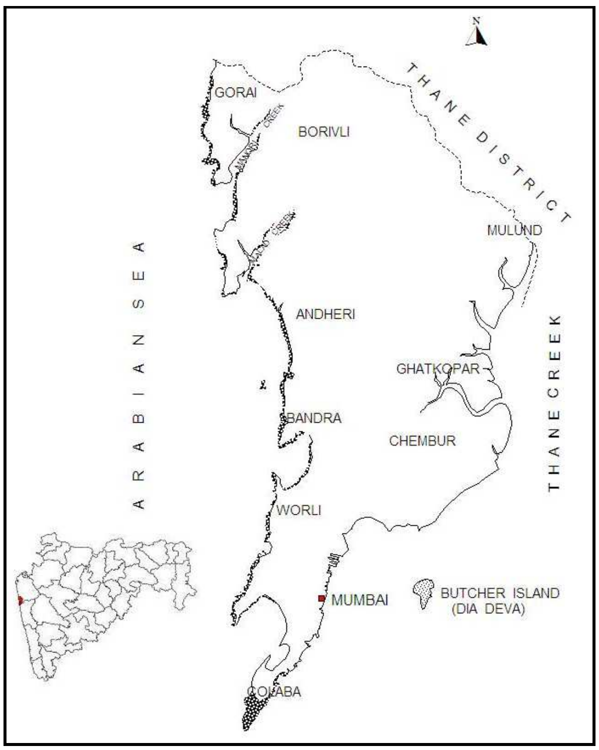
1618/DB/2009

भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड

**GOVERNMENT OF INDIA**
**MINISTRY OF WATER RESOURCES**
**CENTRAL GROUND WATER BOARD**

# महाराष्ट्र राज्य के अंतर्गत मुंबई जिले की भूजल विज्ञान जानकारी

# GROUND WATER INFORMATION GREATER MUMBAI DISTRICT MAHARASHTRA





**By**
**Sourabh Gupta**
**Scientist-D**

द्वारा
सौरभ गुप्ता
वैज्ञानिक - घ



मध्यवर्ती क्षेत्र
नागपुर
**CENTRAL REGION**
**NAGPUR**
**2009**

# GREATER MUMBAI DISTRICT AT A GLANCE

## 1. GENERAL INFORMATION

| | | |
|---|---|---|
| Location | : | North latitude- 18°53' & 19°19'<br>East Longitude- 72°47' & 72°59' |
| Geographical Area | : | 603 sq. km. (Mumbai City- 69 sq. km.; Mumbai Suburb- 534 sq. km. |
| Population (2001) | : | 1,77,02,761 |
| Temperature | : | Maximum- 32.2°C; Minimum- 16.3°C |
| Normal Annual Rainfall | : | 1800 mm to 2400 mm |

## 2. GEOMORPHOLOGY

| | | |
|---|---|---|
| Major Physiographic Units | : | 2; Hill Ridges with intervening Valleys and Coastal Plains |
| Major Drainage | : | 2; Mahim and Mithi |

## 3. SOIL TYPE

2; Medium to deep black and reddish colored soil

## 4. GROUND WATER MONITORING WELLS (As on 30/11/2007)

| | | |
|---|---|---|
| Dugwells | : | 5 |

## 5. GEOLOGY

| | | |
|---|---|---|
| Recent | : | Alluvium |
| Upper Cretaceous To Lower Eocene | : | Basalt (Deccan Trap), Rhyolite and Trachyte |

## 6. HYDROGEOLOGY

| | | |
|---|---|---|
| Water Bearing Formation | : | Basalt–Jointed/Fractured/Weathered Vesicular and Massive Basalt<br>River/Marine Alluvium- Sand and Gravel |
| Premonsoon Depth to Water Level (May-2007) | : | 2.77 to 6.42 m bgl |
| Postmonsoon Depth to Water Level (Nov.-2007) | : | 1.80 to 7.10 m bgl |
| Premonsoon Water Level Trend (1998-2007) | : | Fall: 0.11 to 0.38 m/year |
| Postmonsoon Water Level Trend (1998-2007) | : | Rise: 0.09 m/year<br>Fall : 0.02 to 0.26 m/year |

## 7. GROUND WATER QUALITY

Suitable for drinking but high concentration of pollutants at many places.

