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भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूमीजल बोर्ड

GOVT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUND WATER POLLUTION AROUND INDUSTRIAL CLUSTERS IN MIDC AREAS, AURANGABAD DISTRICT, MAHARASHTRA (AAP 2010-11)

By

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मध्य क्षेत्र / CENTRAL REGION
नागपुर / NAGPUR
2013

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(AAP 2010-11)

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(AAP 2010-11)

1. Introduction

In pursuance of CHQ, letter no 34/CGWB/M (SAM)/WQAA/2010 of dated 1/9/2010 regarding status and monitoring the ground water pollution in the Industrial areas /clusters identified by CPCB in Maharashtra region, the ground water samples were collected from MIDC area of Aurangabad District, Maharashtra during November-2011. The samples were analyzed for routine parameters and heavy metals at Chemical Lab of CGWB, CR, Nagpur.

The Central Pollution control Board (CPCB), in association with Indian Institute of Technology (IIT), New Delhi, has carried out an environmental assessment of Industrial clusters across the country based on Comprehensive Environmental Pollution Index (CEPI) with the aim of indentifying pollution in the industrial clusters and prioritising planning needs for intervention to improve the quality of environment in these industrial clusters and the nation as a whole. In all 88 industrial clusters in the country have been assessed by CPCB and the area of MIDC, Aurangabad is one of them.

The Sampling Area

Aurangabad district is situated in the north central part of Maharashtra between North Latitude 19° 15’ and 20° 40’ and East Longitude 74° 37’ and 75° 52’. It covers an area of 10,107 sq. km falling in parts of Survey of India Toposheet No. 46 L & P and 47 I & M. The district is bounded by Jalgaon district in north by Nashik district in West, Ahmednagar and Beed districts in south and Parbhani and Buldhana districts in east. The world famous Ajanta and Ellora caves are situated in Aurangabad district. There are also a few caves near Aurangabad City. Other monuments of national fame located in the district are Bibi-ka-Maqbara and Daulatabad fort.

The area taken up for ground water pollution study covers Waluj MIDC and Chikhalthana MIDC of Aurangabad District. Waluj MIDC is located about 12 km south west while Chikhalthana MIDC is located east of the main Aurangabad city on Aurangabad-Pune Highway and Aurngabad-Jalna Highway. The area covers about 400 sq. km. and lies between North latitude $19^0 45' 00''$ and $19^0 55' 42''$ and East longitude $75^0 10' 00''$ and $75^0 25' 00''$. The

villages Chikhalthana Naregaon, Brij Wadi, Rajangaon Senpunji, Waluj, Padampur, Bhasnthpur and Ghanegaon constitute the study area. The main industries located in the area are Pharmaceuticals, Pulp & Paper, paper products, Distilleries and Metal, Aluminium, Metal engineering, Tyre, Biotech, Pesticides etc.

2. Climate and Rainfall

The climate of the district is characterized by a hot summer and a general dryness throughout the year except during the south west monsoon season, which is from June to September while October and November constitute the post monsoon season.

The normal annual rainfall over the district varies from about 500 mm to about 840 mm. The average annual rainfall of Aurangabad is 740 mm.

3. Geomorphology

Geomorphologically, the area comprises of varied topographic features and landscape. Most of the hill ranges are located in the south western part of Chikhalthana and north eastern part of Waluj. The sirha dongar has highest elevation of 838 m amsl. The average elevation in the area is about 500 m amsl. The major drainage covering Chikhalthana MIDC area is Sukhna River whereas Waluj MIDC area is drained by Kaum River.

4. Soil

Soil plays a very important role in the agricultural activities and forest growth of the area. The major part of the area is covered by black cotton soil or 'Regur' formed by the weathering of Deccan Trap Basalt. It is rich in plant nutrients such as lime, magnesia, iron and alkalis. It swells and becomes sticky on watering while on drying it contracts and develops many cracks.

5. Ground Water Regime

5.1 Hydrogeology

The major part of the area is underlain by sequence of basaltic lava flows (Deccan Trap). There are two distinct hydrogeological units in the district i.e. fissured formations (different units of basaltic lava flows) and porous formations (isolated patches of alluvial deposits). The occurrence and movement of ground water in these formations are

controlled by water bearing properties of formations.

5.2 Deccan Trap Basalt

Deccan traps are a thick pile of basaltic flows, horizontally disposed and apparently more or less uniform in composition. Each individual flow is a typical section, which varies from porous weathered base to a massive middle unit, becoming increasingly vesicular towards the top. The ground water occurs under water table and semi confined to confined conditions in Deccan Trap Basalt. The vesicular units in different trappean flows range in thickness from 2-8 meters and have primary porosity. However, the nature and density of the vesicles, their distribution, interconnection between the vesicles, depth of weathering and topography of the area are the decisive factor for occurrence and movement of ground water in these units. Since the zeolitic units in vesicular traps are highly susceptible to weathering, the vesicular units comprising weathered zeolitic traps occurring in topographic lows are the main water bearing formation in hard rock terrain of the district.

In massive unit of Deccan Trap Basalt, ground water occurs in soil cum weathered mantle, joints, cracks and other weaker zones. The upper portion of the massive traps show persistent spheroidal weathering and exfoliation which helps in retaining more ground water in these rocks in comparison to compact massive unit. The storage of ground water in compact massive unit totally depends upon the presence of joints and their nature, distribution and interconnection. The average depth range of dug wells in the study area is 12.00 m to 15.00 m and that of bore wells is 50.00 to 60.00 m in hard rock areas, whereas the yields ranges from 0.60 to 3.10 lps.

5.3 Water Level Scenario of the Area

During hydrochemical survey the dug well and bore wells (Sampling Point) were inventoried and water levels were recorded alongwith other hydrogeological details. The depth to water levels in the area recorded during November 2011 is in the range of 3.50 m bgl (Ranjangaon) and 6.8 m bgl (Ghanegaon). The salient features of the locations are given in table: 1.

Table1: Salient Features of Wells Inventoried in MIDC area, Aurangabad District.

