MAJOR PROJECT

Feasibility & Design of rainwater harvesting system for Panch lok, Raj Nagar, Kavi Nagar, Kamla Nehru Nagar and Shastri Nagar

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AIM AND OBJECTIVES

AIM: Feasibility and design of rainwater harvesting system for Panch lok, Raj Nagar, Kavi Nagar, Kamla Nehru Nagar and Shastri Nagar

OBJECTIVES:

- To determine the rainfall characteristics of the area
- To calculate the rainfall discharge
- To find the rainwater potential and its relation with groundwater
- To calculate the runoff from different areas of the colony according to land use and find out the number of recharging structures needed for the colony
- To locate the different types of recharging structures and propose a design prototype for each zone and each land use

RAINWATER HARVESTING

- The term Rainwater Harvesting is usually taken to mean the immediate collection of rainwater running off surfaces upon which it has fallen directly. This definition excludes run-off from land watersheds into streams, rivers, lakes, etc.
- It includes water that is collected within the boundaries of a property, from roofs and surfaces.
- The Rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls. It involves utilization of rain water for the domestic or the agricultural purpose. The method of rain water harvesting has been into practice since ancient times.

Ways of harvesting water

- Capturing run-off from rooftops, roads.
- Capturing run-off from local catchments
- Capturing seasonal flood water from local streams
- Conserving water through watershed management. It involves utilization of rain water for domestic or agricultural purpose.

NEED FOR RAIN WATER HARVESTING

- Most of the rain falling on the surface tends to flow away rapidly, leaving very little for the recharge of groundwater. As a result, most parts of India experience lack of water even for domestic uses.

- Hence, the need for implementation of measures to ensure that rain falling over a region is tapped as fully as possible through rainwater harvesting, either by recharging it into the groundwater aquifers or storing it for direct use.

ADVANTAGES OF RAINWATER HARVESTING

- Augments groundwater table.
- Reduces runoff which chokes drains and avoid flooding of roads.
- Provides self-sufficiency to water supply and to supplement domestic water requirement during summer and drought conditions.
- It reduces the rate of power consumption for pumping of groundwater. For every 1 m rise in water level, there is a saving of 0.4 KWH of electricity.
- In desert, where rainfall is low, rainwater harvesting has been providing relief to people.

DISADVANTAGES OF RAINWATER HARVESTING

- Supplies can be contaminated by bird/animal droppings on catchment surfaces and guttering structures unless they are cleaned/flushed before use

- Poorly constructed water jars/containers can suffer from algal growth and invasion by insects, lizards and rodents. They can act as a breeding ground for disease vectors if they are not properly maintained

WAYS OF HARVESTING RAINWATER:

- SURFACE RUNOFF HARVESTING: It is a method in which rainwater flowing as surface runoff is caught and used for recharging aquifers by adopting appropriate methods.

- ROOF TOP RAINWATER HARVESTING (RTRWH): In rooftop harvesting, the roof becomes the catchment, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system.

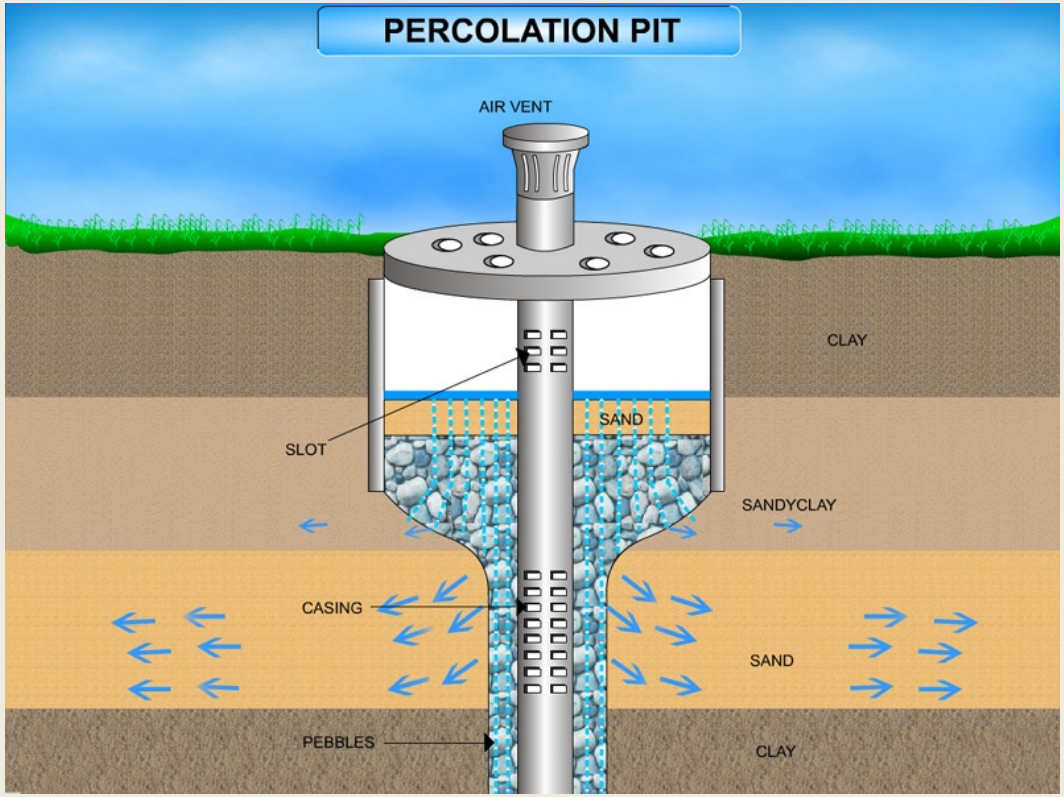
TECHNIQUES OF RAIN WATER HARVESTINGS:

- Storage of rainwater on surface for future use: The storage of rain water on surface is a traditional techniques and structures used were underground tanks, ponds, check dams, weirs etc.

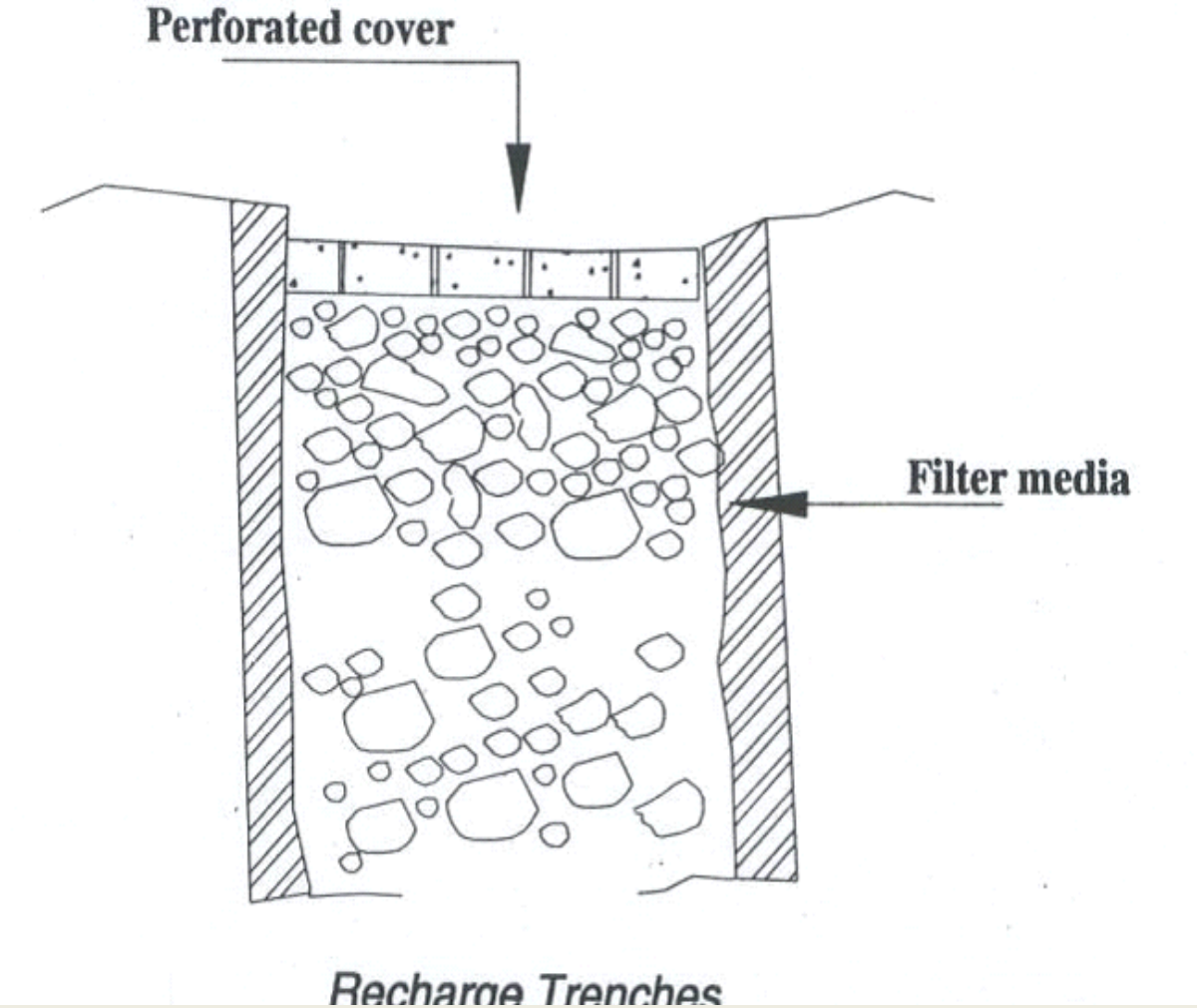
- Recharge to ground water: the collected rainwater is transferred to the ground through suitable means for recharging the depleting aquifers.