## 8. MAJOR GROUND WATER PROBLEMS AND ISSUES

Pollution of ground water as well as surface water due to dumping of sewage and industrial effluents. In addition to this various industrial effluents from oil refineries, reactors, fertilizers have polluted the ground water. As a result the concentration of heavy metals in ground water in the surrounding areas of creek has been observed beyond the prescribed limits. Ground water exploitation for commercial purpose like construction purposes, hotel industry and for domestic purpose of the housing societies is carried out in entire district and the water is extracted from existing dugwells and borewells, even new borewells are also being drilled for this purpose.

# Ground Water Information
# Greater Mumbai District

## Contents



## List of Figures



## List of Tables

# Ground Water Information
## Greater Mumbai District

## 1.0 Introduction

Greater Mumbai district is located on the western most periphery of the Maharashtra State. In year 1885, it was elongated shaped group of seven islands viz., Bombay, Mazgaon, Matunga, Mahim, Worli, Soyster Rode and Old Woman's island but with the advent of development, narrow creeks were filled up and connected to main land. Greater Mumbai district comprises South Salsete, Trombay and Bombay islands having a geographical area of 603 sq. km. (Mumbai City- 69 sq. km. and Mumbai Suburbs- 534 sq. km.). The district is bounded by north latitude 18°53' and 19°19' and eas t longitude 72°47' and 72°58'. Arabian Sea lies on the southern and wester n side of the district while it borders Thane district in the north and eastern side. A map of the district showing the district boundary and headquarter, physical features and location of monitoring wells is presented as **Figure-1**.