Sl no	Village/ Location	Industrial area	Latitude	Longitude	Altitude (mamsl)	Type of well	Total depth (m)	Water level (mbgl)
1	Chikhalthana	Chikhalthana	19° 52'02"	75° 24'40"	582	DW	8.00	5.00
2	Naregaon	Chikhalthana	19° 53'37"	75° 23'10"	599	DW	8.00	6.8
3	Brijwadi	Chikhalthana	19° 53'11"	75° 23'14"	602	HP	50.00	-
4	Ranjangaon (Senpunji)	Waluj	19° 50'36"	75° 12'36"	532	DW	4.00	3.5
5	Ranjangaon (Senpunji) Ekta Nagar	Waluj	19° 50'43"	75° 12'24"	539	DW	7.00	4.30
6	Ranjangaon (Senpunji) Ekta Nagar	Waluj	19° 50'40"	75° 12'35"	539	HP	40.00	-
7	Pandharpur	Waluj	19° 50'12"	75° 15'05"	523	DW	8.00	6.5
8	Chikhalthana	Chikhalthana	19° 51'57"	75° 24'39"	570	HP	50.00	-
9	Bhasnathpur	Chikhalthana	19° 52'55"	75° 23'22"	584	HP	50.00	-
10	Ghanegaon	Waluj	19° 51'39"	75° 12'20"	542	DW	8.00	6.8

6. Hydrochemistry

Sampling:

10 water samples were collected during field investigation. Six water samples were collected from shallow aquifer ie dug wells and four samples from deeper aquifer ie hand pump.

The details about the locations and sources of the samples are given in Table- 2

Table 2 The details of the locations and results of the samples in MIDC area, Aurangabad district.

Locations	Type of well	pH	EC	TDS	TA	TH	NO_3	F	RSC
Chikhalthana Sukhna River	DW	8.1	1180	767	260	420	123	BDL	-3.2
Chikhalthana Naregaon	DW	7.9	2720	1768	230	1140	15	0.25	-18.2
Chikhalthana Brij Wadi	HP	8.0	1470	956	210	350	156	0.12	-2.8

Waluj Rajangaon Senpunji	DW	7.7	2570	1671	200	900	117	BDL	-14
Waluj Rajangaon Ekta Nagar	DW	8.0	1480	962	180	680	74	1.2	-10
Waluj Rajangaon Ekta Nagar	HP	7.9	1450	943	200	400	81	0.31	-4
Waluj Padampur	DW	7.8	1640	1066	170	520	184	BDL	-7
Chikhalthana Village	HP	7.7	2300	1495	320	720	304	BDL	-8
Chikhalthana Bhasnthpur	HP	7.8	2740	1781	170	950	213	BDL	-15.6
Waluj Ghanegaon	DW	8.0	1440	936	190	480	77	BDL	-5.8

Analysis:

Concentration of inorganic constituents like Total Alkalinity (TA), Cl, NO_3, F, and Total Hardness (TH), are determined along with parameters like pH and Electrical conductivity (EC) to study the water quality in relation to aquifer (Table-2). Analysis of trace metals like Pb, Mn, Cu, Zn and Fe were carried out to study contamination of ground water by trace elements (table- 4). The major and minor constituents were determined in the laboratory according to the standard methods given by APHA, using instruments like pH-meter, EC meter, flame photometer and UV-VIS spectrophotometer. Trace metal analysis were carried out by using Atomic Absorption Spectrophotometer.

The chemical characteristics of ground water in the area under investigation are presented in Table 2 and explained below.

6.1 pH

The pH of ground water generally lies in the range of 6-8 and may be altered due to contamination of groundwater by acidic or alkaline effluents.

In the study area the PH of ground water lies in the range of 7.7 to 8.1. There is no sample occurred in the vicinity of MIDC area whose PH is less than 7, all the sample are showing alkaline range.

6.2 Electrical Conductivity (EC) and Total Dissolved Solids (TDS)

The determination of EC and TDS were carried out to know about the extent of mineralisation of ground water in the study area. In basalts, the average EC and TDs values are generally 1000 µS/cm at 25^0C and 570 mg/l respectively.

In the area under investigation, the EC values of ground water are in the range of 1180 to 2740 µS/cm at 25^0C. Three samples are having EC values more than 2500 µS/cm indicating that there is substantial deviation from background values. The EC values of the water samples collected from hand pumps and dug wells in the MIDC area indicate that pollution intensity is moderate in the area.

6.3 Nitrate

In the area under investigation, the nitrate content of ground water lies in the range of 15 to 304 mg/l. The higher values are recorded in the well water of town area where sewage waste and garbage are dumped. Distribution of nitrate in the study area is shown in Plate-1.

6.4 Total Alkalinity

In the area under investigation, Total Alkalinity in ground water lies in the range of 170 to 320 mg/l. 4 the samples have concentration of total alkalinity within the range of desirable limit and six have recorded more than Desirable limit but less than maximum permissible limit of 600 mg/l.

6.5 Fluoride

In the study area, the fluoride content in ground water lies in the range of BDL to 1.2 which is within the maximum permissible limit (1.5 mg/l) of BIS Drinking water Standard for drinking water.

6.6 Total Hardness

In the area under investigation, Total Hardness in ground water lies in the range of 350 to 1140 mg/l.

The perusal of Table 2 shows that concentration of TH in all the samples are above desirable limit in 5 samples and above maximum permissible limit in 5 samples.

6.7 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is considered to be superior to SAR as a measure of sodicity particularly at low salinity levels. The classification of ground water samples based

on RSC values for its suitability for irrigation purpose is shown in table 3.

It is observed from table 3 that all ground water samples show RSC values of less than 1.25 mg/l. Thus, the ground water quality in the wells monitored is good for irrigation purpose and there is a less possibility of developing sodium hazard.

Table 3- : Classification of Ground Water for Irrigation Based on RSC.

RSC	<1.25		1.25-2.50		>2.50	
Category	Good		Doubtful		Unsuitable	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%
10	10	100%	-	-	-	-

6.8 Trace Elements

Trace elements in natural or contaminated ground water with the exception of Iron almost invariably occur at concentrations well below 1 mg/l. Concentrations are low because of constraints imposed by solubility of minerals or amorphous substances and adsorption on clay minerals or on hydrous oxide of iron and magnesium. Isomorphous substitution or co-precipitation with minerals or amorphous substitution or co-precipitation with minerals or amorphous solids can also be important as far as the occurrence of trace elements in natural water is concerned. The solubility of cationic trace elements increases as $_{P}H$ decreases particularly at pH < 5.