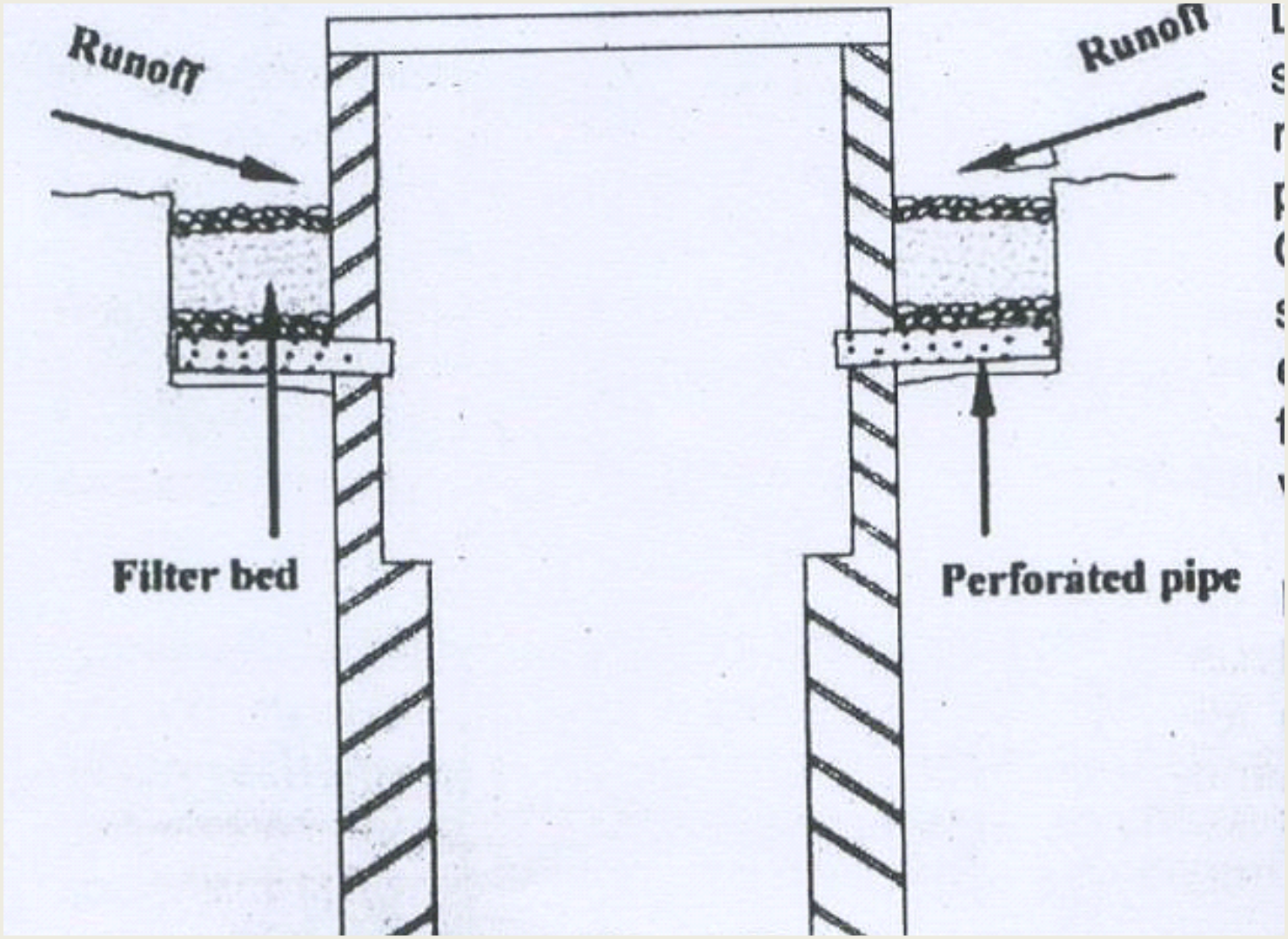
Structures generally used

- Pits: - Recharge pits are constructed for recharging the shallow aquifer. These are constructed 1 to 2 m, wide and to 3 m. deep which are back filled with boulders, gravels, coarse sand.



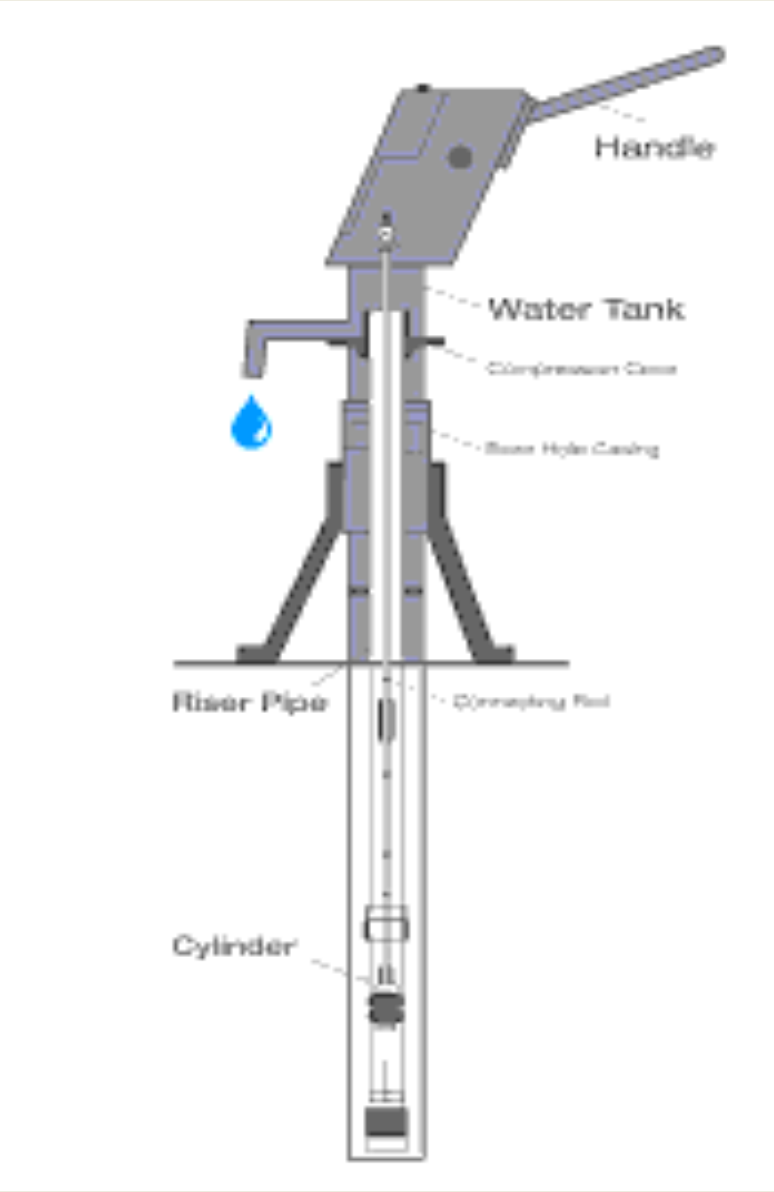
- Trenches: - These are constructed when the permeable strata is available at shallow depth. Trench may be 0.5 to 1 m. wide, 1 to 1.5m deep and 10 to 20 m. long depending up availability of water. These are back filled with filter materials.



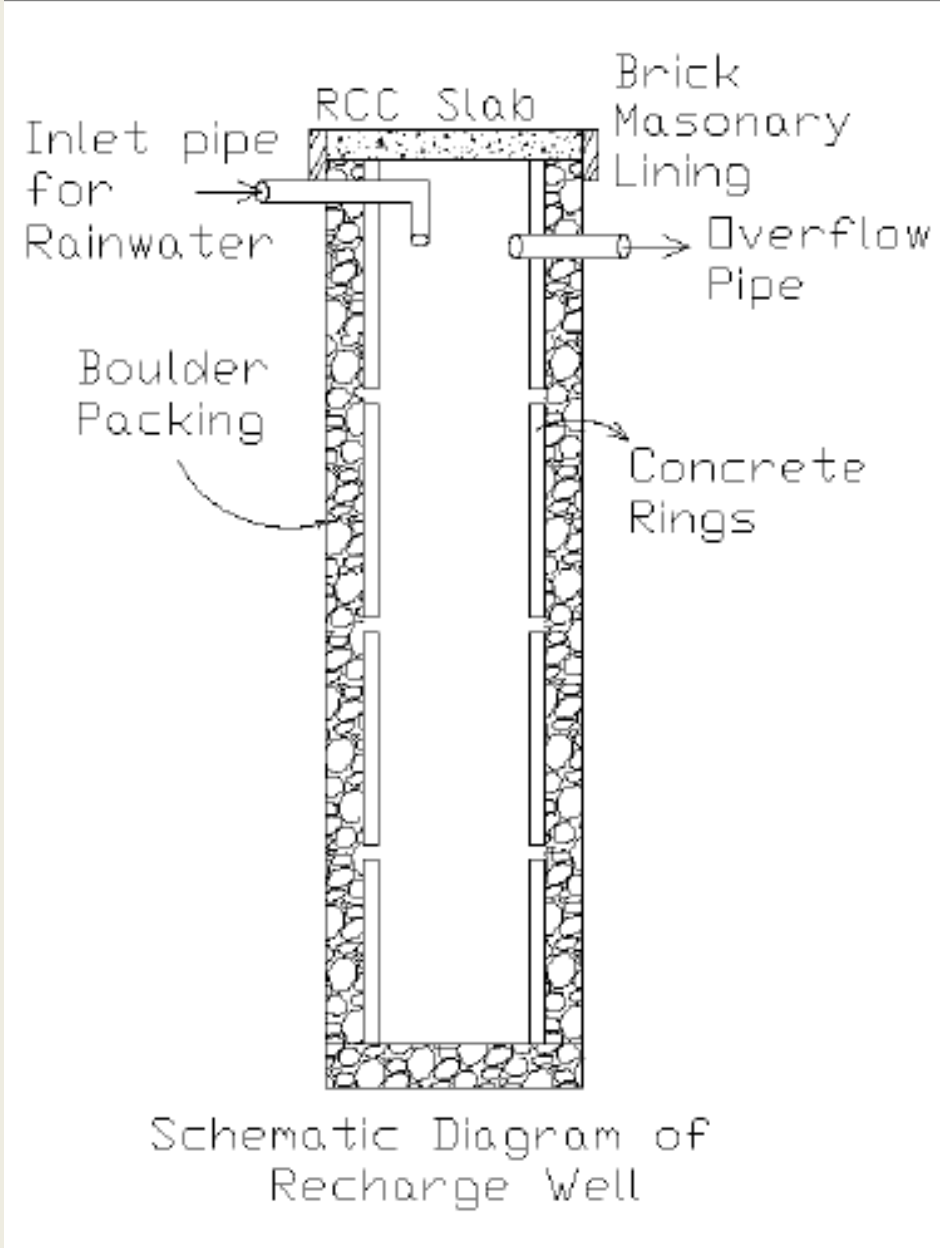


Dug wells: - Existing dug wells may be utilized as recharge structure and water should pass through filter media before putting into dug well.

Hand pumps: - The existing hand pumps may be used for recharging the shallow/deep aquifers, if the availability of water is limited. Water should pass through filter media before diverting it into hand pumps.