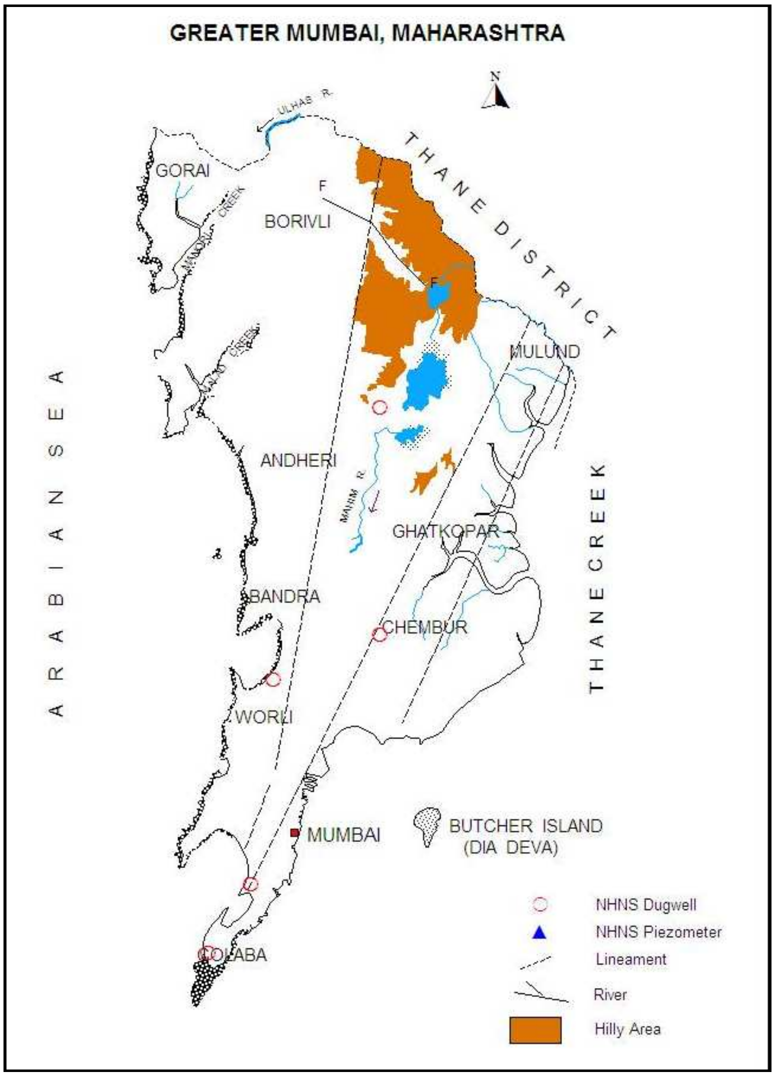



**Figure-1: Location**

The systematic hydrogeological survey for Greater Mumbai was first carried out by Dr. P. K. Naik, CGWB, AAP- 1989–90. Shri Tezongy, a research student of Saint Xavier's College has conducted hydrogeological studies in Greater Mumbai. Shri Sudesh Kumar, Jr. Engineer, Geological Survey of India has conducted detailed geological survey in year 1982–83. The exploratory drilling in the district has not been taken up either by CGWB or GSDA.

## 2.0 Climate and Rainfall

The climate of the district is characterized by an oppressive summer, dampness in the atmosphere nearly throughout the year and heavy south – west monsoon rainfall from June to September. The mean minimum temperature is 16.3℃ and the mean maximum temperature is 32.2℃ a t Santacruze.

The normal annual rainfall over the district varies from about 1800 mm to about 2400 mm. It is minimum in the central part of the district around Kurla (1804.9 mm). It gradually increases towards north and reaches a maximum around Santacruze (2382.0 mm).

## 3.0 Physiography and Soil Types

The broad physiographic feature of the Mumbai district is broad and flat terrain flanked by north – south trending hill ranges. The hill ranges form almost parallel ridges in the eastern and western part of the area. The Powai – Kanheri hill ranges are the other hill extending in the eastern and central part running NNE – SSW. The maximum elevation of the area is 450 m above mean sea level (m amsl) at some of the peaks of hill ranges. Trombay island has north – south running hills with maximum elevation of 300 m above man sea level (m amsl). Malbar, Colaba, Worli and Pali hills are the isolated small ridges trending north – south in the western part of the district. The Powai – Kanheri hills form the largest hilly terrain in the central part of the Salsette island and are the feeder zone for the three lakes viz., Powai, Vihar and Tulsi. There are a number of creeks, dissecting the area. Among them, Thane is the longest creek. Other major creeks are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flangs and swamps.

The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.

Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil.

## 4.0 Ground Water Scenario

### 4.1 Hydrogeology

The entire district is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of Recent age also occur as narrow stretch along the major river flowing in the area. A map depicting the hydrogeological feature is shown in **Figure–2**.