In the area under investigation, 10 water samples were analyzed for trace elements like Mn, Pb, Cu, Zn and Fe and the analysis results reveal that ground water contamination may occur due to the presence of lead. The results of the analysis of trace elements are discussed below.

The chemical characteristics of trace elements of ground water in the area under investigation are presented in Table 4 and explained below.

Table 4: Results of the analysis of trace elements in MIDC area,

Location	DW Type of Well	Cu	Mn	Fe	Pb	Zn
Chikhalthana Sukhna River	DW	0.008	1.006	2.014	BDL	0.074
Chikhalthana Naregaon	DW	0.017	0.762	0.991	0.114	0.034

Chikhalthana Brij Wadi	HP	0.012	BDL	1.123	0.049	0.06
Waluj Rajangaon Senpunji	DW	BDL	0.04	0.194	0.062	0.022
Waluj Rajangaon Ekta Nagar	DW	BDL	0.155	0.143	BDL	0.016
Waluj Rajangaon Ekta Nagar	HP	0.072	0.537	0.308	0.054	0.054
Waluj Padampur	DW	0.011	0.057	0.175	BDL	0.012
Chikhalthana Village	HP	0.035	0.027	2.159	BDL	0.111
Chikhalthana Bhasnthpur	HP	0.019	0.062	1.326	0.116	1.252
Waluj Ghanegaon	DW	0.022	0.025	0.253	0.067	0.019

6.8.1 Manganese (Mn)

The major forms of Manganese in nature are oxides, silicates and carbonates. It is widely distributed in soil and an essential plant micronutrient element in plant metabolism and is expected that the organic circulation of Manganese can influence its occurrence in natural water. The sugarcane plant which is used as raw material in sugar industry may be possible source of Mn in ground water as the effluent generated from sugar and allied industries contains high amount of Mn. The desirable limit of Mn in drinking water is 0.1 mg/L and max. permissible limit is 0.3 mg/L as per BIS standard for drinking water.

The concentration of Manganese found in the ground water of study area is in the range of 0.025 to 1.006 mg/l. The highest concentration was reported in the wells located at Chikhathana Naregaon and Waluj Rajangaon Ekta Nagar. The distribution of Mn in the study area is shown in Plate II.

6.8.2 Iron (Fe)

Iron in ground water generally exists as Fe(II) but may oxidised to Fe(III) when ground water is under aerobic condition.

On land major sources of Iron are the effluents of industries related with the manufacture of Iron or Steel and units in which Iron is one of the raw materials. Inspite of heavy discharge of Iron in the atmosphere and land, solubility controls restrict migration of the Iron to the saturated zone.

In the study area of MIDC, the iron content in content in ground water is well within the permissible limit (1.0 mg/l) except in four samples which may be due to local contamination. The distribution of Iron in the study area is shown in Plate III.

6.8.3 Lead (Pb)

The natural lead content of lake and river water worldwide is in the range of 0.001 to 0.01. Lead content of ground water is generally low due to solubility control and capacity of soils to absorb lead. The higher values of lead have been found where the contamination has occurred particularly from industrial sources. The chemical analysis results of ground water from MIDC indicate that the lead content is in high concentration in 5 out of 10 samples. High concentration of Lead in this area can be directly linked with the industrial activities in the area. The distribution of Lead in the study area is shown in Plate IV.

6.8.4 Copper (Cu)

The copper found in ground water of MIDC study area varies from BDL to 0.072 mg/L. This is also essential micronutrient and very likely to come through the spent wash of distillery. The maximum concentration of 0.072 mg/L is estimated in the well located at Waluj Rajangaon Ekta Nagar. The distribution of Copper in the study area is shown in Plate V.

6.8.5 Zinc (Zn)

The zinc content in MIDC study area varies from 0.012 to 1.252 mg/L. All the ground water samples contain zinc below the desirable limit of BIS (5 mg/L) for the drinking water. The distribution of Zinc in the study area is shown in Plate VI.

6.9 Mechanism of Ground Water Pollution

The ground water pollution mechanism is different from surface water pollution and takes more time for reactions in top soil, unsaturated and saturated zones. The untreated and partially treated effluents wastes in unlimited quantity in industrial area discharges in small channels, low lying areas and pits come in contact with surface and ground water and causes deterioration of water quality.

In unsaturated zone, the pollutants travel primarily vertically downwards and small amount takes horizontal displacement. Here the pollutants movement is mainly controlled

by relative portion of active pore space, moisture content and climate of the area. As the solute moves through the zone of aeration it tends to slow dispersion and take considerable time to percolate. During the travel, substantial quantity of elements retain in soil profile, held up in clays or voids of media due to chemical reactions like ion exchange, dilution, precipitation, oxidation, reduction, absorption and mechanical filtration. The balance part moves in aqueous solution and reaches to saturated zone.

Pollutants in saturated zone usually spread out laterally, floating on the top of aquifer and moves in the ground water flow direction with same velocity. Mechanical dispersion, molecular diffusion and density difference plays a role in attenuation of contaminants to different degrees by various processes.

6.10 Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. The classification of ground water samples was carried out based on the desirable and maximum permissible limits as given by BIS for drinking water in IS-10500-91, Revised 2003 standards for the parameters viz., TDS, TH, Ca, Mg, Cl, SO_4 and NO_3 is given in Table:5

Table 5: Classification of Ground Water Samples based on BIS Drinking Water Standards

(IS-10500-92, Revised 2003)

Parameters	DL	MPL	No of Samples	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
pH	6.5-8.5	No relaxation	10	Nil	10	Nil
TDS (mg/L)	500	2000	10	Nil	10	Nil
TH (mg/L)	300	600	10	Nil	5	5
TA (mg/L)	200	600	10	4	6	Nil
NO_3 (mg/L)	45	No relaxation	10	1	Nil	9
F (mg/L)	1.0	1.5	10	9	1	Nil
Fe(mg/L)	0.3	1.0	10	4	2	4
Pb(mg/L)	0.05	0.05	10	5	Nil	5
Zn(mg/L)	5	15	10	10	Nil	Nil
Cu(mg/L)	0.05	1.5	10	9	1	Nil
Mn(mg/L)	0.1	0.3	10	6	1	3

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit)

The perusal of Table 5 reveals that concentration of PH, TDS, TA, F is above desirable limit but below maximum permissible limit in most of the cases. However, the concentration

of nitrate is found more than MPL at 9 locations (90%) indicating high influence of anthropogenic activity in the vicinity of the wells, causing nitrate contamination.

