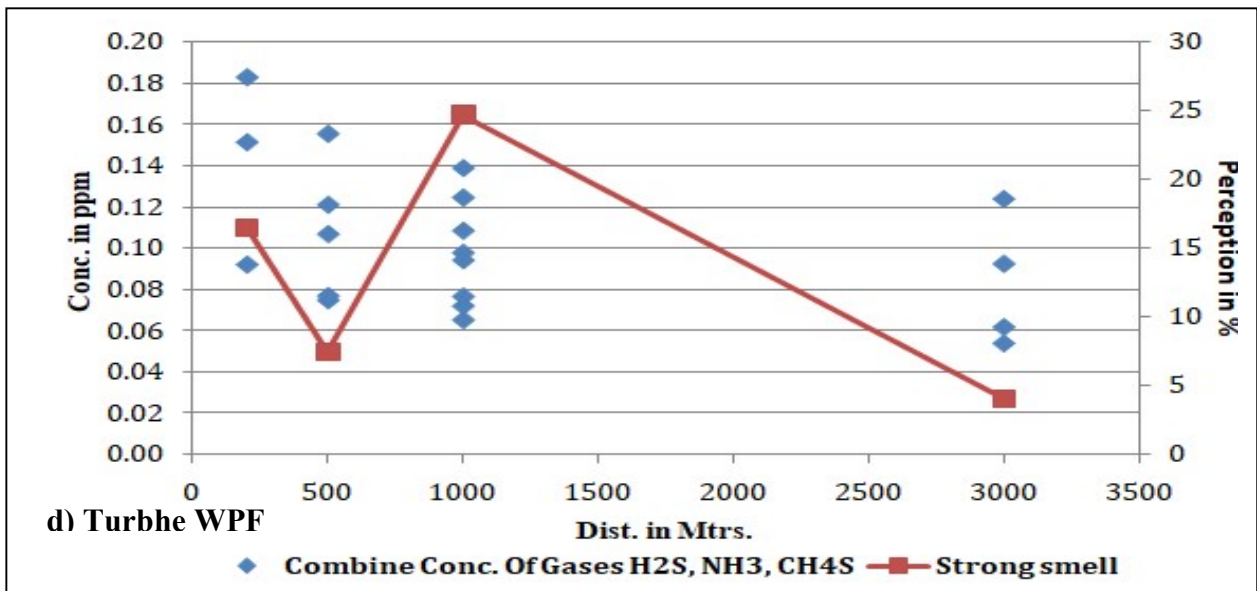
Figure 5.1 (Contd.): Combined Concentrations of Gases H₂S, NH₃& CH₄S
V/s Respondent Per cent of Population

Figure 5.1(b) is representing the perception by percentage population at distances specified at Gorai site, also indicates the persistence of odour exists at the closed site wherein it appears the decomposition process is still ongoing. However, except given point the residential colony the odour phenomenon is almost negligible showing containment of the odour due to its closure.

The **Figure 5.1(c)** for Thane site also indicates persistent strong odour at almost all distances felt by the population which needs to be attention with preventive measures.

Figure 5.1(d) for Turbhe site indicates again persistent smell felt by the residents at all distances at this Waste Processing Facility. However, the fact cannot be denied that this area is also receiving odorous compounds from adjoining chemical industrial area.

It is to be noted here that certain population despite of the higher concentration of gases even at closed distance do not get smell as they have become immune to the persistent presence of the gaseous concentration although between 5 to 30% people are showing the perception of odour, rest of the people say there is no smell but they are of significant, mild and moderate odour. In conclusion it can be said that dumping sites are public nuisances and they can pose public health hazards. Therefore, approach of scientific closure required to be adopted and to bring the impact to minimum as indicated at the site of Gorai dumping site.

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CHAPTER 6
Experimental Studies on Odour Mitigation

6.1 Experimental Setup for Odour Mitigation

Since the odour of the gases from landfills is a continuous cause of health hazards. The efforts are made worldwide to mitigate the odour by using various methods involving different chemical agents and processes.

The philosophy used is:
- Segregation at source and reduction of biodegradable contents reaching to the dump site
- Organize waste by proper spread, compacting and covering with soil layer
- Avoid parking of vehicles full of waste on site during night time
- Install leachate collection method and treatment to the extent possible
- Provide passive vents to dumps wherever possible
- Spraying of deodorant to abate the smell
- Create 'Green Belt' with selected Phyto-remediating and Phyto-decomposing trees

There are also reports on the odour coming from the landfill can be prevented by covering landfill with a mulched woody material having permeability which acts as a bio-filter. Masking agents are also counteracting with the odorous gas phase wherein the treatment agent is mixed directly with the foul airflow. This is usually done by atomizing and then spraying a liquid treatment agent. At landfills, such systems are typically installed at site boundary with the product misted via atomizers.

The reported products are classified as follows:
- Masking agents are mixtures of aromatic oils that cover up an objectionable odour with a more desirable one. The resultant odour is inherently more intense than the original odour, but arguably the character of the odour becomes less offensive.
- Chemical counteractants are mixtures of aromatic oils that cancel or neutralize odour and reduce the intensity.
- Digestive deodorants contain bacteria or enzymes that eliminate odour through biochemical digestive processes; and
- Chemical scavengers are chemicals that can be added to materials to react with the potentially odorous substances. Use includes removal of sulphur from spills of crude oil.

Technologies are also available to control odorous emissions which includes bio-filters *(Sun et al., 2000[25]*, adsorption on activated carbon *(Erto et al., 2010)[26]*and scrubbing with an oxidizing solution *(Smet et al., 1998)[27],* but these technologies are not available to treat very large and diffusive emissions such as those from a waste landfills. Similar study has also been done at Kanjur site and the disposal of municipal solid waste is done by bio-reactor landfill which has Gas and leachate collection system. At Kanjur Solid Waste processing facility, the collected gas is flared and also the other gases which are responsible for odour nuisance are generated in the process are treated with odour neutralizer, but at very high cost.

Some workers have conducted experiments to mitigate odour from landfill sites as well as waste water treatment facility. Shui-Jen Chen et al., in Taiwan at Tian-Wai-Pian landfill in Ji –Long city in Taiwan[28.]They used Natural Effective Microorganism Enzyme (NEME). Their focus was to reduce the odour from combination of NH_3, H_2S and CH_3SH (Methyl Mercaptan). They sprayed certain concentration of this patented enzyme and observed after 8 and 16 hours. They found reduction of odour over 99%.

While in a process of doing seasonal odour perception studies of dumping grounds under this project, we tried to experiment on how odour at these sites can be mitigated with reference to various studies reported with locally available commercial materials. Incidentally we came across the professionals at waste management expo site named M/s. Bioxgreen Technology Pvt. Ltd, M/s. Zenith Chemicals and Allied Industries, M/s. Chaitanya Soil Sciences Pvt. Ltd dealing with this aspect on commercial basis. Rather than experimenting with various molecules decomposing or masking agents we decided to apply the product compositions being marketed by the agencies.

A small experiment for one day at Kanjur and Deonar sites were conducted with different products produced by these companies. The results are as under:-

1) Experiment with M/s. Bioxgreen Technology Pvt.Ltd.at Kanjur Marg Dumping Ground

It is a pharmaceutical company based in Chennai, have developed a product called "Stink kill BXGE-0301" for the odour elimination and they claim, it is Bio-organic natural product easy to use, effective, economical and recommended to use on Municipal Solid Waste including landfill sites and also on liquid waste. They claim the product is non-toxic, non-hazardous, non-flammable and 100% biodegradable. It is not a masking agent but an odour neutralizer. The product is a dry bacterial powder in addition to a separate pack of additives to be mixed on site. They have given safety precautions for using their product.

While conducting an experiment 5 tons of MSW was isolated and mixing was done with the help of JCB machine. A bottle of 1 litre of liquid solution was mixed with the 100 grams of patented powder then poured into 100 litres of water and sprayed over the surface mixed waste and was then covered with tarpaulin sheet for 2 hours. Tarpaulin was then removed and odour measurements were carried out. The measurements are reported in **Table 6.1** and **Figure 6.1**.