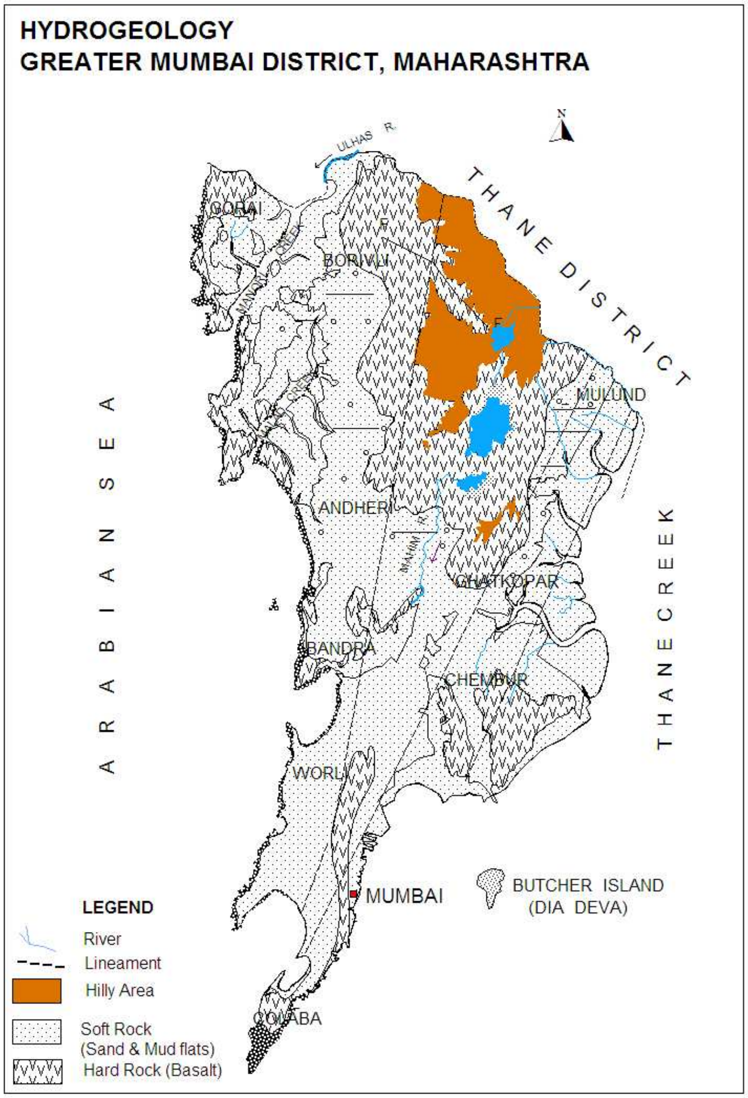



**Figure-2: Hydrogeology**

### 4.1.1 Hard Rock Areas

#### 4.1.1.1 Deccan Trap Basalt

The 'Pahoehoe' flows in the district consists of highly vesicular bottom layer having closely spaced horizontal joints but the thickness is generally less. The vesicles are generally filled with secondary minerals and green earths. In such cases, they do not serve as aquifer. However, such vesicular zones are weathered in most part of the area, thus, making them moderately permeable. But if, vesicles are not filled, they act as highly permeable aquifers. The simple and compound "Pahoehoe" flow comprises a basal vesicular zone, middle relatively massive portion followed by a vesicular top. The vesicles of "Pahoehoe" flows are generally not interconnected and thus there is a variation in water holding capacity from the base to the top of the flow.

The ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing etc., of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers. Generally the phreatic aquifer range down to depth of 15 m bgl. The water bearing zone down to depth of 35 m bgl forms the semi confined aquifer and below this deeper aquifer down to depth of 60 m bgl is observed. The yield of the dugwells varies form 10 to 1000 $m^3$/day, whereas that of borewells ranges between 50 and 1000 $m^3$/day. It is expected that the potential of deeper aquifers would be much more limited as compared to the unconfined/phreatic aquifer.

### 4.1.2 Soft Rock Areas

#### 4.1.2.1 Alluvium

River Alluvium patches along the course of rivers and Marine Alluvium in the coastal area, are highly potential aquifer but with limited areal extent. The ground water occurs under water table condition in sandy / gritty layers. The alluvial fill of low lying areas underlain by weathered basalt has relatively better ground water potential.

## 4.2 Water Level Scenario

Central Ground Water Board periodically monitors 5 National Hydrograph Network Stations (NHNS) in the district, four times a year i.e. January, May (Premonsoon), August and November (Postmonsoon).

### 4.2.1 Depth to Water Level – Premonsoon (May-2007)

The premonsoon depth to water levels monitored during May 2007 ranges between 2.77 m bgl (Church Gate) and 6.42 m bgl (A.M.C. Colony). The depth to water levels during premonsoon has been depicted in **Figure-3**.