In trace metals, the concentration of Fe in 40% of samples, Pb in 50% of samples, Mn in 30% of samples are beyond the maximum permissible limit while the Zinc and Copper contents are within permissible limit.

Therefore, it can be concluded that the ground water quality in major part of the study area is affected by industrial and anthropogenic pollution. The ground water of area is not suitable for drinking purpose.

7. Findings

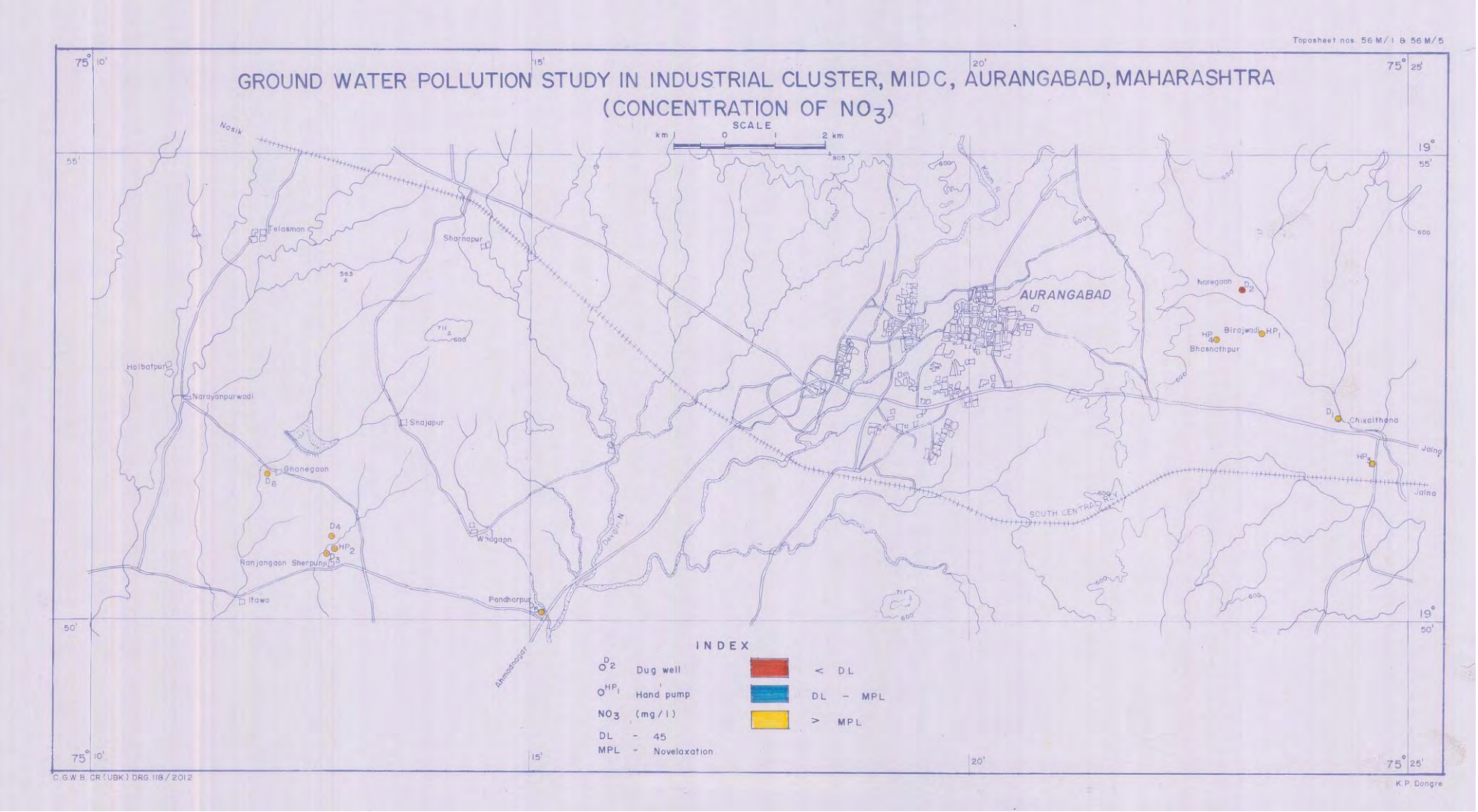
Nearly 200 industries are located in industrial area Chikhalthana MIDC and Waluj MIDC. 10 water samples, 5 each from both the area have been collected to study the status of ground water pollution in the industrial cluster of Aurangabad.

On the basis of Chemical analysis and close examination of analytical results, following findings have been drawn as discussed below:

1. In the study area, the PH of ground water lies in the range of 7.7 to 8.1. Indicating the alkaline nature of ground water exist in the area.
2. EC values of ground water are found in the range of 1180 to 2740 µS/cm at 25^0C . The three samples are having EC values more than 2500 µS/cm indicating that there is substantial deviation from background values. The EC values of the water samples collected from hand pumps and dug wells in the MIDC area indicate that the ground water pollution has been initiated in the area and reached to moderate level.
3. Nitrate content of ground water lies in the range of 15 to 304 mg/l. The higher values are recorded in the well located in the town. This indicates the poor drainage situation of the town and improper disposal of sewage and solid waste.
4. Fluoride content in the ground water, observed in the range of BDL to 1.2 is within the maximum permissible limit (1.5 mg/l ,BIS)for drinking water.
5. Total Hardness in ground water lies in the range of 350 to 1140 mg/l. TH in all the samples is above desirable and also above maximum permissible limit in most of the cases indicating the deterioration of ground water due to pollution.