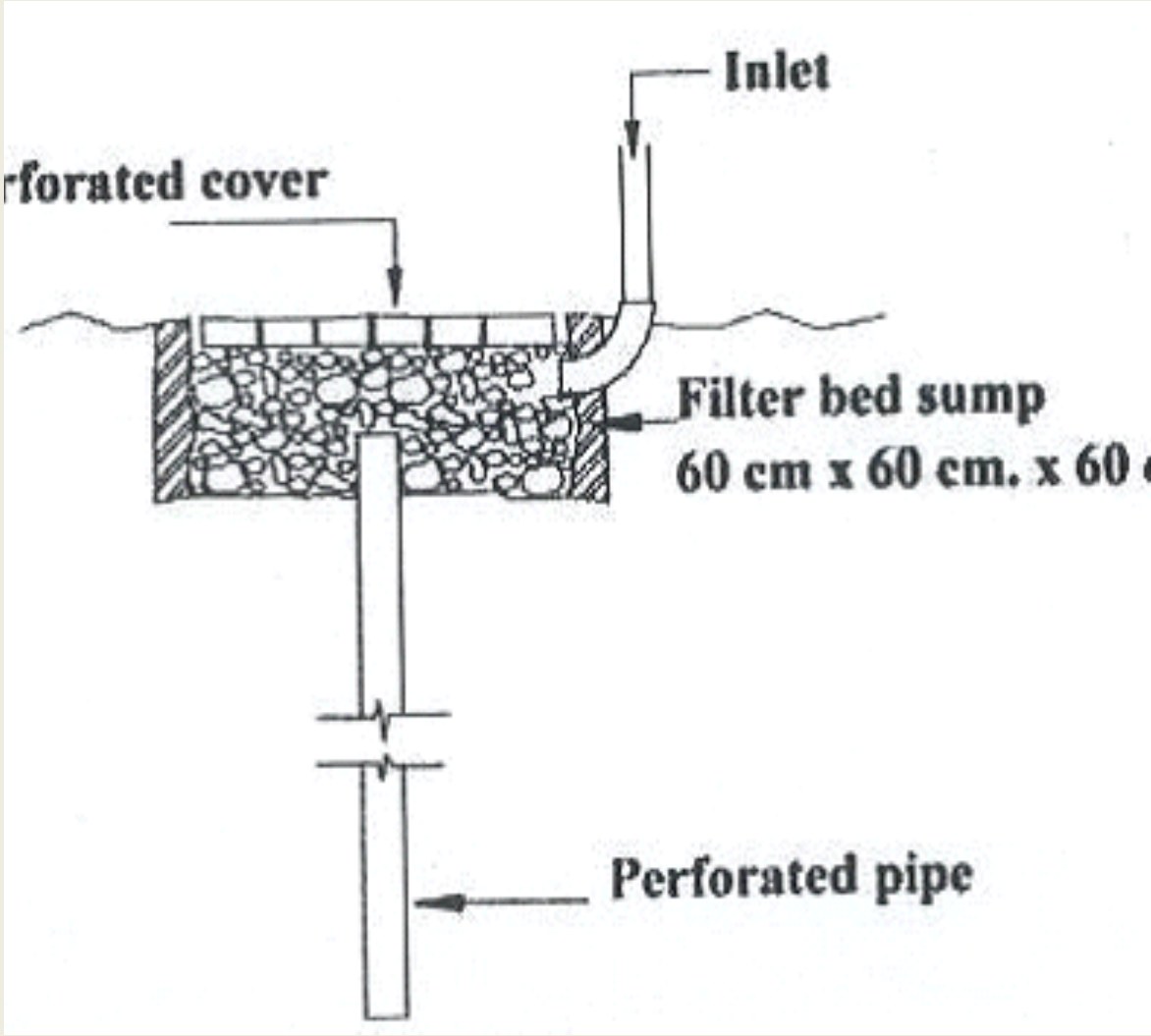


Recharge wells: - Recharge wells of 100 to 300 mm. diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.

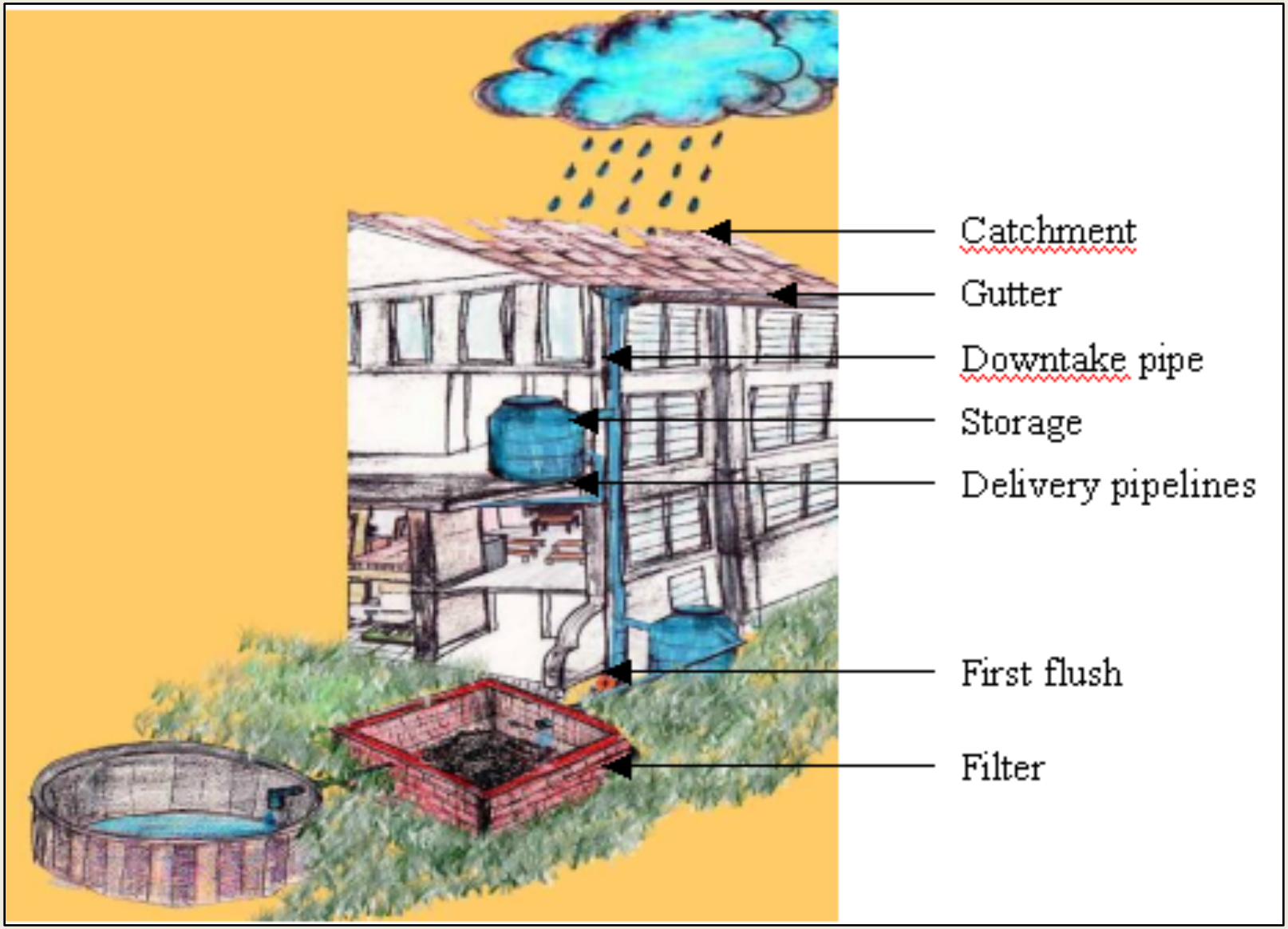


Schematic Diagram of Recharge Well

Recharge Shafts: - For recharging the shallow aquifer which are located below clayey surface, recharge shafts of 0.5 to 3 m. diameter and 10 to 15 m. deep are constructed and back filled with boulders, gravels & coarse sand.



Basic components



Catchment area/roof

This implies the surface upon which rain falls. The roof has to be appropriately sloped preferably towards the direction of storage and recharge.

Gutters and downspouts

The transport channels from catchment surface to storage. These have to be designed depending on site, rainfall characteristics and roof characteristics.

Leaf screens and roof washers

The systems that remove contaminants and debris. At first, a rain separator has to be put in place to divert and manage the first 2.5 mm of rain.

Cisterns or storage tanks

Sumps, tanks etc. where collected rain-water is safely stored or recharging the ground water through open wells, bore wells or percolation pits etc.

Conveying

The delivery system for the treated rainwater, either by gravity or pump.

DESIGN CONSIDERATIONS

Three most important components, which need to be evaluated for designing the rainwater harvesting structure, are:

- Hydrogeology of the area including nature and extent of aquifer, soil cover, topography, depth to water levels and chemical quality of ground water
- Area contributing for runoff i.e. how much area and land use pattern, whether industrial, residential or green belts and general built up pattern of the area
- Hydro-meteorological characters like rainfall duration, general pattern and intensity of rainfall.

TECHNIQUES OF ARTIFICIAL AQUIFER RECHARGE

- **Direct surface techniques/spreading methods**
- **Indirect techniques**

Direct surface technique

- Flooding techniques
- Basins or percolation tanks
- Ditch and furrow system
- Over irrigation
- Direct sub-surface techniques/pit method
- Injection wells or recharge wells
- Recharge pits and shafts
- Dug well recharge
- Bore hole flooding
- Natural openings, cavity fillings.

Indirect techniques

- Induced recharge method
- Aquifer modification
- Besides the above, ground water conservation structures like ground water dams, sub-surface dykes, are quite prevalent to arrest sub-surface flows. Similarly in hard rock areas, rock-fracturing techniques including sectional blasting of boreholes with suitable techniques have been applied to inter-connect the fractures and increase recharge.

LARGER SYSTEMS FOR INSTITUTIONS, STADIUMS, AIRPORTS etc

When the systems are larger, the overall system can become a bit more complicated, for example rainwater collection from the roofs and grounds of institutions, storage in underground reservoirs, treatment and then use for non-potable applications.

ROOF WATER COLLECTION SYSTEMS

In high-rise buildings, roofs can be designed for catchments purposes and the collected roof water can be kept in separate cisterns on the roofs for non-potable uses.

LAND SURFACE CATCHMENTS

- Compared to rooftop catchments techniques, ground catchment techniques provide more opportunity for collecting water from a larger surface area.
- By retaining the flows(including flood flows) of small creeks and streams in small storage reservoirs created by low cost earthen dams, we can meet the water demand during dry periods. This technique is mainly suitable for storing water for agricultural purposes.