Table 6.1: Pre & Post Treatment Measurements
[M/s. Bioxgreen Technology Pvt.Ltd.at Kanjur Marg Dumping Ground]

Emission Gases from Mix Waste	Pre-Treatment Concentration (ppm)	Post – Treatment After Half an hr	After 1 Hr Conc. (ppm)	After 1 & ½ hr Conc.	After 2 Hrs Conc.	After 3 Hrs Conc.	After 4 Hrs Conc.	After 5 Hrs Conc.	After 6 Hrs Conc.
VOC	1.5	1.3	1.1	0.9	0.8	0.5	0.36	0. 23	0.12
Mercaptan	0.09	0.04	0.026	0.018	0.017	-	-	-	-
Dimethyl Sulphide	683 (ppb)	30.9 (ppb)	2.5 (ppb)	0.16 (ppb)	0	-	-	-	-
CH$_4$	23.1	2.4	0. 39	0.07	0	-	-	-	-
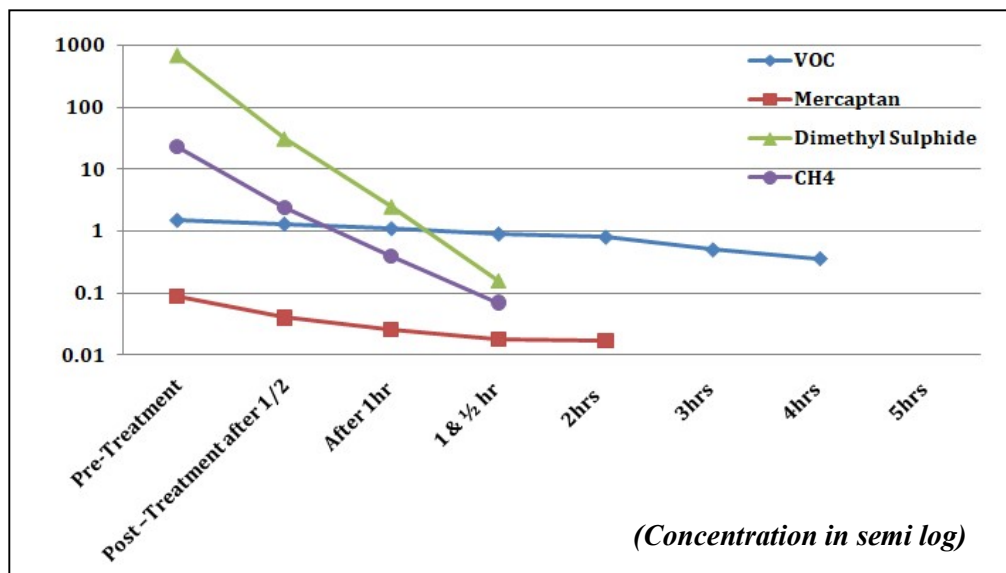
Figure 6.1: Pre & Post Treatment Measurements
[M/s. Bioxgreen Technology Pvt. Ltd. at Kanjur Marg Dumping Ground]

2) Experiment with M/s. Zenith Chemicals and Allied Industries at Deonar Site

It is a chemical industry producing different products and based in Satara, Maharashtra and has been supplying their product called "Biowizard". The manufacturer claims that their product reacts biochemically with odour causing molecules, breaks down volatile organic compounds into inert and smell free compounds which rapidly reduces odour at landfill sites and composting facilities. They

also claim that their product is effective on a wide range of volatile organic compounds and is cost effective, long residual effect, non-toxic, safe for humans and the environment. The product is claimed to be a composition of natural mixer of various grains and oils. The product is to be mixed with water at a ratio of 5 gm/ltr of water prepared for 20 liters solution. The activation time is 8 to 12 hours at room temperature. The experiment was conducted at Deonar dumping site in their presence. The results are represented in **Table 6.2** and **Figure 6.2**.

Table 6.2: Pre & Post Treatment Measurements
[M/s. Zenith Chemicals and Allied Industries at Deonar Site]

Emission Gases from Mix Waste	Pre-Treatment Concentration (ppm)	Post – Treatment After Half an hr	After 1 Hr Conc. (ppm)	After 1 & ½ hr Conc.	After 2 Hrs Conc.	After 3 Hrs Conc.	After 4 Hrs Conc.	After 5 Hrs Conc.	After 6 Hrs Conc.
Mercaptan (ppb)	39	20.3	10.3	10	7	3	1.4	0.61	0.2
H_2S	0.05	0.032	0.021	0.03	0.01	0	-	-	-
Dimethyl Sulphide	1.4	0.7	0.5	0.03	0	0	-	-	-
CH_4	14.89	6.5	2.4	1.1	0.51	0.11	0.016	-	-
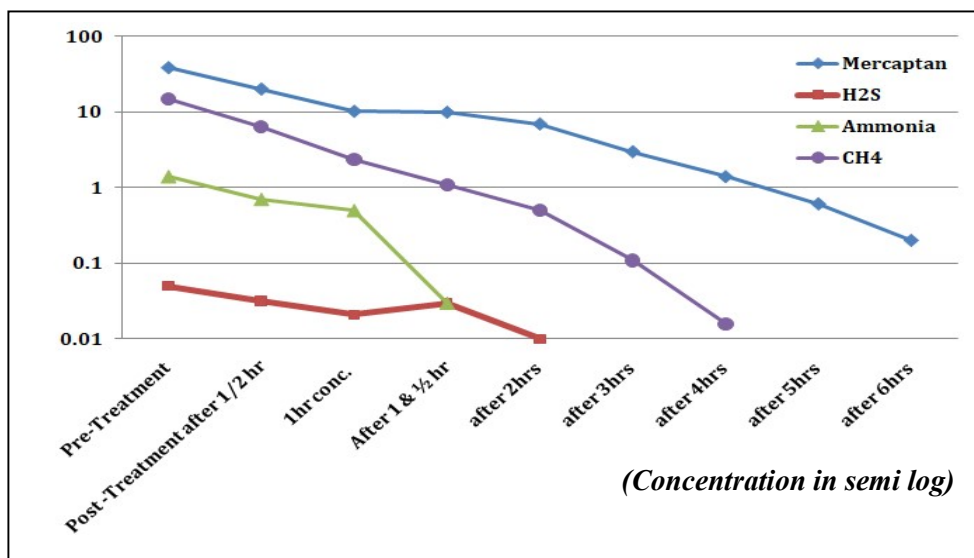
Figure 6.2: Pre & Post Treatment Measurements
[M/s. Zenith Chemicals and Allied Industries at Deonar Site]

3) Experiment with M/s. Chaitanya Soil Sciences Pvt. Ltd at Deonar Site

It is a company based in Pune and producing different products for abatement of odours of solid waste, waste water and nallah clean-up activity. Their product is called as "Chaitanya Enzymes", which is non-hazardous, non-pathogenic, non-genetically altered and Micro-organism and Microbial nutrient on inert any media. The product is non-flammable, non-hazardous, and soluble in water, pre-flowing of White to Light Brown powder, non-toxic product. The solution was prepared by addition of 1 Kg powder into 10 liters of water and spread over 5tons of fresh Municipal Solid Waste. They have given safety precautions for use of their products, personal protection, storage and handling of the product including the transportation. The experiment was conducted for one day and results are tabulated in **Table 6.3 and Figure 6.3**.

Table 6.3: Pre & Post Treatment Measurements
        [M/s. Chaitanya Soil Sciences Pvt. Ltd at Deonar]

Emission Gases from Mix Waste	Pre-Treatment Concentration (ppm)	Post – Treatment After Half an hr	After 1 Hr Conc. (ppm)	After 1 & ½ hr Conc.	After 2 Hrs Conc.	After 3 Hrs Conc.	After 4 Hrs Conc.	After 5 Hrs Conc.	After 6 Hrs Conc.
Mercaptan (ppb)	40	39.2	38	38	38	30	27	22	18
H_2S	0.12	0.061	0.04	0.029	0.02	0	-	-	-
Dimethyl Sulphide	1.76	1.4	1.2	1.1	1.03	0.69	0.45	0.38	0.2
CH_4	21.26	4	0.36	0.05	0	-	-	-	-
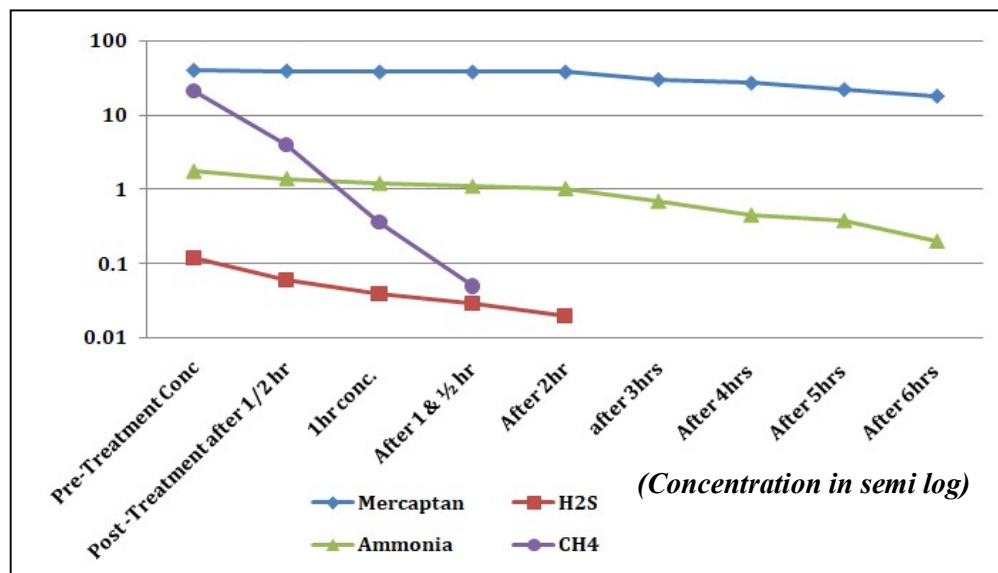
Figure 6.3: Pre & Post Treatment Measurements
[M/s. Chaitanya Soil Sciences Pvt. Ltd. at Deonar]

From the analysis of the products and after conducting the experiments, examination of the results, it is found that these products can be used for abatement of the odour at the dumping sites by examining composition and concentrations to be used as recommended by the manufacturer by considerably examining in greater details. WTERT-India do not recommend any product but states that the products shall be natural products (herbal based), non-toxic, non-hazardous, non-flammable, safe to use for the application.