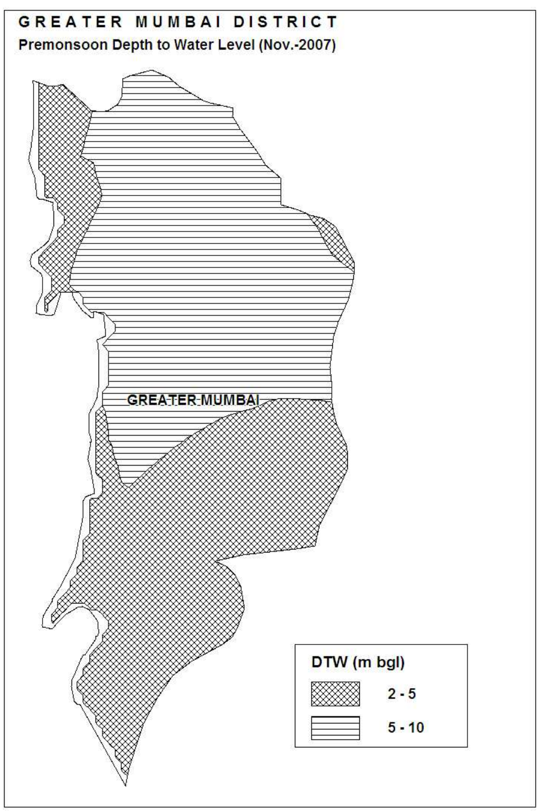



**Figure-3: Depth to Water Level (Premonsoon- May 2007).**

The shallow water levels between 2 and 5 m bgl are observed in southern part, whereas moderate water levels in the range of 5 to 10m bgl are observed in northern part of the area.

#### 4.2.2 Depth to Water Level – Postmonsoon (Nov.–2007)

The depth to water levels during postmonsoon (Nov. 2007) ranges between 1.80 m bgl (Church Gate) and 7.10 m bgl (A.M.C. Colony). Spatial variation in postmonsoon depth to water level is shown in **Figure-4.** The water levels in major part of the district range between 2 and 5 m bgl. Shallow water levels of < 2 m bgl are observed in small area in southern part, whereas water levels of 5 to 10 m bgl are observed in north central part of the district.

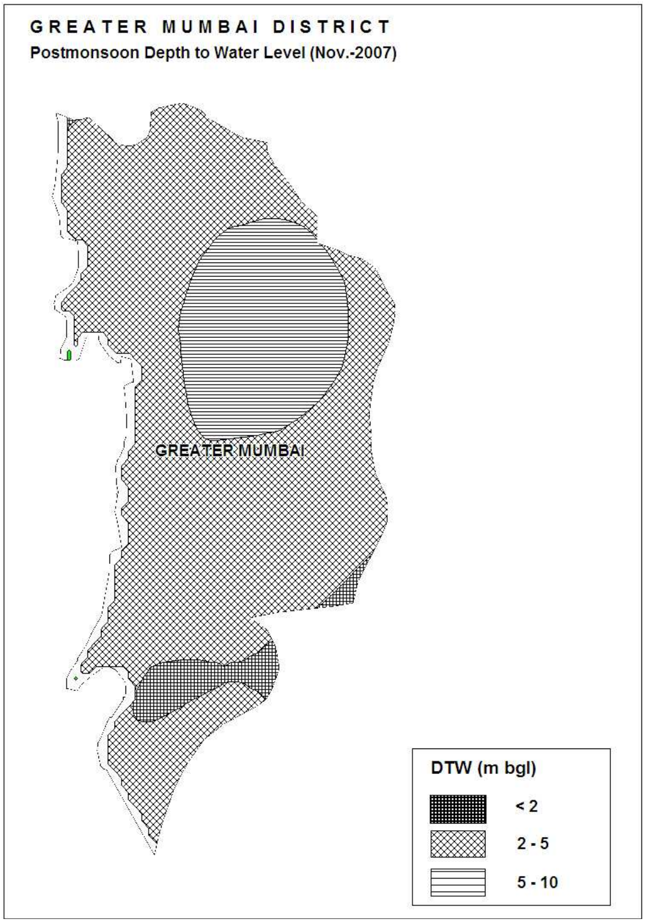



**Figure-4: Depth to Water Level (Postmonsoon- Nov.2007).**

#### 4.2.3 Seasonal Water Level Fluctuation (May to Nov 2007)

Seasonal water level fluctuation between premonsoon and postmonsoon of 2007 have been computed. The rise in water levels in the range of 0.97 (Church Gate) to 1.85 m (Mahim) are observed, whereas fall in water level of 0.68 is observed at 1 NHNS located at A.M.C. Colony. In major part of the district rise within 2 m is observed, rise of 2 to 4 m is seen in extreme northern parts of the district, whereas fall of up to 2 m is observed in north central part of the district.