FEASIBILITY OF ARTIFICIALLY RECHARGING GROUND WATER

The feasibility of artificially recharging ground water is governed by the following factors:

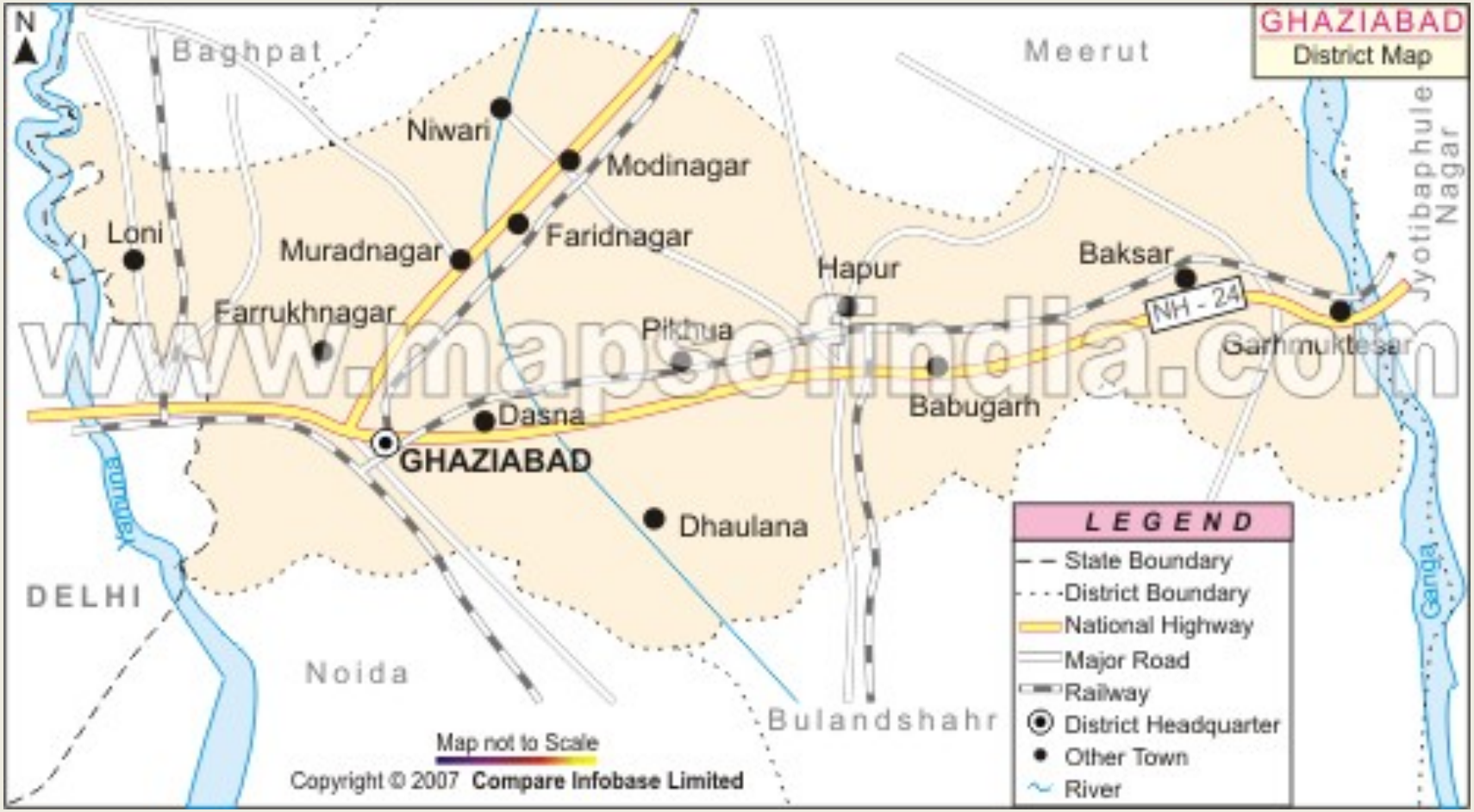
- Availability of suitable site, mainly from topographical and cultural considerations, for establishing recharge facilities.
- Presence of suitable source to supply water of required quality in requisite quantity.
- Lithological composition, thickness and permeability characteristics of rocks in the zone of aeration saturation.
- Cost-benefit considerations.

COST ANALYSIS

- Cost of a Rainwater harvesting system designed as an integrated component of a new construction project is generally low.
- Designing a system onto an existing building is costlier because many of the shared costs (roof and gutters) can be designed to optimize system.
- In general, maximizing storage capacity and minimizing water use through conservation and reuse are important rules to keep in mind.
- With careful planning and design, the cost of a rainwater system can be reduced considerably.

Ghaziabad Location Overview

- Ghaziabad City
- Located in north east part of NCR
- Lies between Doab Region
- Covers an area of 1966 sq km
- Yamuna, Hindon and Ganga main river for water drain
- Study area is between Panch lok to Kavi Nagar N-S, Raj nagar to Kamla Nehru Nagar W-E


GHAZIABAD
District Map
N
Baghpat
Meerut
Niwari
Modinagar
Loni
Muradnagar
Faridnagar
Hapur
Baksar
NH - 24
Farrukhnagar
Pilkhua
Garhmuktesar
Babugarh
Dasna
GHAZIABAD
Dhaulana
DELHI
Noida
Bulandshahr
Jyotibaphule Nagar
Ganga
LEGEND
State Boundary
District Boundary
National Highway
Major Road
Railway
District Headquarter
Other Town
River
Map not to Scale
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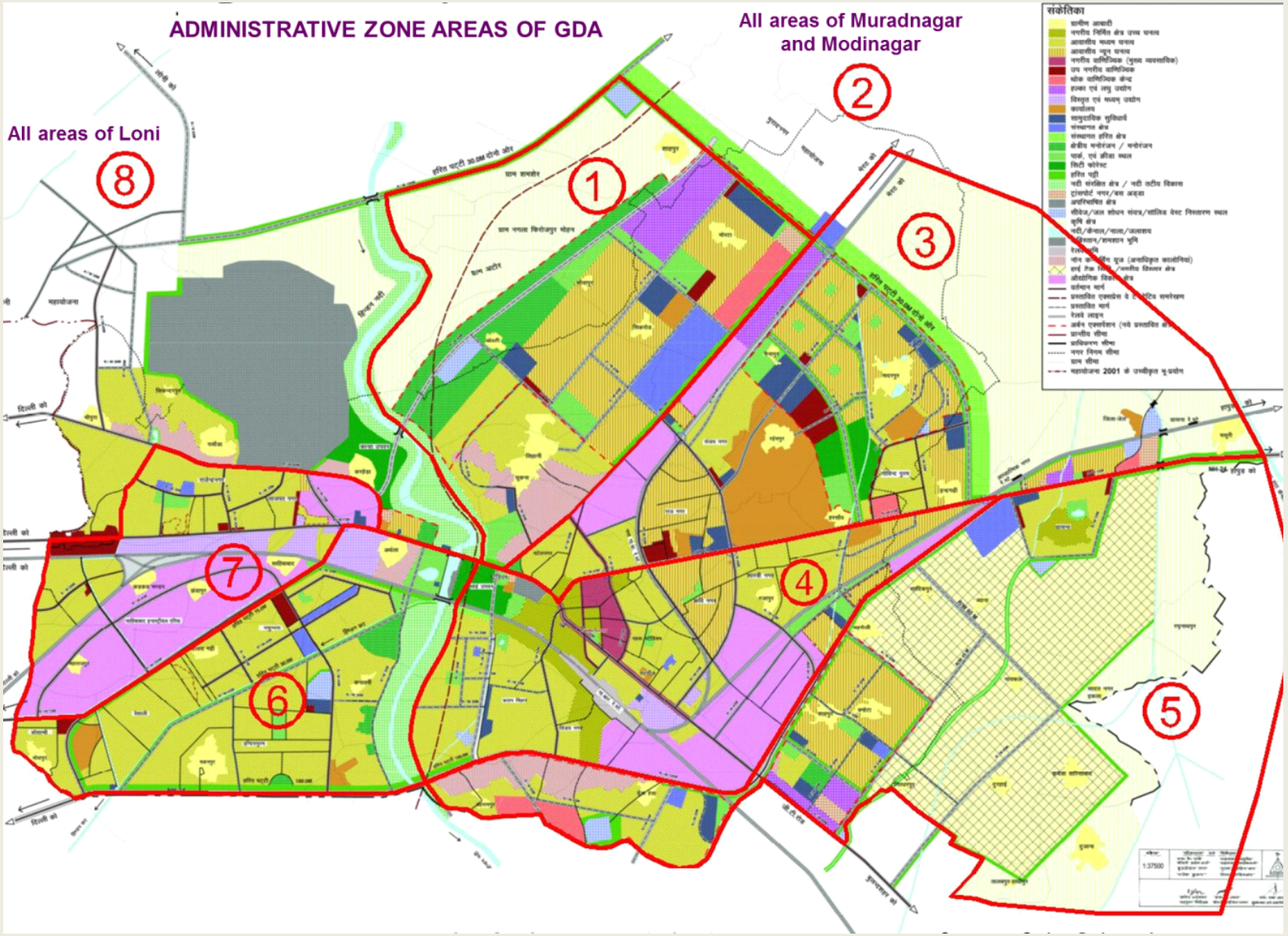


Administrative zone areas of GDA

DEMOGRAPHY

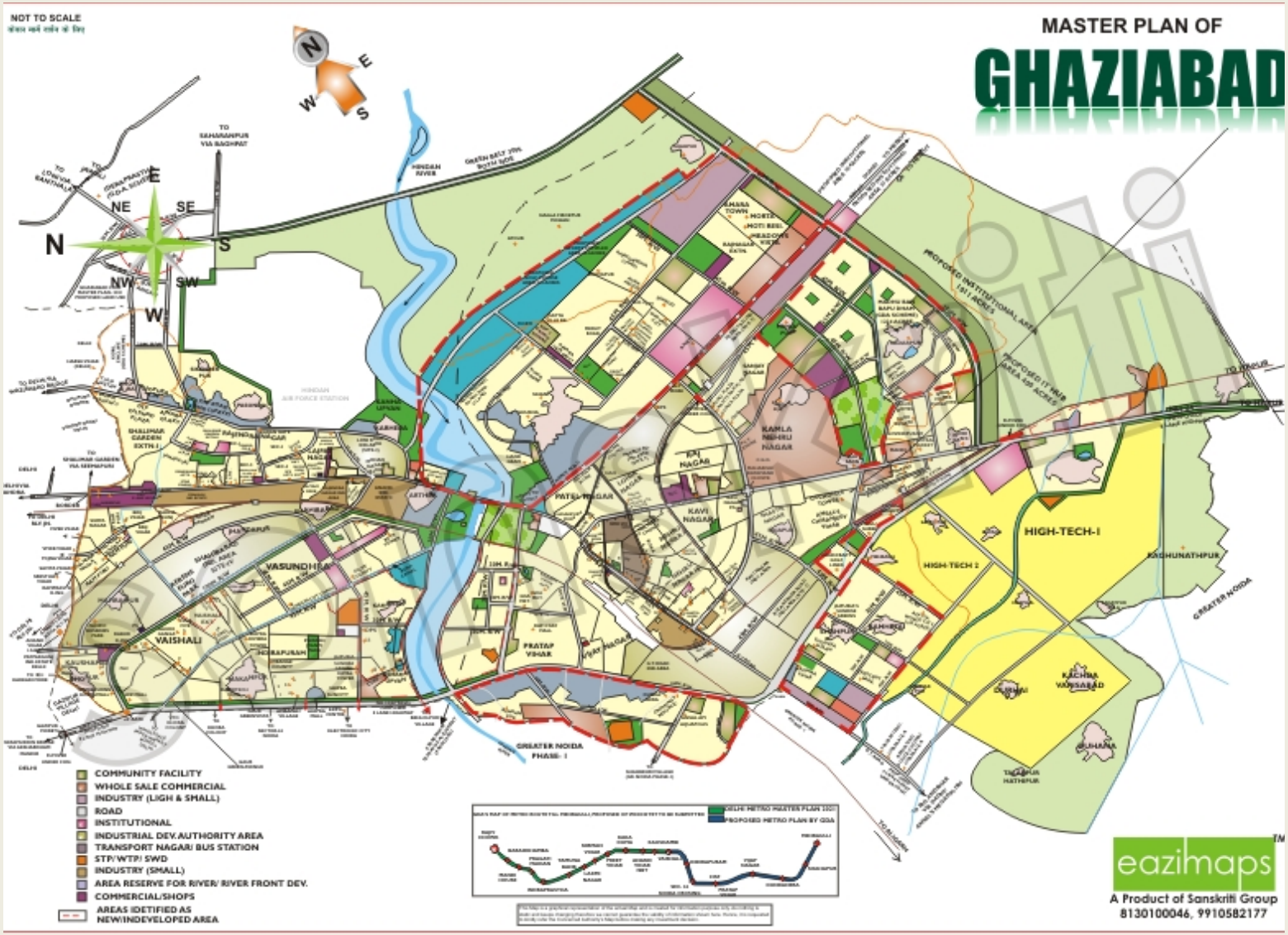
Year	Population	Decadal Growth Rate (%)
1971	128,036	
1981	287,170	124.3%
1991	511,759	78.2%
2001	968,521	89.3%