6. The concentrations of Manganese found in the ground water are in the range of 0.025 to 1.006. The highest concentration was recorded in the wells located at Chikhathana Naregaon and Waluj Rajangaon Ekta Nagar. However, the Iron content in ground water is seen within the permissible limit (1.0 mg/l) except in four samples which specifies the percolation of industrial waste into ground water system of the area.
7. The high concentration of lead content is seen at 5 locations. The presence of high concentration of Lead in the ground water can be directly linked with the industrial activities in the area.
8. The maximum concentration of copper (0.072 mg/L) in ground water is observed in the well located at Waluj Rajangaon Ekta Nagar. Whereas the zinc content in study area varies from 0.012 to 1.252 mg/L. Though the concentration of Iron and zinc were recorded below the desirable limit of BIS for the drinking water but their very presence in the ground water indicates the effect of industrial pollution in the area.

PLATE-I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GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF NO3)
SCALE
km 1 0 1 2 km
75° 10'
75° 25'
19° 55'
19° 50'
Nasik
Telasman
Sharnapur
AURANGABAD
Naregaon
Birajwadi
Bhasnathpur
Halbatpur
Narayanpurwadi
Shajapur
Ghanegaon
Chikalthana
Jalna
Wadgaon
Ranjangaon Sherpunji
Pandharpur
Ahmednagar
SOUTH CENTRAL RLY
INDEX
Dug well
Hand pump
NO3 (mg/l)
DL - 45
MPL - Novelaxation
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118/2012
K.P. Dongre

PLATE-II

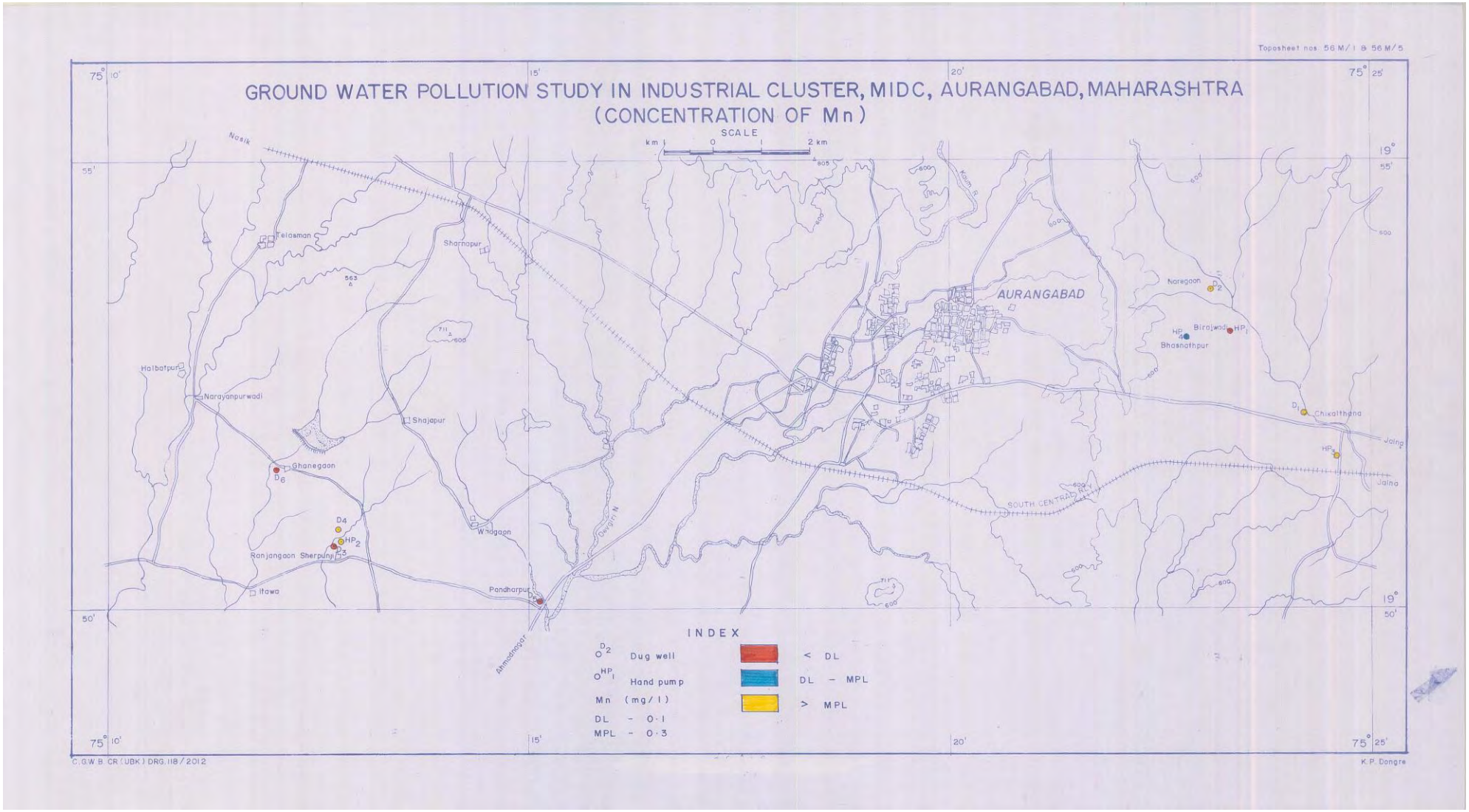

Toposheet nos. 56 M/1 & 56 M/5
GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF Mn)
SCALE
km 1 0 1 2 km
75° 10'
15'
20'
75° 25'
19° 55'
19° 50'
Nasik
Telasman
Shernapur
Kham R.
AURANGABAD
Naregaon
Birajwadi
Bhasnathpur
Hatbatpur
Narayanpurwadi
Shajapur
Chikalthana
Jalna
Ghanegaon
Wadgaon
Dangri N.
SOUTH CENTRAL RLY.
Ranjangaon Sherpunji
Itawa
Pondharpur
Ahmadnagar
INDEX
Dug well
Hand pump
Mn (mg/l)
DL - 0·1
MPL - 0·3
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118/2012
K.P. Dongre