#### 4.2.4 Water Level Trend (1998 – 2007)

Trend of water levels for premonsoon and postmonsoon periods for last ten years (1998-2007) have been computed for 4 NHNS. Analysis of long term water level trend data indicates fall in water levels has been observed in all the 4 NHNS and it ranges between 0.11 (Church Gate) and 0.38 m/year (A.M.C. Colony).. During postmonsoon period rise in water level of 0.09 m/year has been recorded at only 1 NHNS located at Mahroli (Chemur) while at 3 NHNS fall in water level have been recorded and it ranges between 0.02 (Colaba (Dandi)) and 0.26 m/year (A.M.C. Colony). Thus in major parts of the district, both during premonsoon and postmonsoon seasons declining water level trends have been recorded.

The premonsoon and post monsoon trend maps were also prepared and the same are presented in **Figure-5**. During premonsoon period entire district shows fall in water level trend of up to 20 cm/year, whereas during postmonsoon period rise in water level trend of up to 20 cm/year is observed in extreme northern part and central southern parts and the rest of the district shows fall in water level trend of up to 20 cm/year.

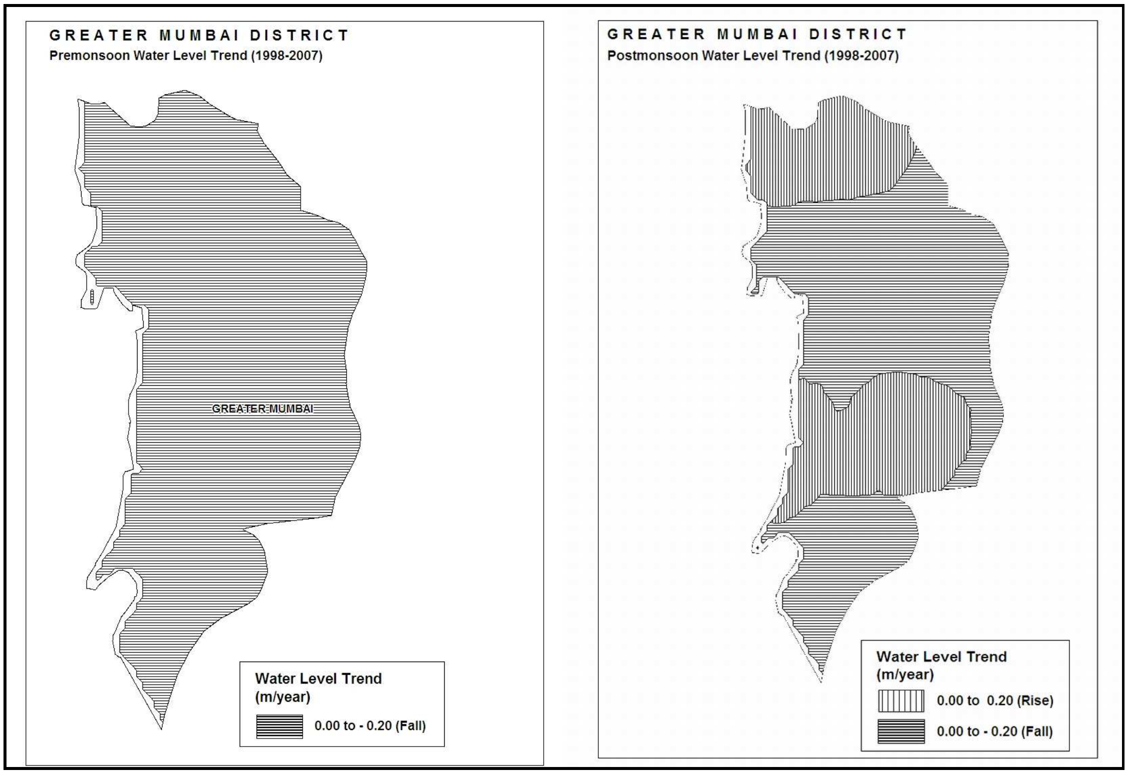



**Figure-5: Premonsoon (L) and Postmonsoon (R) Water Level Trend (May and Nov. 1998-2007).**

### 4.3 Yields of Wells

The yields of the wells are the functions of the permeability and transmissivity of aquifer encountered. This varies with location, diameter and depth of wells. There are mainly two types of ground water structures i.e. dugwells and borewells in the area. The yields of the dugwells varies form 10 to 1000 $m^3$/day, whereas that of borewells ranges between 50 and 1000 $m^3$/day tapping the promising aquifer in the depth range of 60 to 80 m bgl, however, majority of the borewells are low yielding and are fitted with hand pump. The variation in yield between premonsoon and postmonsoon is quite high.