Source: Census of India

As of the 2011 census, this district had a population of 4,661,452 (3rd highest in UP). It contributes 2.33% of the total population of UP.

Master Plan and Land Use

- Ghaziabad Master Plan 2001 was formulated for an area of 100.4 sq. km, of which by 2001, about 84.8 sq. km was developed.
- The existing land use of Ghaziabad development area (84.8 sq. km) shows that 60 percent of the land is under residential use followed by industrial areas.
- The gross density of the population is 130 persons per hectare.
- The Ghaziabad Master Plan 2021 has been formulated to an area of 155.54 sq. km.


NOT TO SCALE
MASTER PLAN OF
GHAZIABAD
N
E
W
S
NE
SE
NW
SW
HINDAN RIVER
VASUNDHRA
VAISHALI
KAVI NAGAR
PATEL NAGAR
PRATAP VIHAR
KAMLA NEHRU NAGAR
HIGH-TECH-I
HIGH-TECH 2
RAGHUNATHPUR
GREATER NOIDA
GREATER NOIDA PHASE- I
COMMUNITY FACILITY
WHOLE SALE COMMERCIAL
INDUSTRY (LIGH & SMALL)
ROAD
INSTITUTIONAL
INDUSTRIAL DEV.AUTHORITY AREA
TRANSPORT NAGAR/ BUS STATION
STP/ WTP/ SWD
INDUSTRY (SMALL)
AREA RESERVE FOR RIVER/ RIVER FRONT DEV.
COMMERCIAL/SHOPS
AREAS IDETIFIED AS NEW/INDEVELOPED AREA
eazimaps
A Product of Sanskriti Group
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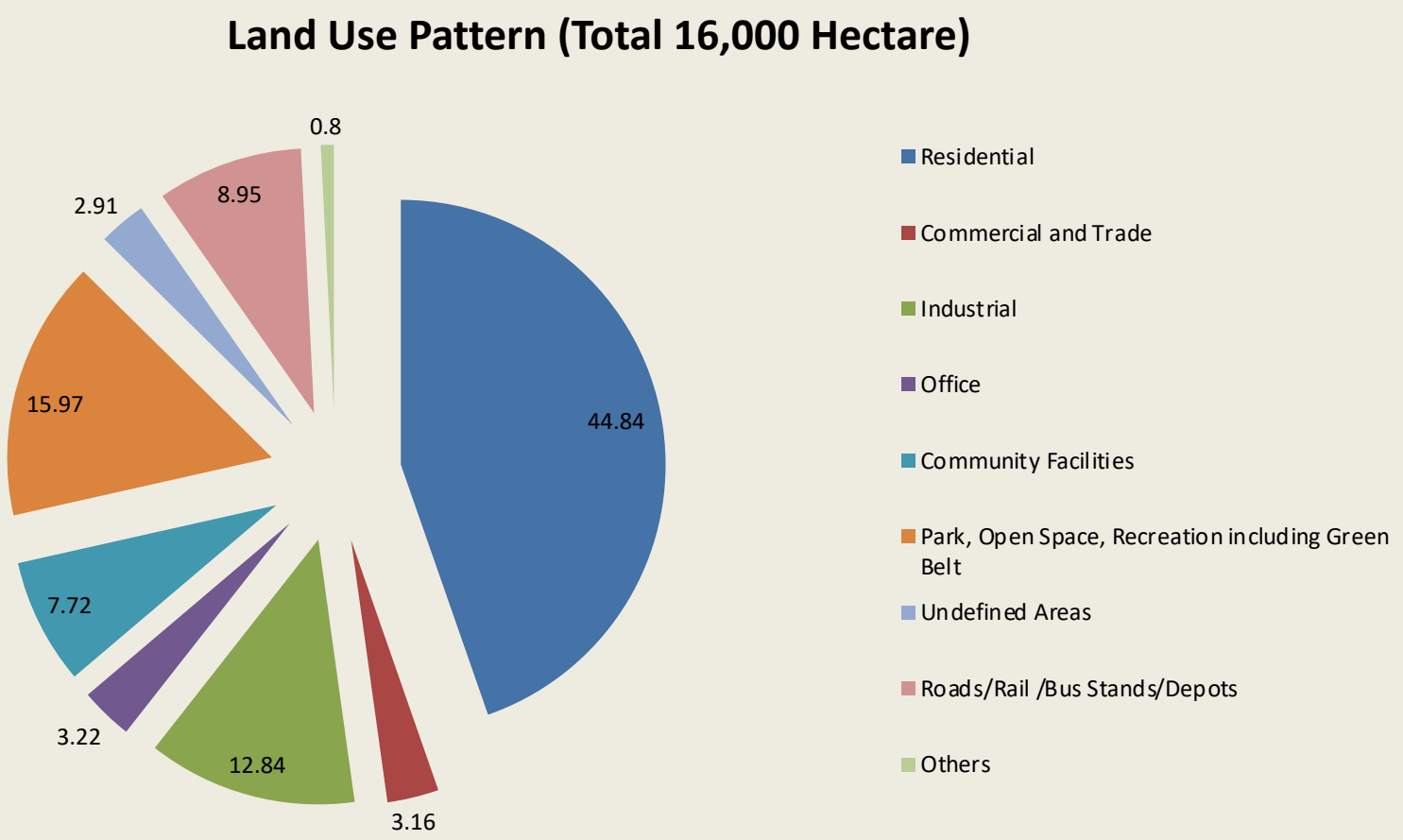
LAND USE


Land Use Pattern (Total 16,000 Hectare)
0.8
8.95
2.91
15.97
44.84
7.72
3.22
12.84
3.16
Residential
Commercial and Trade
Industrial
Office
Community Facilities
Park, Open Space, Recreation including Green Belt
Undefined Areas
Roads/Rail /Bus Stands/Depots
Others

S.No.	Land use Category	Area(Hectares)	Percentage
1	Residential	6975.00	44.84
2	Commercial and Trade	491.00	3.16
3	Industrial	1933.00	12.84
4	Office	501.00	3.22
5	Community Facilities	1201.00	7.72
6	Park, Open Space, Recreation including Green Belt	2484.00	15.97
7	Undefined Areas	452.00	2.91
8	Roads/Rail /Bus Stands/Depots	1392.00	8.95
9	Others	125.00	0.80
	TOTAL	15554.00	100.00

Land use of Ghaziabad- Area and Percentage

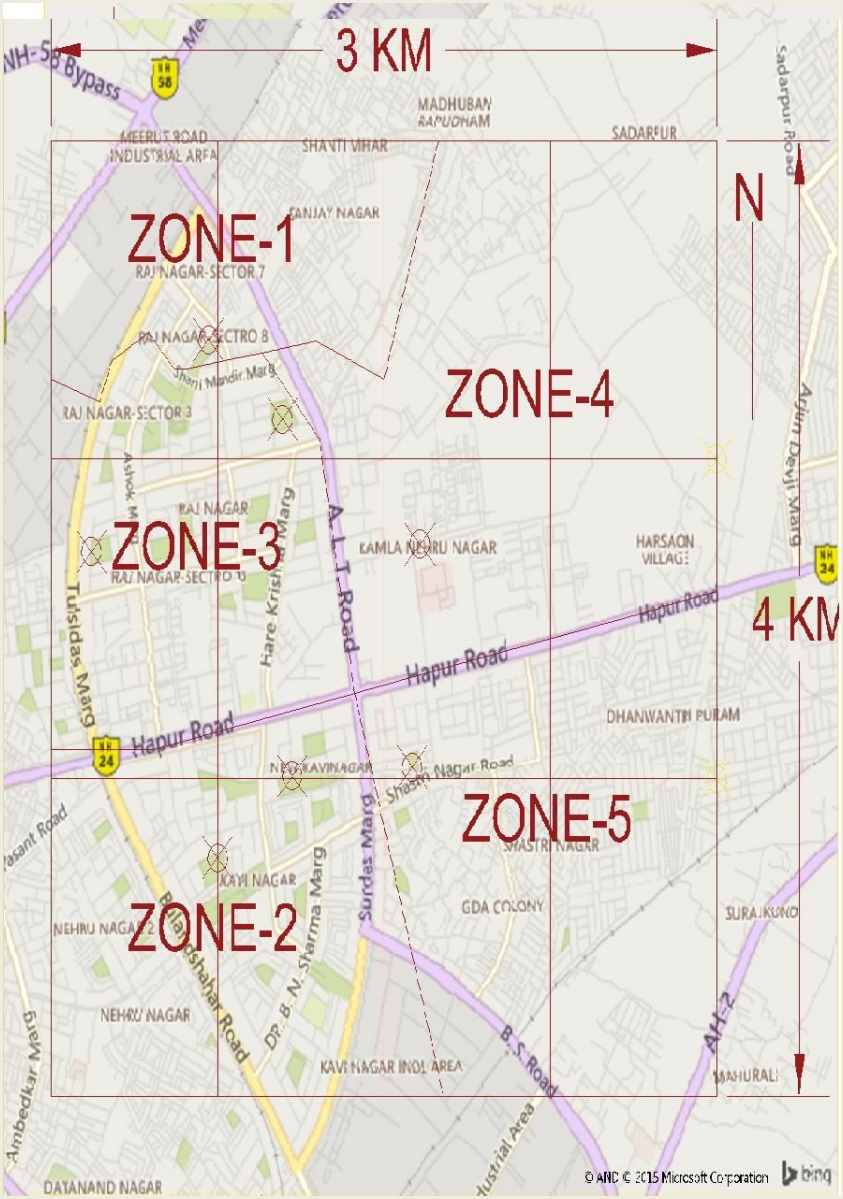
STUDY AREA

For Rainwater Harvesting feasibility study, we have chosen five zones given below:-

- PANCH LOK- ZONE-1
- KAVI NAGAR- ZONE-2
- RAJ NAGAR- ZONE-3
- KAMLA NEHRU NAGAR- ZONE-4
- SHAHSTRI NAGAR- ZONE-5

STUDY AREA

- The total area combing these 5 localities which is covered is aprrox 12 sq km area by forming a grid
- In each small grid we did four inch bore hole for analysis of soil strata profile up to ground water level upto 35m.
- Mostly is done near park area.
- These localities were mainly residential colonies. Paths are paved and all houses have pucca rooftop.
- In every 1-1.5 sq km there is a park.