From **Table 6.1andFigure 6.1** it is observed that dimethyle sulphide, methane and mercaptan concentrations seize to show any concentrations within two hours and they show the linear decrease in concentration with permissible accuracy and precision and they seize to show off by two hours as far as VOC'S are concerned, the concentration reduce substantially up to 6 hr and then it is showing that small concentrations always exists and which could be showing beyond 24 hours, if the measurements are continued. It is obviously the VOC's are the mixture of ultramicroscopic, ultra micron size which form aerosols which shall always show the tendency to float in atmosphere and as they generally are not impacted even by rainfall, humidity and meteorological parameters. Here it is seen they cannot be even embedded /masked by such a reagent used in this experiment; however it is worth noting that the reagent is able to reduce the concentration of larger size aerosols.

The observations of measurements of the reagent 'Biowizard' reported in **Table 6.2** and **Figure 6.2** for Deonar dumping ground it is observed H_2S and NH_3 do not show any measurements beyond 2 hours whereas mercaptan also drastically falls within 4 hours close to zero and methane is showing the poor response at least up to 6 hours.

The observations in **Table 6.3** and **Figure 6.3**shows the reagent 'Chaitanya Enzymes' can reduce the concentration of methane to almost below detectable level within 2 hours, H_2S almost negligible within 3 hours, whereas NH_3 concentration is falling gradually and showed presence even after 6 hours, Mercaptan shows poor response and did not show much falls in concentration at least 6 hours of measurements.

Therefore, above all experiments show that the patented commercial reagents or by trying other some masking reagents can overcome the concentrations of gases which all cumulatively creating the kind of odour which creates repelling smell and also health hazards. The originate molecules responsible from the site can be meant to react to other chemical molecules resulting in formation of complex / coordinating species, which always results into change into physical and chemical characteristic of the gases. We at experimental site also observed that after 3 to 4 hours staying at the

site of experiment, we hardly could feel the odour due to these gases. Therefore fairly said odour can be controlled by scientific methods.

6.2. Short Term Mitigation Measures

The mitigation measures derived based on the various articles, publications and practices adopted by the local bodies and practicable to abate the odour nuisance to certain extent till the scientific processing and disposal is taken place or fully implemented compliant to the MSW Rules.

- Segregation at source and reduction of Biodegradable contents reaching to the dump site
- Unloaded waste shall be dozed, levelled and compacted with daily earth cover
- Minimize fresh waste exposure
- Avoid parking of vehicles full of waste on site during night time
- Provide Leachate collection and treatment to the extent possible
- Provide passive vents wherever possible
- Spraying of Deodorant (Herbal based, water Soluble) to abate the smell, whenever complaints are received in particular period of the day. Provide plantation/ Green belt (of selected species) wherever possible
- Switch over from open dumping to control dumping in phase manner
- Prepare Closure plan for open dumping and stage wise development of the new site, if identified and allocated for future disposal
- Protect the site with fencing or guarding the site from unauthorized entry to avoid fires and make arrangement for fire fighting in case it occurs

6.3 Long Term Mitigation Measures

The long term mitigation measures are progressive steps for scientific processing and disposal in phase Manner without disturbing existing activity with systematic planning. These measures suggested based on the studies, literatures, papers and the practices adopted by the developer agencies and to be treated as a guidance document.

- Select appropriate Technology for scientific processing based on the Screening and set up the facility with assured quantity of waste in phases
- Switch over from Controlled dumping to scientific processing & disposal by stage wise development
- Plan for Sanitary landfill for safe disposal of residual waste and inert waste
- Switch over from control dumping to Scientific/ Sanitary land filling on a land with facility designed with all protective measures, as per the rules *(As per CPHEEO Manual)*

- Plan for Sanitary land filling at Regional level for group of Local Bodies to make cost effective as setting up individually for lesser quantities is very costly consideration of Manpower, Heavy Machinery Cost and complex Operational and compliances issues

- Develop "Environment Management Plan" for Waste Processing and Land filling and shall be made Mandatory for the Developer agency for its adherence &fulfilment

- Develop Green belt surrounding to the facility with selection of species of 15-20 M width at least on Habitation side

- Create a buffer zone of 200 m – 250 m from the boundary of the facility towards habitation side

- Carry out regular monitoring of all parameters at regular intervals and submit compliances to the Regulatory authorities.

- Plan for up gradation for the facility to take care futuristic requirements.

- Take adequate measures to control fires and establish permanent Fire Fighting System.

- Organize Training Programs for the operating Staff.

- Conduct Awareness Programmes amongst Citizens and organize visits to the facility.

Considering the short term and long term measures, it is recommended that the Urban Local Bodies shall set up their processing facility and scientific landfill within their jurisdiction depending upon the availability of land or group of ULBs shall set up Regional Landfill facility as amendment in the Act dated 20th Dec. 2012 to direct the Corporations/councils to partake in the common facility on certain terms and conditions. The open dumping shall be converted to controlled dumping and then to scientific landfill at the same site by partial Bio-Remediation/Bio mining or at the regional facility.

6.4 Conclusions

> Scientific study for analysis of these odorous gases throughout the year indicates that the hazardous gas emissions are a continuous process irrespective of the seasons. The odour perception among the residents and floating population is the effect of resultant of combination of all gases. However each entity of the composition shall have its independent chemical and physical entity which shall have its own characteristics and individual health effects. The finding shows that the measurement of concentrations and people's perceptions are in close agreements to each other.

> As explained in Chapter 1, the Deonar dumping site of MCGM is the oldest and largest site in India established in 1927, admeasuring 120 ha area. When there were no Rules or Guidelines in existence even till 2000, the process of dumping was managed with utmost

care like dozing and leveling of waste and daily and putting earth cover to minimize smell and facilitate decomposition.

➢ The Diva-Khardi dumping ground is having smallest size 5 ha area. Wherein also leveling and dozing is frequently carried out by Thane Municipal Corporation.

➢ Gases generated from dumping sites are hazardous and each gas can cause specific health hazard as known to have. This will affect nearby habitation and therefore needs to be controlled, if not immediately combated of diminish by appropriate waste management technology.

➢ The Urban Local Bodies should develop an "Action Plan" for closure of dumping sites and switch over to processing and scientific land-filling. The good results ore observed in case of Gorai dumping site.

➢ Our studies indicate that the measures can be taken for abatement of odorous gases as shown in the outcome of our experiments as well as suggested / reported in the mitigation measures.

➢ In the surveys carried out for perception & clinics and dispensaries, it is observed that there is a need for Health Survey around dumping sites at least for 2 seasons. We recommend continuation of these studies.

➢ As there are no studies on indexing of various odorous compounds generated at dumping site or at processing facility, an innovative approach can be made with which odour dispersion around dumping ground or landfill can be estimated by using the odourless methane as an "odour index". By estimating methane production rate from the landfill and by using air dispersion model, a "**critical zone**" around the landfill with regard to odour can be determined. Methane has been known to be used as an index for biogas migration. As far as odour is concerned, in addition to hydrogen sulphide, ammonia, mercaptans, organo sulphur compounds, there are other trace species like alkylbenzens, limonene, easters and other hydro carbons are required to be taken into account while measuring odorous compounds. They can be measured and compared with the odour limit concentrations of the odorous biogas compounds.

➢ **6.5 Tolerance Zone / Safe Zone**

1. With respect to the studies carried out herein including perception studies conducted, several measures of abatement of odour as described under "Short term measures" are implemented

a "Safe Zone" found to be of 200 mtr to 250 mtr on "Case to case basis" from the boundary of the processing facility on habitation side will be sufficient.