Even though the borewells drilled in the area by both official and private agencies, are in large number, no adequate data regarding areal extent of the aquifer is available. The borewells in low lying area are affected by saline water whereas in upland areas the source water is relatively fresh.

### 4.4 Ground Water Quality

Central Ground Water Board monitors the ground water quality of the district through analysis of water samples collected from its National Hydrograph Network Stations (NHNS) which represent the shallow aquifer of the district only. The objective behind quality monitoring is to understand an overall picture of ground water quality of the district. During year 2007, CGWB has carried out the ground water quality monitoring at 5 NHNS.

The results of chemical analysis shows that the ground water in the district is alkaline in nature. The concentration of major ions indicates that among the cations, the concentration of sodium and magnesium ion is almost same followed by calcium, while among the anions the concentration of bicarbonate ion is highest, followed by chloride, sulphate and nitrate ions. The suitability of ground water for irrigation purpose was not assessed as the entire area is urban.

#### 4.4.1 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. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TDS, TH, Ca, Mg, Cl, $SO_4$, $NO_3$ and F prescribed in the standards and is given in Table-1.

**Table-1: Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003).**

| **Parameters** | **DL** (mg/L) | **MPL** (mg/L) | **Samples with conc. < DL** | **Samples with conc. in DL-MPL** | **Samples with conc. >MPL** |
|---|---|---|---|---|---|
| TDS | 500 | 2000 | 5 | Nil | Nil |
| TH | 300 | 600 | 4 | 1 | Nil |
| Ca | 75 | 200 | 5 | Nil | Nil |
| Mg | 30 | 100 | 3 | 2 | Nil |
| Cl | 250 | 1000 | 5 | Nil | Nil |
| $SO_4$ | 200 | 400 | 5 | Nil | Nil |
| $NO_3$ | 45 | No relaxation | 5 | Nil | Nil |
| F | 1.0 | 1.5 | 5 | Nil | Nil |

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

The perusal of Table-1 shows that the concentrations of all the parameters in all the samples are within the MPL. Therefore, it can be concluded that the ground water quality in majority of the area is good for drinking purpose.

The ground water quality of deeper aquifer is brackish to slightly saline in some localities such as Colaba, Dharavi and Khar as observed from BMC data. Yhis may be due to ingression of sea water. In view of this it is suggested that borewells drilled especially along the coastal areas should be pumped at the optimum discharge, so that it does not result in sea water ingression, failing to do so may spoil the fresh water aquifers.

### 4.5 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area. Ground water in the district is predominantly used for domestic, industrial and commercial purpose in the form tanker water supply to the hotel industry, construction purpose etc. The ground water development in the district is mostly through dugwells and borewells. The utilization of ground water through borewells is more in the Andheri, Malad, Goregaon, Kandivili, Bhandup, Kurla, Chembur and Ghatkoper areas. In addition to that new borewells are being drilled in every upcoming society/colony to partially cater to the domestic requirements. Similarly new borewells are taken up in the industrial areas to cater to their partial needs.

## 5.0 Ground Water Management Strategy

At present ground water has less significance for development in the district owing to the limited availability as compared to huge demands of large population. The ground water development is quite low due to quality issues, low yielding nature of aquifers etc.

### 5.1 Ground Water Development

The ground water is presently developed through dugwells and borewells. Hydrogeological set-up and disposition of rock types show that availability of ground water resources will be limited to ground water worthy areas mostly located in Salsete island and limited areas of Bombay and Trombay islands. About 500 to 800 wells can be constructed if the yield of wells is considered to be 30 to 50 $m^3$/day. In these areas the ground water can be developed through dugwells and borewells/tubewells. However the sites for borewell/ tubewells need to be selected only after proper scientific investigation and they should only be used for drinking water supply and not for industrial and commercial exploitation. The promising and productive aquifers exist in the depth range of 60 to 80 m bgl in view of this it is expected that deeper aquifers can offer additional quantity of ground water especially where borewells are high yielding. In the Alluvial areas shallow dugwells of 5 to 10 m depth, whereas in Deccan Trap Basalt areas dugwells of 7 to 15 m depth are the most feasible structures for ground water development. The ground water quality also needs to be ascertained and the wells used for water supply should be first checked for nitrate and other pollutants

Even though ground water is available in the area, more emphasis is given on creating surface water reservoirs, rather than developing ground water in a planned way. The conjunctive utilization of available surface and ground water in systematic and planned way will be the best solution for meeting present and future demands of water.