3 KM
4 KM
N
ZONE-1
ZONE-2
ZONE-3
ZONE-4
ZONE-5
MADHUBAN BAPUDHAM
SADARPUR
SHANTI VIHAR
SANJAY NAGAR
RAJ NAGAR-SECTOR 7
RAJ NAGAR-SECTRO 8
RAJ NAGAR-SECTOR 3
RAJ NAGAR
KAMLA NEHRU NAGAR
HARSAON VILLAGE
DHANWANTRI PURAM
SHASTRI NAGAR
GDA COLONY
SURAJKUND
NEHRU NAGAR
KAVI NAGAR INDL AREA
MAHURALI
DATANAND NAGAR
Hapur Road
Tulsidas Marg
Hare Krishna Marg
A. T. I. Road
Surdas Marg
Dr. B. N. Sharma Marg
Bulandshahar Road
B. S. Road
AH-2
Arjun Devji Marg
Sadarpur Road
Ambedkar Marg
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3 KM
4 KM
N
ZONE-1
ZONE-2
ZONE-3
ZONE-4
ZONE-5
graphics LLC Earthstar Geographics SIO © 2016 Microsoft Corporation
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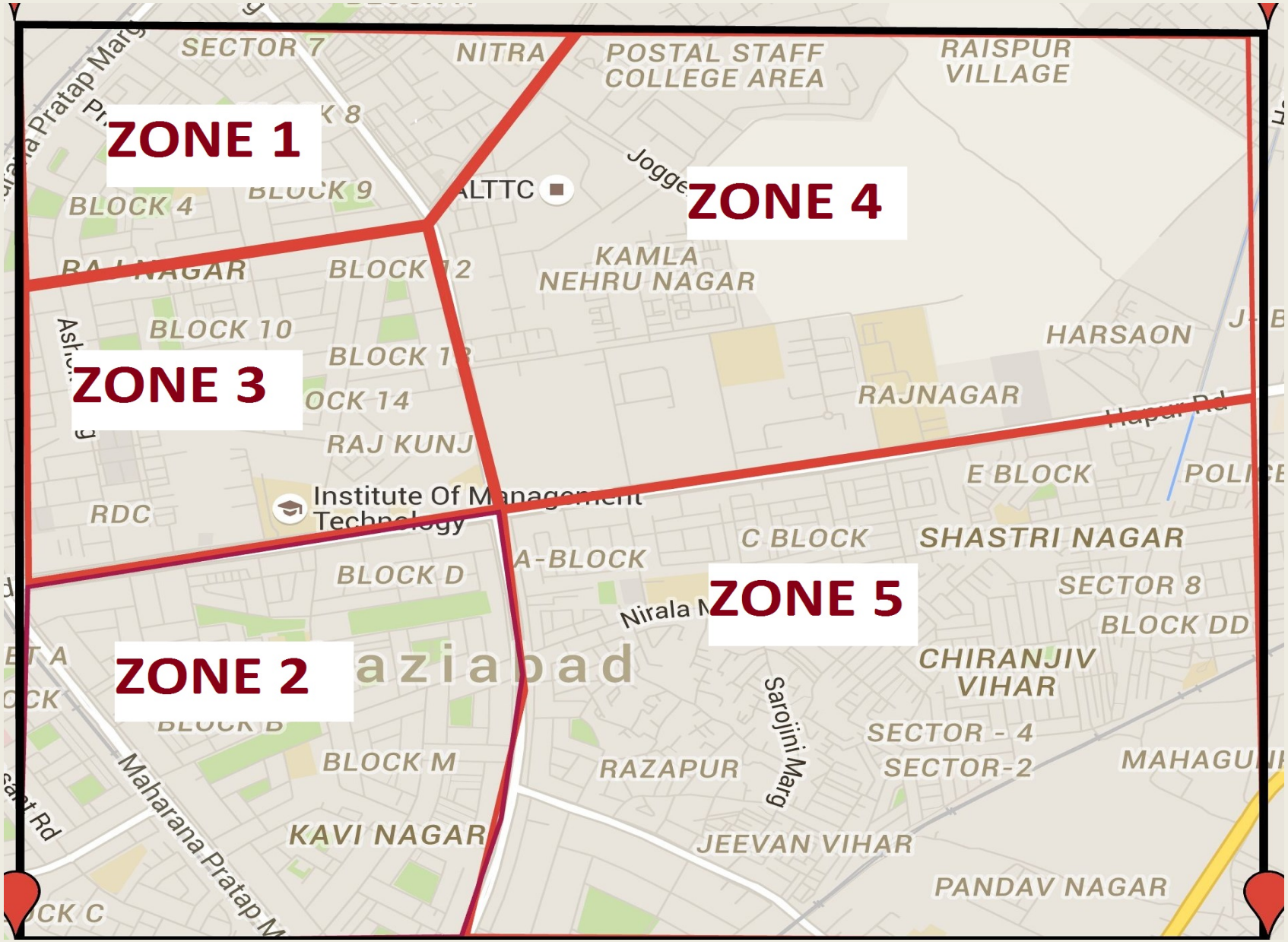
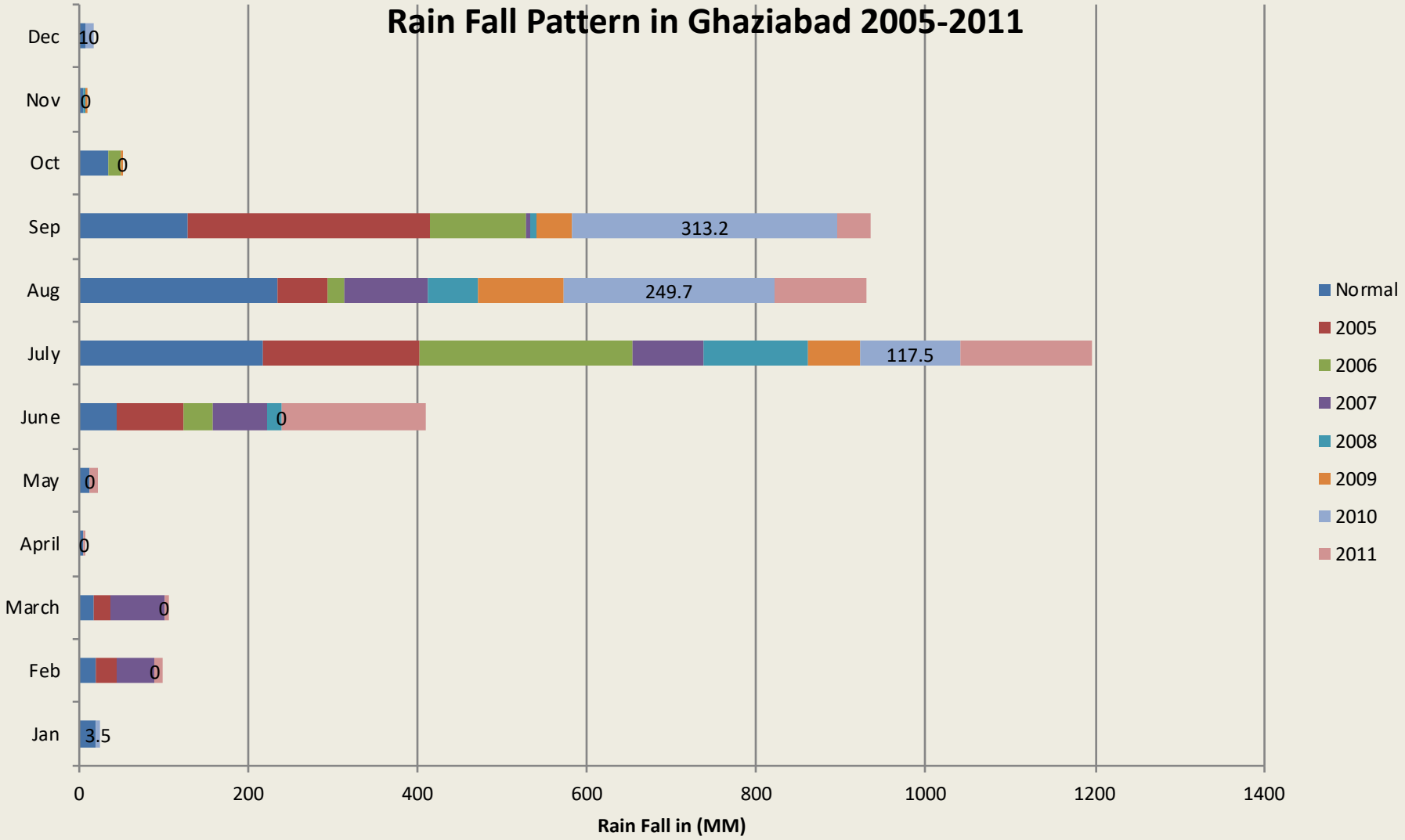

ZONE 1
ZONE 4
ZONE 3
ZONE 5
ZONE 2
SECTOR 7
NITRA
POSTAL STAFF COLLEGE AREA
RAISPUR VILLAGE
BLOCK 4
BLOCK 9
ALTTC
KAMLA NEHRU NAGAR
BLOCK 10
HARSAON
RAJNAGAR
RAJ KUNJ
RDC
Institute Of Management Technology
E BLOCK
C BLOCK
SHASTRI NAGAR
BLOCK D
A-BLOCK
SECTOR 8
BLOCK DD
CHIRANJIV VIHAR
BLOCK M
RAZAPUR
SECTOR - 4
SECTOR-2
KAVI NAGAR
JEEVAN VIHAR
PANDAV NAGAR
Maharana Pratap
Sarojini Marg