2. The Green Belt of the selected species with respect to their properties of Phyto-decomposition, Phyto-absorbtion and overall Phyto-remediation shall be adopted to minimize the problems as well as creating aesthetic value. (Ref. CPCB Guidelines of April 2017).

Further, the Buffer Zone effectiveness can be reinforced with "Green Belt" within the boundaries to reduce the adverse effects from the activity area like air and noise pollution, soil erosion etc. It is further suggested that transformation of open dumping and stage-wise developments of scientific processing and land filling will have to be implemented by the Urban Local bodies by preparation of an Action Plan. The open dumps which are saturated shall be scientifically closed like transformation of Gorai site.

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Physical Assessment Data Sheet

Date: 9 January, 2019   Site Name: Deonar Dumping

Details of Sampling:

Sr. No.	Components	Weight (Kg)
1	Fruits	8.57
2	Vegetables	45.35
3	Food Waste	5.74
4	Fine Organic Waste	1.97
5	Leaves	3.59
6	Hay and Straw	0.01
7	Coconut	1.10
8	Paper	6.63
9	Wooden Matter	0.26
10	Cloth	2.93
11	Coal	-
12	Packing Material	5.10
13	Thermocol	0.05
14	Metal	0.38
15	Plastic	3.29
16	Glass	1.07
17	Crockery	0.14
18	Earthen Waste	-
19	Stones & Bricks	0.14
20	Ash & Fine Waste	-
21	Rubber & Leather	-
22	Others	1

Physical Assessment Data Sheet

Date: 29 May, 2019   **Site Name: Thane Transfer Station (Wagle Estate)**

Details of Sampling:

Sr. No.	Components	Weight (Kg)
1	Fruits	-
2	Vegetables	3.80
3	Food Waste	0.77
4	Fine Organic Waste	19.92
5	Leaves	0.20
6	Hay and Straw	-
7	Coconut	-
8	Paper	1.60
9	Wooden Matter	0.37
10	Cloth	0.56
11	Coal	-
12	Packing Material	-
13	Thermocol	0.02
14	Metal	-
15	Plastic	2.50
16	Glass	0.38
17	Crockery	0.14
18	Earthen Waste	-
19	Stones & Bricks	-
20	Ash & Fine Waste	-
21	Rubber & Leather	0.04
22	Others	-

Physical Assessment Data Sheet

Date: 15 March, 2019   **Site Name: Turbhe WPF**

Details of Sampling:

Sr. No.	Components	Weight (Kg)
1	Fruits	1.61
2	Vegetables	-
3	Food Waste	0.02
4	Fine Organic Waste	11.36
5	Leaves	0.02
6	Hay and Straw	-
7	Coconut	1.55
8	Paper	0.27
9	Wooden Matter	0.01
10	Cloth	1.19
11	Coal	-
12	Packing Material	0.03
13	Thermocol	-
14	Metal	0.03
15	Plastic	0.37
16	Glass	1.10
17	Crockery	-
18	Earthen Waste	-
19	Stones & Bricks	0.07
20	Ash & Fine Waste	-
21	Rubber & Leather	-
22	Others	0.03

Combine concentrations of gases H_2S, NH_3, CH_4S

Deonar Dumping Ground						
Location	Distance Mtrs.	Strong smell	All Season gases			Combine Gas H_2S, NH_3, CH_4S
			H_2S avg.	NH_3 avg.	CH_4S avg.	
Shivaji Nagar Bus Depot	200	15.87	0.38	0.17	0.11	0.22
BMC building	200	15.87	0.06	0.00	0.01	0.02
Hindi Urdu MNC School	200	15.87	0.09	0.15	0.02	0.09
Bhim Nagar	500	17.78	0.14	0.13	0.03	0.10
Ambedkar Ground	500	17.78	0.18	0.20	0.03	0.14
Bhadra Hospital	500	17.78	0.11	0.25	0.02	0.13
Mankhurd Fire Station	500	17.78	0.18	0.16	0.03	0.13
R.S.C.(opp)	1000	32.70	0.06	0.00	0.04	0.03
Railway Sankalp Colony	1000	32.70	0.29	0.07	0.07	0.15
Shree swami samarth	1000	32.70	0.03	0.12	0.04	0.06
Atlanta ground	1000	32.70	0.07	0.16	0.06	0.10
Red Brick	1000	32.70	0.19	0.54	0.08	0.27
Shivaji Nagar Police Station	1000	32.70	0.17	0.25	0.08	0.17
Fire Brigade Colony	3000	7.94	0.10	0.27	0.02	0.13
Pestom Sagar	3000	7.94	0.12	0.22	0.04	0.13
Vashi Bridge	3000	7.94	0.08	0.07	0.07	0.07
Manoranjan Maidan	3000	7.94	0.17	0.59	0.06	0.27
Maharashtra Nagar Bus stop	3000	7.94	0.11	0.15	0.06	0.11
Ramabai Nagar	3000	7.94	0.19	0.03	0.06	0.09
Deonar MNC Colony	3000	7.94	0.10	0.11	0.04	0.08
Mohite Patil School	3000	7.94	0.07	0.16	0.05	0.09

Combine concentrations of gases H₂S, NH₃, CH₄S

Gorai Dumping Ground						
Location	Distance Mtrs.	Strong smell	All Season gases			Combine Gas H₂S, NH₃, CH₄S
			H₂S avg.	NH₃ avg.	CH₄S avg.	
Closure Point	200	9.64	0.14	ND	0.05	0.09
Sonchafa Nursery	200	9.64	0.15	0.20	0.05	0.13
Chinmay Society	200	9.64	0.12	0.09	0.08	0.10
Shanti Dhaan	200	9.64	0.12	0.04	0.08	0.08
Malgudi Hotel	200	9.64	0.17	0.08	0.03	0.09
Gorai Bus Depot	500	0.35	0.30	0.29	0.06	0.22
Maxus Mall	500	0.35	0.22	0.22	0.02	0.15
Pepsi Ground	500	0.35	0.09	ND	0.02	0.06
Pillai Acadamy	500	0.35	0.23	0.39	0.04	0.22
Gorai 2	1000	0	0.19	0.14	0.06	0.13
Suvidya School	1000	0	0.18	1.51	0.02	0.57
MHB Colony	1000	0	0.13	0.07	0.01	0.07
Gokhale College	1000	0	0.18	0.39	0.07	0.22
New MHB Colony	3000	0	0.15	ND	0.02	0.08
Gorai bridge	3000	0	0.09	0.44	0.04	0.19
Borivali Fire Station	3000	0	0.17	0.22	0.03	0.14
Ferry Point 1	3000	0	0.12	0.01	0.04	0.06
Ferry Point 2	3000	0	0.29	0.02	0.07	0.13

Combine concentrations of gases H$_2$S, NH$_3$, CH$_4$S

Diva-Khardi Dumping Ground						
Location	Distance Mtrs.	Strong smell	All Season gases			Combine Gas H$_2$S, NH$_3$, CH$_4$S
			H$_2$S avg.	NH$_3$ avg.	CH$_4$S avg.	
Salvi Nagar 1	200	13.53	0.21	0.03	0.03	0.09
Salvi Nagar 2	200	13.53	0.22	0.11	0.07	0.13
Sumit Plaza	200	13.53	0.20	5.92	0.01	0.11
Aadarsh Gurukul	500	14.19	0.22	3.58	0.06	0.14
National School	500	14.19	0.14	0.77	0.02	0.31
Ekvira Chawl	500	14.19	0.20	0.35	0.01	0.19
Sudama Greens	500	14.19	0.21	0.03	0.03	0.09
Gaondevi Apartments	1000	10.26	0.14	0.20	0.03	0.12
Om Residency	1000	10.26	0.24	1.17	0.04	0.48
Sudama Regency	1000	10.26	0.30	0.32	0.04	0.22
Global English School	1000	10.26	0.24	0.12	0.04	0.13
Diva Post office	3000	5.24	0.04	11.42	0.02	0.03
Diva High School	3000	5.24	0.19	0.86	0.03	0.36
Saraswati School	3000	5.24	0.23	0.51	0.02	0.25
Mumbra Hospital	3000	5.24	0.29	2.29	0.04	0.16
Mumbra Police Station	3000	5.24	0.31	0.37	0.05	0.24
Sakharam Patil School	3000	5.24	0.30	0.44	0.03	0.26
Global Park	3000	5.24	0.24	0.48	0.03	0.25
Kalsekar College	3000	5.24	0.31	0.26	0.04	0.20
Bedekar Nagar	3000	5.24	0.20	0.14	0.06	0.13
Rainbow English School	3000	5.24	0.17	0.31	0.04	0.17