PLATE-III

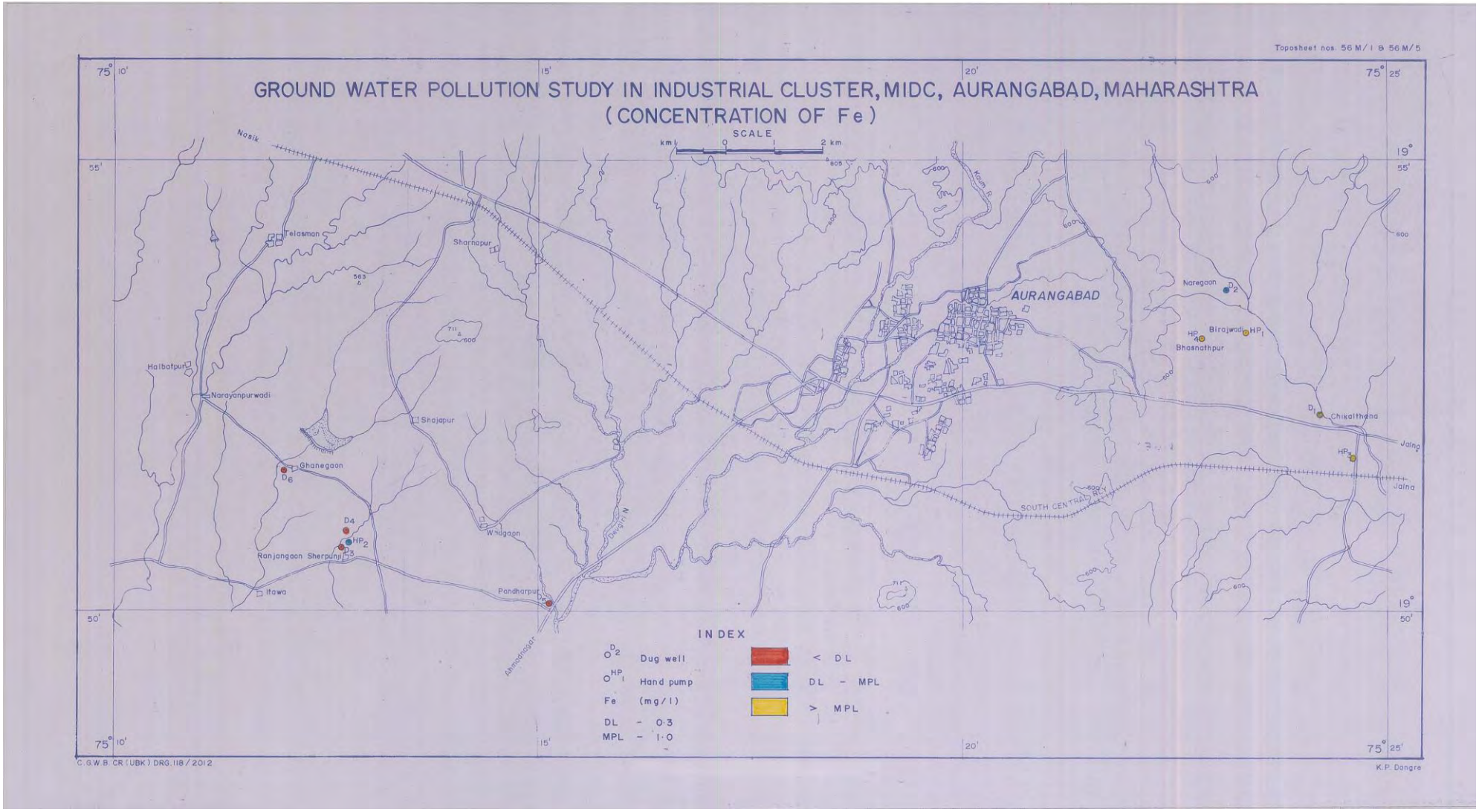

Toposheet nos. 56 M/1 & 56 M/5
GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF Fe)
SCALE
km 0 1 2 km
75° 10'
75° 25'
19° 55'
19° 50'
Nasik
Telasman
Sharnapur
AURANGABAD
Kham R.
Naregaon
Birajwadi
Bhasnathpur
Halbatpur
Narayanpurwadi
Shajapur
Chikalthana
Jalna
Ghanegaon
SOUTH CENTRAL RLY.
Wadgaon
Ranjangaon Sherpunji
Itawa
Pandharpur
Dongri N
Ahmednagar
INDEX
Dug well
Hand pump
Fe (mg/l)
DL - 0·3
MPL - 1·0
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118 / 2012
K.P. Dongre