### 5.2 Water Conservation and Artificial Recharge

The artificial recharge structures feasible are recharge shafts/borewells, whereas water conservation can be done through roof top rain water harvesting. Existing dugwells/borewells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells.

These sites need to be located where the hydrogeological conditions are favorable, i.e., where sufficient thickness of unsaturated/de-saturated aquifer exists and water levels are more than 5 m deep. The postmonsoon depth to water level map and premonsoon/postmonsoon water level trend map gives a good idea of areas suitable for artificial recharge of ground water and such areas are limited in extent located in north central part of the district, where water levels are moderately deep and falling water level trends are also observed. In other areas with shallow water levels, roof top rain water harvesting is also feasible by storing rainwater in storage tanks, thereby supplementing the main source of water.

## 6.0 Major Ground Water Problems and Issues

The pollution of ground water as well as surface water is the major problem in the district. The creeks in the region have become the dumping ground of sewage and industrial effluents. In addition to this, various industrial effluents from oil refineries, reactors, fertilizers plants at Chembur have polluted the sea water in eastern part and are hazardous to marine life.

The data of Maharashtra Pollution Control Board (MPCB) indicate high concentration of Mercury (Hg) than the prescribed limit of 1.90 ppm. The alkali and dye industries are responsible for mercury pollution in the Thane creek. The higher Arsenic (As) concentration of more than 2.00 ppm and slightly more is observed in fishes from Thane and Chembur. The other heavy metals like Lead (0.60 ppm), Cadmium (12.60 ppm) and Copper (8.84 ppm) are also reported from creek water.

Ground water exploitation for commercial purpose is carried out in entire district and the water is extracted from existing dugwells and borewells, even new borewells are also being drilled for this purpose. The ground water is used for construction purposes, hotel industry and for domestic purpose of the housing societies. Excessive ground water development in the beach and coastal areas can lead to saline water intrusion as observed in some parts of Colaba, Dharavi and Khar from BMC data.

## 7.0 Recommendations

1. The availability of ground water resources is limited to ground water worthy areas mostly located in Salsette island and limited areas of Bombay and Trombay islands. About 500 to 800 wells can be constructed if the yield of wells is considered to be 30 to 50 m3/day.
2. In these areas the ground water can be developed through dugwells and borewells/tubewells. However the sites for borewell/ tubewells need to be selected only after proper scientific investigation and they should only be used for drinking water supply and not for industrial and commercial exploitation.
3. In the Alluvial areas shallow dugwells (5 to 10 m), whereas in Deccan Trap Basalt areas dugwells (7 to 15 m) are the most feasible structures for ground water development.
4. The conjunctive utilization of available surface and ground water in systematic and planned way will be the best solution for meeting present and future demands of water.
5. Ground water exploitation for commercial purpose needs to be regulated as the ground water is extracted from existing dugwells and borewells,

even new borewells are also being drilled for this purpose leading to saline water intrusion in beach and coastal areas.

6. The scope exists for constructing suitable artificial recharge structures in limited areas located in north central part of the district like recharge shafts/borewells. The existing dugwells/borewells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells.
7. Roof top rain water harvesting is also feasible by storing rainwater in storage tanks in areas with shallow water levels, thereby supplementing the main source of water.
8. There are thousands of industrial units of various types. These industries cause pollution to ground water and even to surface water. Besides this the city is heavily populated, at very high population density the sanitation facility is quite inadequate which has given rise to nitrate pollution in the district. The special studies in Chembur area reveals presence of Cu, Cr, Ca, As, Hg in ground water which are extremely harmful. In view of the above, it is imperative that a well organized study should be conducted demarcate the areas of safe drinking water.