Combine concentrations of gases H₂S, NH₃, CH₄S

Location	Distance Mtrs.	Strong smell	All Season gases			Combine Gas H₂S, NH₃, CH₄S
			H₂S avg.	NH₃ avg.	CH₄S avg.	
Samata Hindi School	200	16.47	0.30	ND	0.06	0.18
WTP Gate	200	16.47	0.13	ND	0.05	0.09
WPF	200	16.47	0.26	ND	0.05	0.15
Shivshakti nagar	500	7.47	0.11	0.31	0.04	0.16
BASF	500	7.47	0.21	0.10	0.06	0.12
Parsik Hill	500	7.47	0.10	ND	0.05	0.07
Yashraj Biotech	500	7.47	0.12	ND	0.04	0.08
Sky Indusries	500	7.47	0.14	ND	0.07	0.11
Turbhe Naka	1000	24.71	0.19	0.17	0.05	0.14
Indira Nagar	1000	24.71	0.11	ND	0.03	0.07
Global lab	1000	24.71	0.15	0.04	0.04	0.08
Savita Chemicals	1000	24.71	0.14	0.10	0.05	0.10
Wasan Toyota	1000	24.71	0.16	0.14	0.08	0.12
Prabhat dairy	1000	24.71	0.08	0.08	0.04	0.07
Shalimar	1000	24.71	0.12	0.09	0.07	0.09
Hari Baba Sadhu Marg	1000	24.71	0.13	0.16	0.04	0.11
Shiravane Gaon	3000	4.02	0.11	0.02	0.03	0.05
Vashi post office	3000	4.02	0.11	0.04	0.03	0.06
Khairane Gaon	3000	4.02	0.21	0.03	0.04	0.09
Jui Nagar MNC School	3000	4.02	0.20	0.13	0.04	0.12

The table above is under the heading **Turbhe WPU**.

Climate Data

Climatic condition of Mumbai City:

Pre-Monsoon (summer)

The summer season in Mumbai falls between mid-Feb. to mid-June wherein the maximum temperature observed in 2018 was 38.4^0 C and minimum was 17 ^{0}C. The humidity recorded was max. 95% and min.52%. The wind direction keeps varying as per the atmospheric pressure of surrounding region. During the 5 days of measurements i.e. 25th April 2018 to 22nd May, 2018 the climatic conditions observed, where maximum temperature recorded was 38.5^0C and minimum was 30.1^0C. Whereas, maximum humidity observed was 71.4% and minimum was 52.5 % and the wind directions were changing as per the atmospheric pressure.

Monsoon and Post Monsoon

The onset of monsoon of Mumbai begins on 10th June and recedes in September. The month of June is usually observed hotter with the max. temperature of 35.2^0C & $min.23.4^0$C. Humidity observed was max. 98% Min.18% and on setting of monsoon temperature starts falling. During the 5 days of measurements i.e. from 3rd Oct. 2018 to 7th Nov. 2018 the temperature observed was max. 38^0C and minimum 20^0C. The relative humidity was max.60.1 % and min. 31.4 %. The annual precipitation of rain for Mumbai recorded for 2018 was 2422 mm, whereas sometimes it is unprecedented. The average rainfall recorded for the year 2018 was 2386 mm and 2019 was 3475 mm, whereas wind directions was constant from South West to North East and rarely varies in monsoon.

It must be also noted that Mumbai city received unprecedented rainfall in a single day was 944 mm on 26th July, 2005, and 915mm on 15th Sept 2019. These factors also make serious impacts on dumping grounds like dilution of leachates, extraction of potential of gas generation capacity of MSW etc.

Winter:

The winter season is observed from October to about Mid-Feb. The maximum temperature observed in winter season for 2019 was 35.6^0C and minimum was 14.4^0C and the relative humidity was 93% maximum and 15% minimum. During 5 days of measurements from 22nd Dec. 2018 to 15th Feb. 2019, the max. temperature recorded was 34^0C and minimum was 27.6^0C. The relative humidity recorded was max. 44.2 RH and min. 32.5 RH. The wind directions observed were varying frequently during the measurements. (Ref:-Metrological Data-2018)

The climatic conditions of Mumbai shall always have either favourable or adverse effects from time to time. In summer there is lot of volatility and high temperature disperses the VOCs and other gases to the larger distance quite rapidly. The high temperature encompassing with possible inflammable substances in the solid waste leads to often fire breaking on the dumping ground which unfortunately has become regular feature resulting into complete vitiation of Mumbai climate and residents around the site suffer most. It could be worthwhile to carry measurements immediately after breaking of fire and heavy rainfall or during severe cold climatic condition as all of them do affect emission /generation of obnoxious gases and impairs air quality. Whereas in Winter, when the temperature is lowest i.e. Dec. to January the diffusion of gases spreads across the Mumbai because of low temperature and increased density of gases and low volatility. Therefore, Mumbai experiences health hazards of the gases generated from the waste at dumping grounds. There are often outbreaks of respiratory diseases in Mumbai city which are marked as the seasonal diseases and health hazards. In addition to vehicular pollution, the dumping grounds do have serious impact on health of Mumbai.

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Measurement of Contour Map - Deonar Dumping Ground

Sr No.	location				Distance in Mtrs.	VOC			H2S			CH4		
	Name of the Points	Point Code.	longitude	latitude		Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Deonar Dumping ground	DG	72.92807	19.07137	0	1.4	0.17	1.8	0.24	0.65	0.31	24.15	27.1	19.8
1	Shivaji nagar police Stn.	A	72.91644	19.06335	1000	0.06	0.05	0.27	0.15	0.28	0.09	2.5	5.03	7.5
2	Shree Swami Samarth Building	B	72.92264	19.05727	1000	0.88	0.05	0.37	0.01	0.06	0.02	16	4.28	2.6
3	Atlanta ground	C	72.925	19.05579	1000	0.61	0.05	0.52	0.12	0.07	0.02	2.5	3.4	2.3
4	Railway Sankalp Colony	D	72.93296	19.05521	1000	0.3	0.09	0.47	0.15	0.65	0.08	2.5	3.4	2.4
5	Red Brick Building	E	72.91749	19.06187	1000	0.24	0.05	0.64	0.18	0.3	0.09	18.72	13.81	6.7
6	Railway Sankalp Colony Bus St.	F	72.932986	19.055233	1000	0.06	0.06	0.5	0.01	0.12	0.05	2.5	3.4	3.3
7	BMC Building	G	72.93044	19.05939	200	0.06	0.15	1.32	0.01	0.02	0.15	2.5	3.4	2.3
8	Shivaji Nagar Bus depot	H	72.92947	19.06631	200	0.41	0.05	1.25	0.24	0.65	0.26	24.15	3.4	2.3
9	Nirankar Nagar	I	72.92582	19.0672	200	0.06	0.05	1.32	0.01	0.02	0.06	2.5	3.4	2.3
10	Hindi Urdu MNC School	J	72.92119	19.06807	200	0.44	0.05	1.43	0.11	0.1	0.07	2.5	3.4	2.3
11	New Bhim Nagar	K	72.92378	19.05862	500	0.75	0.05	0.85	0.18	0.08	0.16	2.5	3.4	2.3
12	Ambedkar Ground	L	72.92173	19.06082	500	0.47	0.05	1.15	0.13	0.14	0.24	22.01	4.94	2.3
13	Bhadra Hospital	M	72.92811	19.05808	500	1.27	0.05	1.11	0.11	0.02	0.21	2.5	3.4	6.8
14	Fire Brigade	N	72.9314	19.05688	500	0.22	0.05	1.29	0.05	0.15	0.17	2.5	27.1	16.1
15	Maharashtra Nagar Bus stop	O	72.93781	19.05166	3000	0.36	0.17	1.23	0.11	0.1	0.11	2.5	3.4	6.0
16	Vashi Bridge	P	72.941568	19.05287	3000	0.06	0.05	1.22	0.01	0.12	0.12	2.5	3.4	6.7
17	Mohite Patil School	Q	72.93439	19.0542	3000	0.43	0.05	1.38	0.2	0.11	0.09	2.5	3.4	6.0
18	Fire Brigade Colony	R	72.92195	19.055856	3000	0.67	0.05	1.27	0.03	0.04	0.09	2.5	3.4	4.2
19	Pestom Sagar	S	72.90249	19.06946	3000	0.38	0.05	1.68	0.07	0.23	0.07	2.5	6.64	7.7
20	Ramabai Nagar	T	72.91576	19.07846	3000	0.08	0.05	1.21	0.05	0.21	0.31	2.5	8.57	19.8
21	Manoranjan Maidan	U	72.91311	19.0633	3000	0.06	0.05	1.46	0.19	0.28	0.04	1.48	7.65	12.0
22	Deonar MNC Colony	V	72.92465	19.05295	3000	0.46	0.05	1.22	0.16	0.07	0.2	2.5	3.4	4.2