PLATE-IV

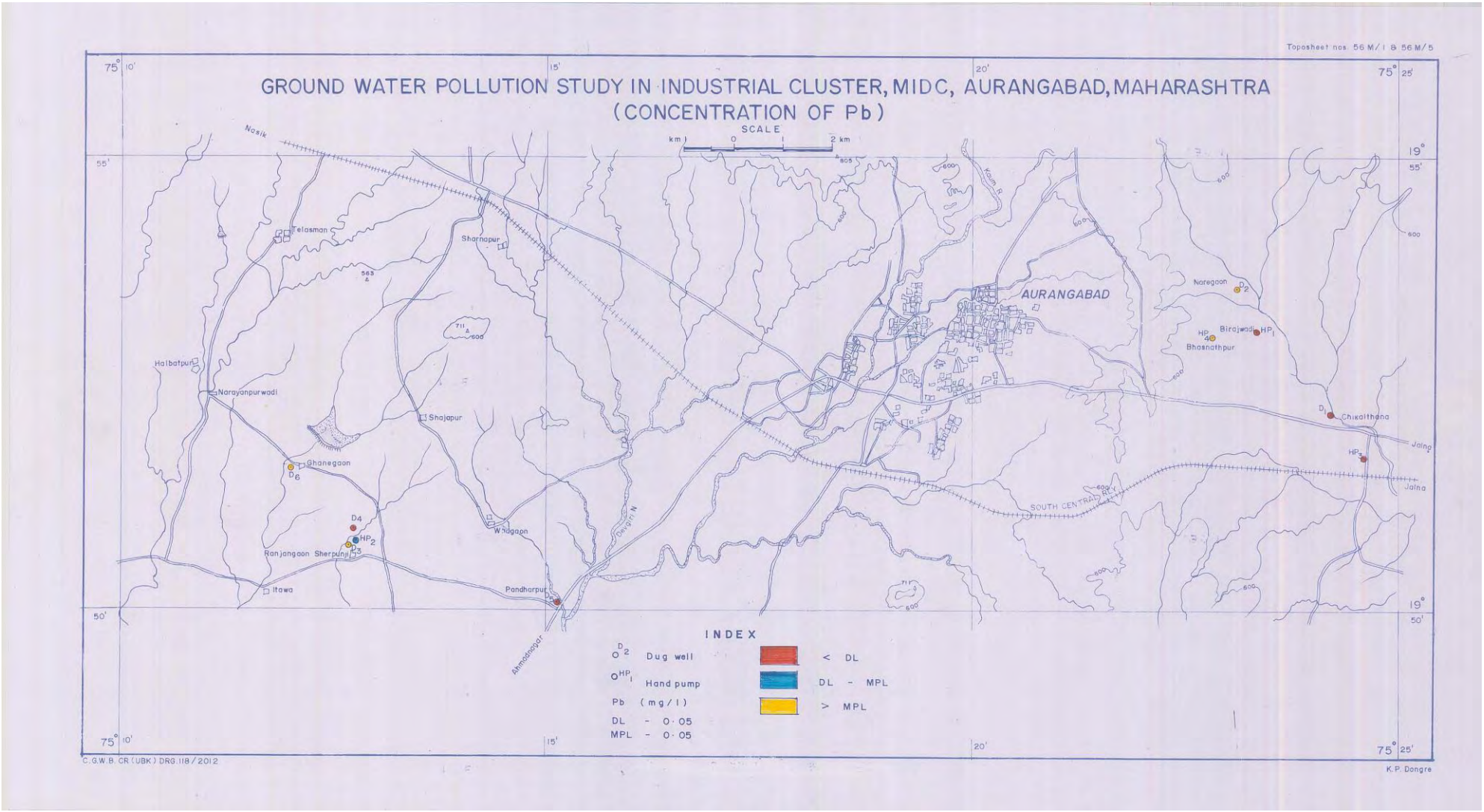

Toposheet nos. 56 M/1 & 56 M/5
GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF Pb)
SCALE
km 1 0 1 2 km
75° 10'
15'
20'
75° 25'
19° 55'
19° 50'
Nasik
Telasman
Sharnapur
AURANGABAD
Naregaon
Birajwadi
Bhasnathpur
Halbatpur
Narayanpurwadi
Shajapur
Shanegaon
Chikalthana
Jalna
SOUTH CENTRAL
Wadgaon
Ranjangaon Sherpunji
Itawa
Pandharpur
Ahmednagar
INDEX
Dug well
Hand pump
Pb (mg/l)
DL - 0·05
MPL - 0·05
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118/2012
K.P. Dongre