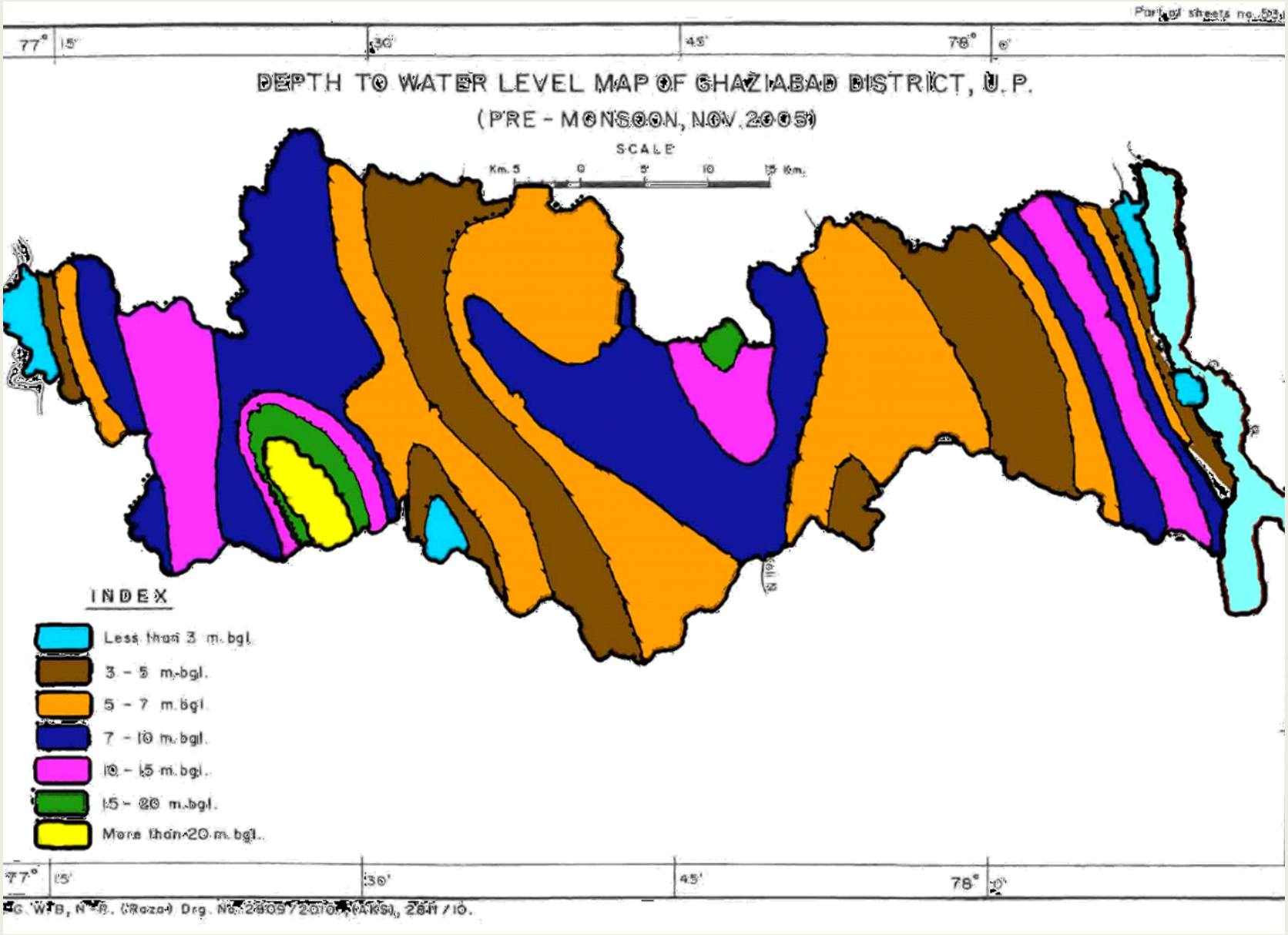
CLIMATE & SOIL CONDITION

- Dry, Extreme temperatures during summer and winter
- Summer 23-42`C & Winter 7-26`C (JAN-MAY)
- The average rainfall is 732 mm and is generally limited to the months during June to September
- Ghaziabad forms a part of the Indo-Gangetic alluvium. Soil is characterized mainly by silty sand and loamy soils (Bhur, Matiyar, Domat)

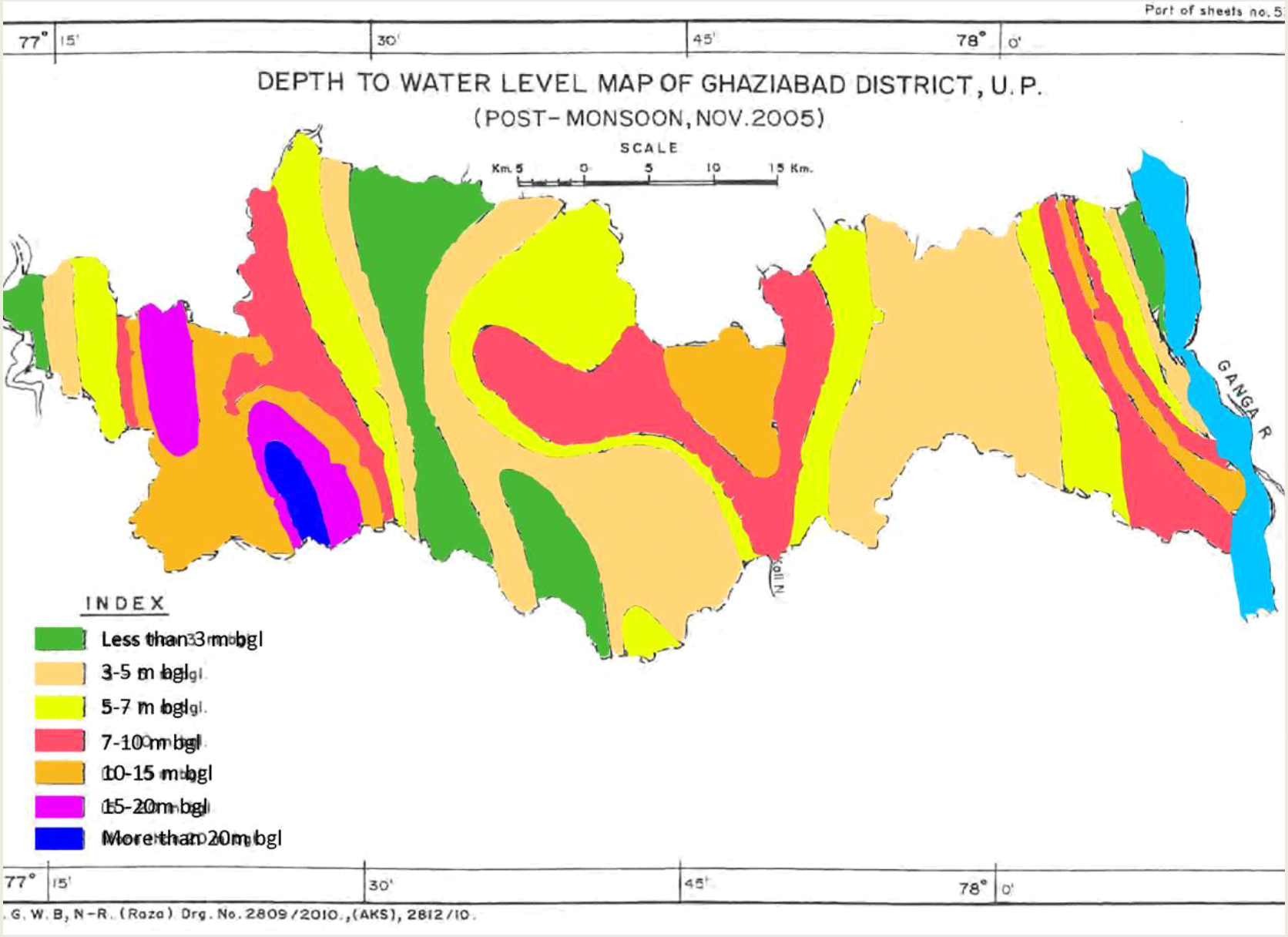

Rain Fall Pattern in Ghaziabad 2005-2011
Dec
Nov
Oct
Sep
Aug
July
June
May
April
March
Feb
Jan
10
0
0
313.2
249.7
117.5
0
0
0
0
3.5
0
200
400
600
800
1000
1200
1400
Rain Fall in (MM)
Normal
2005
2006
2007
2008
2009
2010
2011

DEPTH TO WATER LEVEL OF GHAZIABAD

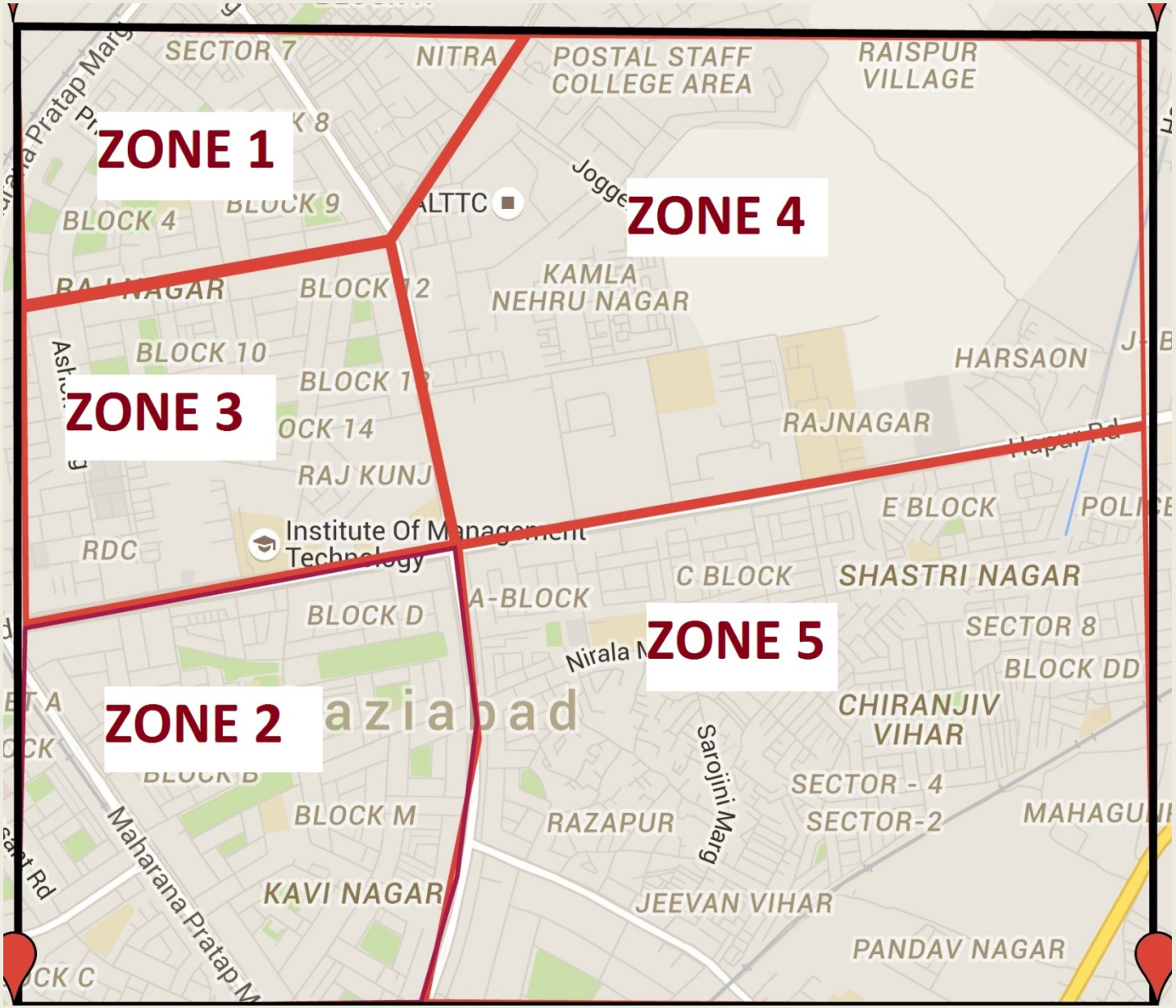
- The water table rises up and down according to the time of the month. Before monsoons it is lower and after monsoons it is higher.
- Pre-monsoon Depth to water level during 2011:20.58 mbgl
- Post-monsoon Depth to water level during 2011:19.95 mbgl
- The fluctuation in pre monsoon and post monsoon ground water level is approximately 0.6 mbgl.