Sr No.	Name of the Points	Point Code.	NH3			CH4S			DMS			PM10		
	location		Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Deonar Dumping ground	DG	0.93	0.74	1.4	196.01	108.2	148.32	826.55	311.83	281.52	1.342	0.549	0.72
1	Shivaji nagar police Stn.	A	0.19	0.55	0.23	88.62	50.56	111.45	554.73	40.12	50	0.192	0.191	0.187
2	Shree Swami Samarth Building	B	0.16	0.2	0.23	50.65	35.62	32.19	474.05	57.04	55	0.19	0.18	0.114
3	Atlanta ground	C	0.24	0.11	0.13	20	35.34	116.73	657.59	40.12	54	0.878	0.18	0.221
4	Railway Sankalp Colony	D	0.1	0.11	0.23	39.4	108.2	63.99	826.55	311.83	60	0.387	0.18	0.255
5	Red Brick Building	E	0.88	0.74	0.23	96.66	26.05	101.98	815.46	40.12	65	0.2	0.237	0.473
6	Railway Sankalp Colony Bus St.	F	0.1	0.11	0.23	20	34.33	94.36	40.12	67.9	70	0.2	0.209	0.231
7	BMC Building	G	0.1	0.11	0.23	20	21.41	18.43	40.12	40.12	75	0.21	0.18	0.246
8	Shivaji Nagar Bus depot	H	0.4	0.11	0.11	196.01	74.05	68.57	800	50	80	0.2	0.18	0.227
9	Nirankar Nagar	I	0.1	0.11	0.23	20	20	41.59	40.12	80	82	0.2	0.16	0.2
10	Hindi Urdu MNC School	J	0.28	0.11	0.16	20	20	27.04	562.01	90	86	0.25	0.25	0.216
11	New Bhim Nagar	K	0.1	0.27	0.12	54.17	20	22.65	170.41	60	78	0.186	0.186	0.226
12	Ambedkar Ground	L	0.93	0.11	0.23	36.11	20	38.93	595.1	65	76	0.267	0.274	0.622
13	Bhadra Hospital	M	0.67	0.11	0.23	29.59	20	21.26	606.15	55	74	0.21	0.18	0.343
14	Fire Brigade	N	0.67	0.13	0.3	20	33.66	17.03	607.01	21.88	57.52	0.173	0.118	0.144
15	Maharashtra Nagar Bus stop	O	0.14	0.11	0.29	48.13	104.86	30.05	800	27.42	73	0.329	0.265	0.328
16	Vashi Bridge	P	0.1	0.11	0.2	20	64.94	148.32	40.12	40.12	76	0.22	0.164	0.236
17	Mohite Patil School	Q	0.16	0.11	0.23	32.36	45.52	60.11	800	142.63	78	1.342	0.549	0.72
18	Fire Brigade Colony	R	0.14	0.12	0.23	35.01	34.32	22.5	800	58	72	0.21	0.18	0.355
19	Pestom Sagar	S	0.44	0.23	0.23	45.38	59.8	25.07	800	68	119.42	0.23	0.125	0.37
20	Ramabai Nagar	T	0.1	0.11	0.23	35.27	68.48	75.98	247.78	70	281.52	0.24	0.162	0.299
21	Manoranjan Maidan	U	0.14	0.18	1.4	24.18	79.38	65.99	40.12	75	228.97	0.177	0.529	0.431
22	Deonar MNC Colony	V	0.6	0.2	0.1	49.31	26.28	42.88	423.33	82	65.11	0.22	0.18	0.324

Measurement of Contour Map - Gorai Dumping Site

Sr No.	Location				Distance in Mtrs.	VOC			H2S			CH4		
	Name of the Points	Point Code.	longitude	latitude		Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Gorai Dumping site	DG	72.826566	19.235955	0	ND	ND	1.6	0.56	0.35	0.28	40.02	25.73	10.61
1	Borivali Fire stn.	A	72.84013	19.229998	3000	ND	ND	1.27	0.14	0.2	0.17	21.05	6.03	4.85
2	Chinmay Society	B	72.82862	19.233192	200	ND	ND	1.41	0.22	0.18	0.13	17.89	6.45	9.8
3	Gorai closure point	C	72.825918	19.233866	200	ND	ND	1.2	0.13	0.14	0.28	7.6	6.05	4.05
4	Pillai Acadamy	D	72.82559	19.230691	500	0.16	ND	1.12	0.16	0.19	0.15	1.28	6.4	4.09
5	Ferry pt.1(Pagoda)	E	72.816485	19.229787	3000	ND	ND	0.91	0.15	0.24	0.26	26.07	25.73	2.31
6	Ferry pt.2(Uttan)	F	72.80799	19.225591	3000	ND	ND	0.77	0.16	0.18	0.1	7.9	6.5	2.29
7	Gokhale college	G	72.837082	19.232348	500	ND	ND	0.5	0.19	0.12	0.07	40.02	7	10.61
8	Gorai 2	H	72.823904	19.2270581	1000	ND	ND	0.34	0.23	0.21	0.15	8.1	6.8	2.32
9	Gorai bridge	I	72.828063	19.2264	3000	ND	ND	0.33	0.11	0.04	0.11	15.09	14.62	2.55
10	Gorai Depot	J	72.830252	19.232717	500	ND	ND	0.49	0.13	0.13	0.09	7.9	6.3	2.64
11	Malgudi Hotel	K	72.825948	19.232655	200	ND	ND	0.6	0.16	0.17	0.04	8.3	6.1	1.72
12	Maxus Mall	L	72.828552	19.231984	500	ND	ND	0.47	0.17	0.35	0.09	8.4	7.45	3.05
13	MHB colony	M	72.838128	19.231255	1000	ND	ND	0.5	0.18	0.29	0.07	7.8	6.8	2.32
14	New MHB Colony	N	72.839346	19.227802	3000	ND	ND	0.71	0.19	0.14	0.09	7.5	7	3.03
15	Pepsi Ground	O	72.824788	19.230792	500	ND	ND	0.73	0.14	0.24	0.08	8.2	7.1	2.92
16	Shanti Daan	P	72.828055	19.23333	200	ND	ND	0.64	0.2	0.33	0.13	8.3	6.9	2.4
17	Sonchafa nursery	Q	72.827804	19.232819	200	ND	ND	0.58	0.19	0.18	0.17	8.4	7.2	2.33
18	Suvidya School	R	72.82852	19.229389	1000	ND	ND	0.59	0.56	0.26	0.05	17.73	14.95	2.35

Sr No.	Name of the Points	Point Code.	NH3 Pre-monsoon	NH3 Post monsoon	NH3 Winter	CH4S Pre-monsoon	CH4S Post monsoon	CH4S Winter	DMS Pre-monsoon	DMS Post monsoon	DMS Winter	PM10 Pre-monsoon	PM10 Post monsoon	PM10 Winter
-	Gorai Dumping site	DG	1.84	2.69	0.34	128.72	107.92	100.38	ND	ND	ND	0.891	0.922	0.398
1	Borivali Fire stn.	A	0.23	0.14	0.135	18.66	19.27	57.32	ND	ND	222.28	0.086	0.086	0.209
2	Chinmay Society	B	0.26	0.39	0.136	38.8	11	41.7	41.4	ND	102.59	0.108	0.108	0.167
3	Gorai closure point	C	ND	1.18	0.16	24.37	20.48	25.17	ND	ND	40.44	0.103	0.098	0.217
4	Pillai Acadamy	D	ND	0.142	0.133	42.59	31.83	53.87	ND	ND	84.09	0.116	0.116	0.398
5	Ferry pt.1(Pagoda)	E	0.46	0.37	0.34	36.87	19.5	54.42	66.09	ND	23.83	0.137	0.106	0.158
6	Ferry pt.2(Uttan)	F	ND	0.143	0.132	19	18.67	54.81	ND	ND	129.23	0.12	0.048	0.117
7	Gokhale college	G	ND	0.43	0.131	70.5	10.45	100.38	ND	ND	0	0.078	0.078	0.141
8	Gorai 2	H	0.26	0.146	0.29	56.41	47.3	15.71	ND	ND	ND	0.098	0.1	0.087
9	Gorai bridge	I	ND	0.149	0.13	71.82	107.92	22.74	ND	ND	ND	0.891	0.922	0.098
10	Gorai Depot	J	ND	0.141	0.27	108.51	101.5	29.89	ND	ND	ND	0.089	0.086	0.204
11	Malgudi Hotel	K	ND	0.139	0.132	128.72	90.59	32.47	ND	ND	ND	0.079	0.078	0.142
12	Maxus Mall	L	ND	0.24	0.14	109.33	49.58	27.52	ND	ND	ND	0.133	0.127	0.136
13	MHB colony	M	ND	0.139	0.155	25	30.62	36.54	ND	ND	ND	0.11	0.139	0.133
14	New MHB Colony	N	ND	0.137	0.139	60.48	66.86	20.67	ND	ND	ND	0.102	0.106	0.211
15	Pepsi Ground	O	0.29	0.3	0.14	52.72	80.89	13.27	ND	ND	ND	0.083	0.084	0.244
16	Shanti Daan	P	1.84	2.69	0.15	122.91	77.04	17.75	ND	ND	ND	0.162	0.136	0.204
17	Sonchafa nursery	Q	0.22	0.146	0.139	38.2	7.26	13.93	43	ND	ND	0.113	0.103	0.166
18	Suvidya School	R	0.4	0.91	0.149	44.95	24.11	27.99	ND	ND	ND	0.111	0.147	0.162