PLATE-V

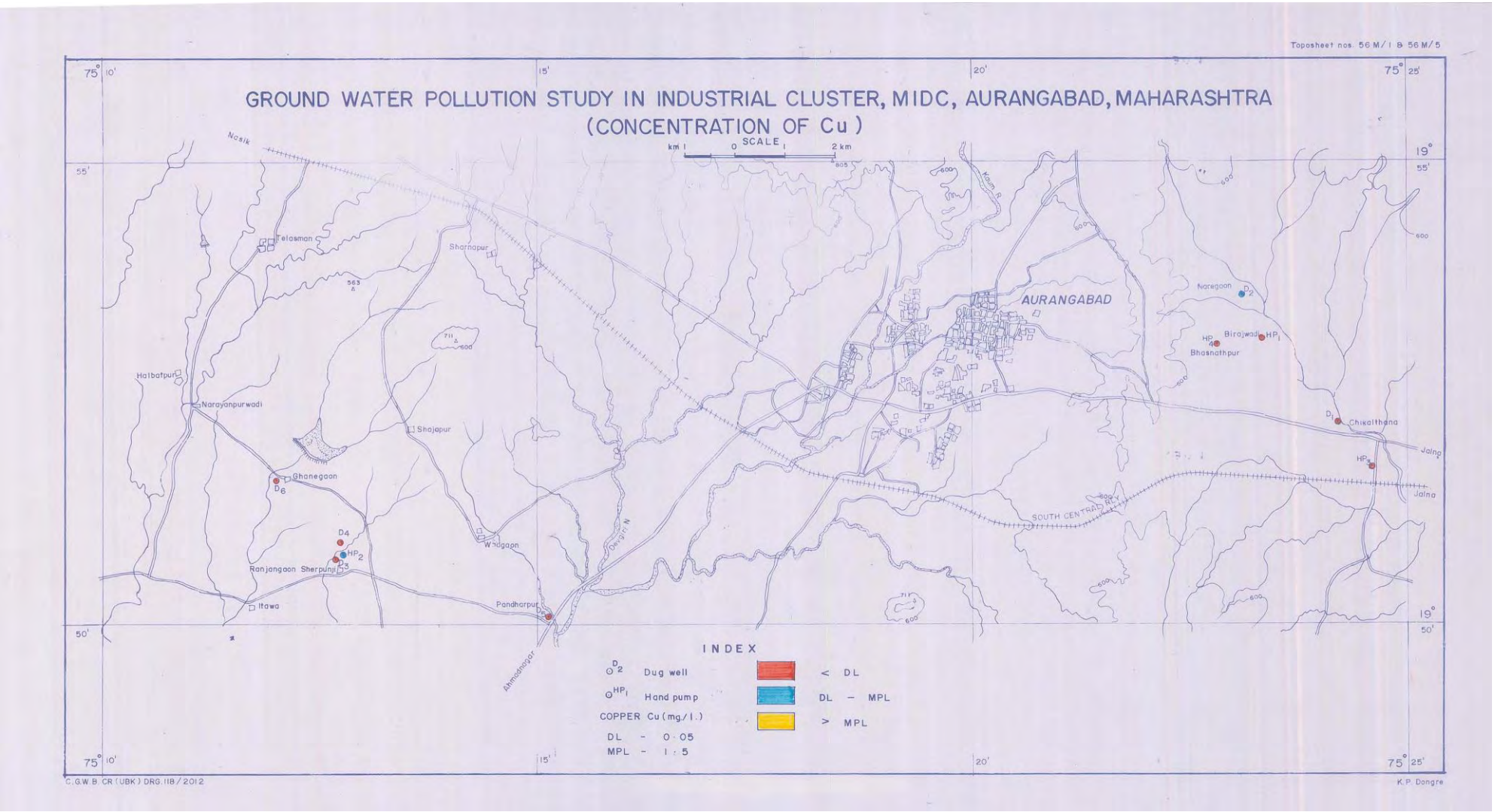
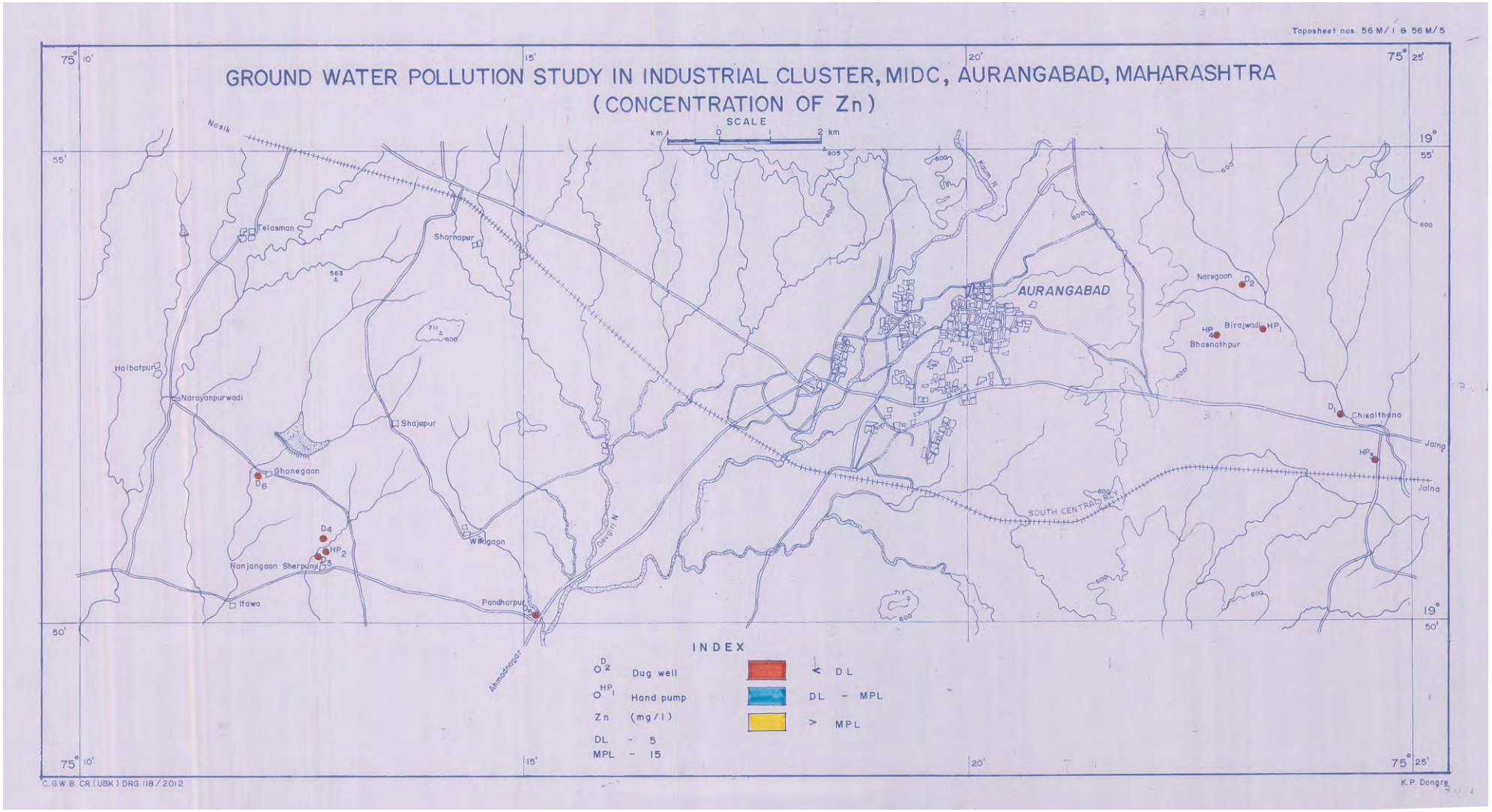

Toposheet nos. 56 M/1 & 56 M/5
GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF Cu)
SCALE
km 1 0 1 2 km
75° 10'
15'
20'
75° 25'
19° 55'
19° 50'
Nasik
Felasman
Sharnapur
AURANGABAD
Naregaon
Birajwadi
Bhasnathpur
Halbatpur
Narayanpurwadi
Shajapur
Ghanegaon
Chikalthana
Jalna
Wadgaon
Ranjangaon Sherpunji
Itawa
Pandharpur
Ahmednagar
SOUTH CENTRAL RLY
INDEX
Dug well
Hand pump
COPPER Cu (mg./l.)
DL - 0·05
MPL - 1·5
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118/2012
K.P. Dongre

PLATE-VI


Toposheet nos. 56 M/1 & 56 M/5
GROUND WATER POLLUTION STUDY IN INDUSTRIAL CLUSTER, MIDC, AURANGABAD, MAHARASHTRA
(CONCENTRATION OF Zn)
SCALE
km 1 0 1 2 km
75° 10'
15'
20'
75° 25'
19° 55'
19° 50'
Nasik
Telasman
Sharnapur
AURANGABAD
Noregaon
Birajwadi
Bhasnathpur
Halbatpur
Narayanpurwadi
Shajapur
Ghanegaon
Chikalthana
Jalna
SOUTH CENTRAL RLY
Wadgaon
Ranjangaon Sherpunji
Pandharpur
Ahmednagar
Dudhna R.
Kham R.
INDEX
Dug well
Hand pump
Zn (mg/l)
DL - 5
MPL - 15
< DL
DL - MPL
> MPL
C.G.W.B. CR (UBK) DRG. 118 / 2012
K.P. Dongre