Measurement of Contour Map - Diva Khardi Dumping Ground

Sr No.	Location				Distance in Mtrs.	VOC			H2S			CH4		
	Name of the Points	Point Code.	longitude	latitude		Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Diva Khardi Dumping Ground	DG	73.038498	19.175459	0	0.8	1.17	2.15	0.65	0.65	0.43	ND	ND	ND
1	Aadarsh Gurukul	A	73.04398654	19.18105607	500	0.6	0.11	1.01	0.47	0.12	0.07	ND	ND	ND
2	Bedekar Nagar	B	73.05917637	19.18695436	3000	ND	0.11	1.67	0.43	0.14	0.17	ND	ND	ND
3	Diva high school	C	73.03974995	19.18556128	3000	0.6	0.11	2.15	0.49	0.14	0.13	ND	1.02	ND
4	Diva post office	D	73.04340014	19.1864629	3000	ND	0.11	ND	0.212	0.14	0.04	ND	4.87	6.97
5	Ekvira Chawl	E	73.04138182	19.17981805	200	ND	0.15	ND	0.26	0.11	0.14	ND	ND	ND
6	Global Park	F	73.02702777	19.16609104	3000	0.2	0.28	1.24	0.34	0.2	0.18	4.1	14.83	2.35
7	Global school	G	73.05132526	19.18372692	1000	0.49	0.06	1.12	0.45	0.19	0.07	ND	ND	ND
8	Gaondevi	H	73.04087476	19.18284463	1000	0.8	0.16	ND	0.29	0.14	0.13	ND	ND	ND
9	Kalsekar college	I	73.02921577	19.15791481	3000	0.4	0.4	1.03	0.213	0.65	0.13	2.06	3.57	ND
10	Mumbra Hospital	J	73.02260054	19.18575087	3000	ND	0.11	1.16	0.214	0.33	0.23	1.22	5.39	3.03
11	Mumbra Police Stn.	K	73.02282536	19.18378065	3000	ND	0.8	1.38	0.65	0.18	0.09	10.05	11.95	1.79
12	National school	L	73.0440175	19.17842289	500	ND	0.11	1.96	0.215	0.17	0.05	ND	ND	26.11
13	Om residency	M	73.04683366	19.16278348	1000	0.61	0.11	1.62	0.39	0.22	0.13	ND	ND	ND
14	Rainbow school	N	73.0462317	19.15200307	3000	ND	0.11	1.62	0.217	0.21	0.16	1.33	ND	ND
15	Sakharram Patil Vidya Mandir	O	73.02368511	19.17603495	3000	ND	0.7	1.07	0.41	0.3	0.19	3.75	3.2	3.08
16	Salvi Nagar 1	P	73.04022172	19.17697974	200	ND	0.12	0.89	0.34	0.17	0.28	ND	ND	ND
17	Salvi Nagar2	Q	73.0421284	19.17673426	200	ND	1.17	1.14	0.218	0.23	0.08	12.18	8.18	ND
18	Saraswati school	R	73.0593903	19.1581129	3000	ND	0.11	1.02	0.48	0.17	0.14	ND	ND	0.04
19	Sudama Greens	S	73.04720343	19.1693818	500	0.36	0.11	1.35	0.45	0.14	0.14	ND	ND	ND
20	Sudama Regency	T	73.04526	19.16926336	1000	ND	0.23	1.56	0.219	0.27	0.43	ND	ND	ND
21	Sumit Plaza	U	73.04535042	19.18151021	500	ND	0.11	ND	0.48	0.11	0.02	ND	ND	ND

	Location		NH3			CH4S			DMS			PM10		
Sr No.	Name of the Points	Point Code.	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Diva Khardi Dumping Ground	DG	5.58	34.12	1.52	51.22	143.16	144.54	774.33	158.02	491.21	0.481	2.703	2.471
1	Aadarsh Gurukul	A	0.39	ND	0.15	40.23	14.26	139.99	637.82	ND	489.92	0.107	0.26	0.155
2	Bedekar Nagar	B	0.43	10.36	0.152	37.01	8.12	144.54	154.95	71.32	264.13	0.124	0.264	0.4
3	Diva high school	C	0.68	1.91	0.156	39.32	10.11	27.35	97.87	73.74	35	0.202	0.659	0.684
4	Diva post office	D	ND	34.12	0.154	ND	39.04	30.69	55	0.7	38	ND	2.703	2.471
5	Ekvira Chawl	E	0.63	ND	0.41	10.96	12.65	18.76	648.94	ND	73.5	0.168	0.301	0.257
6	Global Park	F	0.54	0.65	0.26	34.19	26.53	41.69	54	ND	40.93	0.481	0.265	0.555
7	Global school	G	0.35	ND	0.156	28.01	12.62	71.45	520.71	ND	345.48	0.117	0.267	0.16
8	Gaondevi	H	0.46	ND	0.154	51.22	15.28	11.18	540.62	107.43	93.51	0.136	0.268	0.452
9	Kalsekar college	I	0.34	0.16	0.33	43.94	22.16	57.62	52	ND	36	0.418	0.617	0.797
10	Mumbra Hospital	J	4.58	0.61	0.68	26.31	16.77	70.46	57	ND	83.76	0.276	0.27	0.361
11	Mumbra Police Stn.	K	0.5	0.34	0.27	28.29	46.06	88.07	56	ND	38	0.286	0.271	0.238
12	National school	L	0.36	0.58	1.52	5.41	10.98	39.42	56	ND	180.91	0.1	0.267	1.272
13	Om residency	M	0.53	2.97	0.157	50.32	50.93	30.56	144.55	ND	37	0.14	0.369	0.15
14	Rainbow school	N	0.37	ND	0.73	39.15	70.47	13.61	701.65	ND	76.67	0.084	0.439	0.32
15	Sakharram Patil Vidya Mandir	O	0.56	0.11	0.64	26.77	11.3	62.86	56	ND	41.44	0.374	0.374	0.499
16	Salvi Nagar 1	P	0.34	ND	0.159	17.21	18.41	69.79	774.33	ND	491.21	0.179	0.269	0.287
17	Salvi Nagar2	Q	0.36	ND	0.156	12.42	143.16	42.7	52	158.02	190.99	0.072	0.878	0.196
18	Saraswati school	R	0.35	1.18	0.154	41.95	5.8	15.82	502.05	ND	39	0.142	0.266	0.155
19	Sudama Greens	S	0.35	ND	0.152	35.27	ND	42.46	373.3	ND	289.69	0.111	0.265	0.155
20	Sudama Regency	T	0.37	ND	0.82	20	20.02	65.31	398.38	ND	154.53	0.076	0.267	0.348
21	Sumit Plaza	U	0.39	17.49	0.157	16.3	1.53	16.88	51	87.65	36	0.112	0.263	0.155

Measurement of Contour Map - Turbhe Waste Processing Facility

Sr No.	location			Distance in Mtrs.	VOC			H2S			CH4		
	Name of the Points	Point Code	longitude	latitude	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter	Pre-monsoon	Post monsoon	Winter
-	Turbhe Waste Processing Facility	DG	73.0226	19.077779	0	0	0	1.9	0.15	0.12	0.25	ND	ND	ND
1	Indira Nagar	A	73.0307	19.077	1000	ND	ND	0.57	ND	0.14	0.02	ND	ND	ND
2	Head post office vashi	B	72.9977	19.0772	3000	ND	ND	1.38	0.14	0.14	0.06	ND	ND	5.48
3	BASF Const.	C	73.0267	19.0774	500	ND	ND	0.49	0.27	0.15	0.2	ND	ND	2.9
4	Entrance of WPF	D	73.0246	19.077	200	ND	ND	0.38	0.12	0.15	0.09	5.84	ND	ND
5	Global Lab MIDC Main Rd	E	73.0283	19.0705	1000	ND	ND	1.9	0.1	0.2	0.05	ND	ND	8.52
6	Haribaba Sadhu marg	F	73.0204	19.069	1000	ND	ND	1.55	0.16	0.15	0.09	ND	ND	8.58
7	Jui Nagar Municipal school	G	73.0162	19.0515	3000	ND	ND	1.41	0.16	0.15	0.3	ND	ND	2.66
8	Khairane Village/Bonkode	H	73.0147	19.0983	1000	ND	ND	1.26	0.25	0.14	0.23	ND	ND	0.03
9	Parsik Hill B.s	I	73.0268	19.0798	500	ND	ND	0.86	0.15	0.16	0.23	ND	ND	ND
10	Prabhat Diary	J	73.018	19.0786	1000	ND	ND	1.64	0.09	0.09	0.06	ND	ND	3.34
11	Road for WPU	K	73.0244	19.0782	200	ND	ND	1.66	0.16	0.21	0.04	ND	ND	0.77
12	Samata Hindi School	L	73.0213	19.0795	200	ND	ND	1.45	0.51	0.28	0.12	ND	ND	1.09
13	Savita Chemicals Stop	M	73.0173	19.0852	1000	ND	ND	1.43	0.16	0.13	0.14	ND	ND	0.22
14	Shalimar stop	N	73.0277	19.0854	1000	ND	ND	1.38	0.14	0.13	0.08	ND	ND	2.71
15	Shirvane Gaon	O	73.0229	19.0527	3000	ND	ND	1.49	0.12	0.12	0.09	ND	ND	3.6
16	Shivshakti Nagar	P	73.0206	19.0779	500	ND	ND	1.61	0.16	0.11	0.06	ND	ND	26.2
17	Sky Industries Ltd	Q	73.0261	19.0808	500	ND	ND	1.75	0.18	0.13	0.11	ND	ND	3.41
18	Yashraj Biotechnology	R	73.0243	19.08175	500	0.5	ND	1.86	0.16	0.16	0.03	ND	ND	30.59
19	Turbhe Naka	S	73.01926	19.0696	1000	ND	ND	1.69	0.14	0.18	0.25	ND	ND	4.44
20	Wason Toyota	T	73.0223	19.0867	1000	ND	ND	1.2	0.15	0.19	0.14	ND	ND	0.64

Sr No.	Name of the Points	Point Code.	NH3 Pre-monsoon	NH3 Post monsoon	NH3 Winter	CH4S Pre-monsoon	CH4S Post monsoon	CH4S Winter	DMS Pre-monsoon	DMS Post monsoon	DMS Winter	PM10 Pre-monsoon	PM10 Post monsoon	PM10 Winter
-	Turbhe Waste Processing Facility	DG	ND	ND	ND	85.5	44.44	68	0	0	375	0.274	0.334	1.9
1	Indira Nagar	A	ND	ND	ND	ND	62.72	30.52	ND	ND	35.2	0.18	0.367	0.26
2	Head post office vashi	B	ND	ND	0.13	31.3	31.3	24.95	ND	ND	145.72	0.822	0.822	0.225
3	BASF Const.	C	ND	ND	0.03	89.09	62.35	21.05	ND	ND	35.6	0.208	0.271	0.235
4	Entrance of WPF	D	ND	ND	ND	63.27	74.43	26.28	ND	ND	78.7	0.292	0.254	0.195
5	Global Lab MIDC Main Rd	E	ND	ND	0.11	61.46	37.84	31.92	ND	ND	93.56	0.18	0.419	0.506
6	Haribaba Sadhu marg	F	ND	ND	0.47	48.17	38.07	22.74	ND	ND	126.32	0.169	0.221	0.413
7	Jui Nagar Municipal school	G	ND	ND	0.38	51.89	49.69	26.19	ND	ND	34.9	0.202	0.282	0.267
8	Khairane Village/Bonkode	H	ND	ND	0.09	43.9	35.47	45.06	ND	ND	35.2	0.199	0.188	0.198
9	Parsik Hill B.s	I	ND	ND	ND	40.12	46.85	52.86	ND	ND	374.97	0.229	0.264	0.388
10	Prabhat Diary	J	ND	ND	0.24	28.77	28.77	51.38	ND	ND	36.72	0.429	0.429	0.438
11	Road for WPU	K	ND	ND	ND	49.85	66.14	24.71	ND	ND	35.6	0.218	0.233	1.874
12	Samata Hindi School	L	ND	ND	ND	61.49	68.46	59.93	ND	ND	158.87	0.28	0.184	0.253
13	Savita Chemicals Stop	M	ND	ND	0.3	54.86	55.41	42.15	ND	ND	36.2	0.234	0.199	0.298
14	Shalimar stop	N	0.25	0.03	ND	82.24	73.17	64.47	ND	DMS	337.65	0.175	0.205	0.422
15	Shirvane Gaon	O	ND	ND	0.07	32.75	32.73	21	ND	ND	77.44	0.528	0.528	0.581
16	Shivshakti Nagar	P	0.53	0.29	0.12	51.24	45.95	35.53	ND	ND	58.89	0.206	0.131	0.401
17	Sky Industries Ltd	Q	ND	ND	ND	99.11	104.42	19.5	ND	ND	316.69	0.256	0.349	0.268
18	Yashraj Biotechnology	R	ND	ND	ND	61.36	40.17	10.94	ND	ND	152.75	0.346	0.224	0.242
19	Turbhe Naka	S	ND	ND	0.52	83.62	55.75	23.79	ND	ND	76.9	0.645	0.843	0.378
20	Wason Toyota	T	ND	ND	0.41	ND	109.37	44.32	ND	ND	35.6	0.222	0.217	0.19

Survey Sheet For Perception Study

Sheet No.: 56

Site: Deonar	GPS:-	Date:
Distance: 500m		14/2/18

Name: Humayu Gulam majawar	Age: 52
Occupation: service	Gender: M / F
House Type: complex	Residing Since: 3 years.

Odour related:
1) Whether you notice foul smell: Yes / No ✓
2) When smell causes maximum discomfort? : Day / Night ✓ / Evening ✓
3) Maximum smell is found in which season? : Summer ✓ / Monsoon ✓ / winter. ✓
4) Do you get bad smell:

Mild	Strong	Very Strong
	✓	✓

Health related issue:
1) Respiratory and health related issues: Headache ✓ / Nausea ✓ / Coughing / Bronchitis/Eye Irritation

2) Since when: (Year/ Month / Day) 8 years
3) Previous health issues: ✗

Other Remarks:

14/02/2018

Signature of the Survey person

Health Survey

Questionnaire for Hospital/Dispensary/Polyclinic Near to Dumping Site

Name of Dumping Site:- Deonar

Date:	11/8/19		
GPS:		Distance: - 2	

Sr No.	Name of Dispensary/Polyclinic/Hospital & Address	Name of Doctor	Speciality/General	No. of Patients per month & Age Group		Health Issues Specific/General
				0-15	15 onwards	
1	Sagar Hospital	Dr. Afzal khan	General	3-4	10-15	Fever, cough, skin problms rare
2	Kalpad att Clinic	Dr. chavan	General	30-40	30-40	fever, cold, itching cough, etc. Typhoid. skin irritation most
3	Noori clinic	Dr. Khas Abdullah	General	10-20	20-30	Asthmatic condn cough, cold, Allergi
4	shika clinic	Dr. mohd. Hussain	General	5-10	10-20	fever, cold. Asthmatic, Bronchitis,
5	Sure cure clinic	Dr. R.R. vishwakarma	General	15-20	10-15	Viral infection cough, cold, asthma

Questionnaire for Medical Shops

Name of Dumping Site:-

Date:		
GPS:	Distance:	

Sr. No	Name of Medical Shop & Address	Approximate No. of Customers per day	Types of Medicines sold per day	Most commonly sold Medicines
1	Baba medical Store Prasad	-	IT Mae, rainfall MPx -625	Diabetes, B.P, Fever
2	Honesthey Medical	-	Ojocine, 500,	Daibetes, BP, Back Pard, Fever
3	Anad Medital	-	Diclozen, Pain-D	—//—
4	Mew Bhavani Medical Store	-	Parccitox,	Fever, vomiting
5	Raja Medical store	-	Dolo-650, O-2	Cough, rashes,
6	Lotus chemist & General Store	-	MPX-600, O-2 Ondam	Daibets, B.P, Loose motion,