17 Water Level Fluctuation-Pre Monsoon



Water Level Fluctuation-Post Monsoon


ZONE 1
ZONE 4
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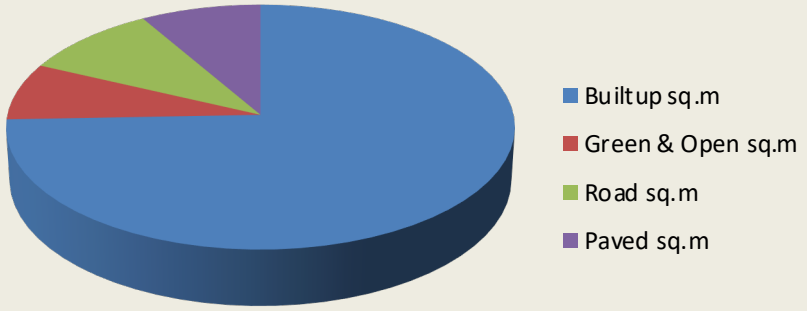
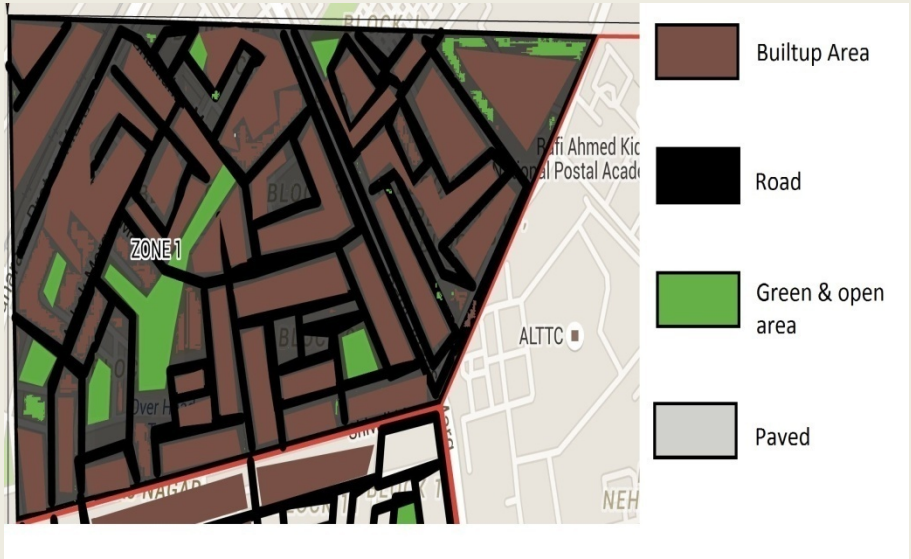
E BLOCK
C BLOCK
SHASTRI NAGAR
BLOCK D
A-BLOCK
SECTOR 8
BLOCK DD
CHIRANJIV VIHAR
Sarojini Marg
SECTOR - 4
SECTOR-2
BLOCK M
RAZAPUR
KAVI NAGAR
JEEVAN VIHAR
PANDAV NAGAR
Maharana Pratap

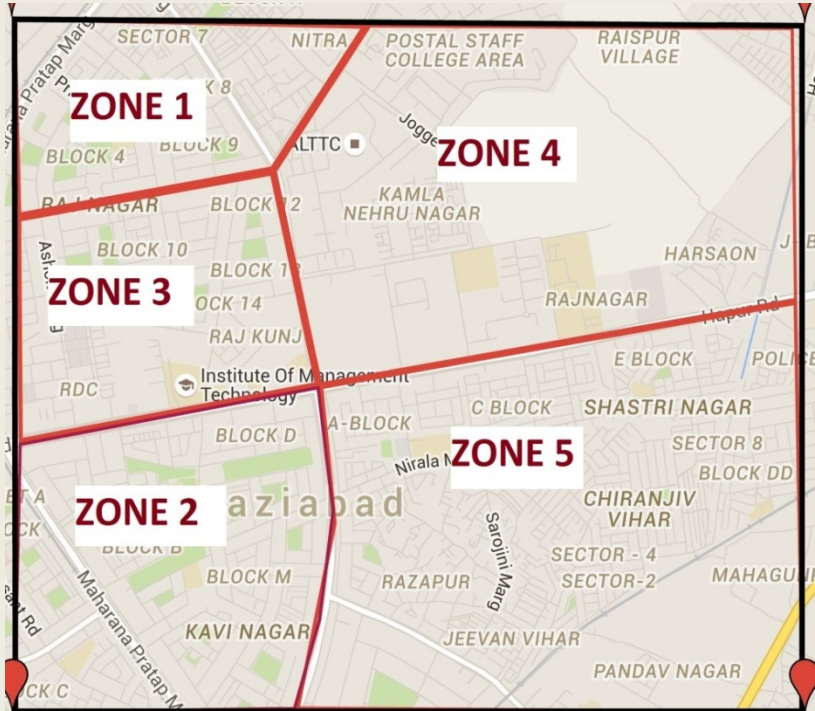
ZONING PLAN

		Zone 1		
Area Type	Surface Coefficient C	Rainfall Intensity I meter/spell	Area Sq.M	Rainfall Potential Q cubic meter/spell
BUILT UP	0.85	0.025	930080	19764.2
GREEN	0.3	0.025	94270	707.025
ROAD	0.65	0.025	120320	1955.2
PAVED	0.75	0.025	105330	1974.938
TOTAL Q1				24401.36

Area Distribution in Zone 1

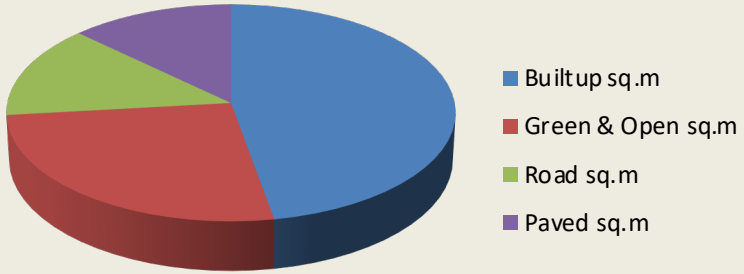


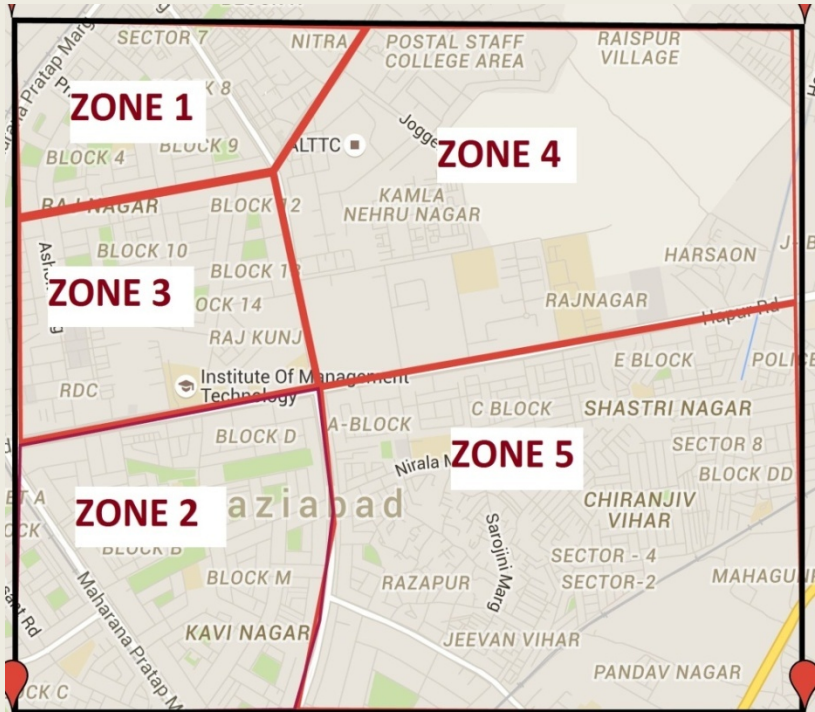




		Zone 2		
Area Type	Surface Coefficient C	Rainfall Intensity I meter/spell	Area Sq.M	Rainfall Potential Q cubic meter/spell
BUILT UP	0.85	0.025	1019180	21657.58
GREEN	0.3	0.025	562670	4220.025
ROAD	0.65	0.025	299868	4872.855
PAVED	0.75	0.025	278282	5217.788
TOTAL Q2				35968.24

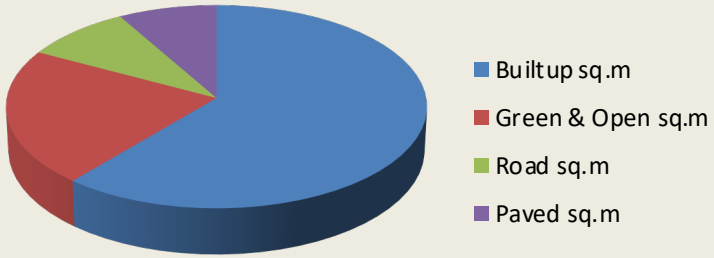
Area Distribution in Zone 2

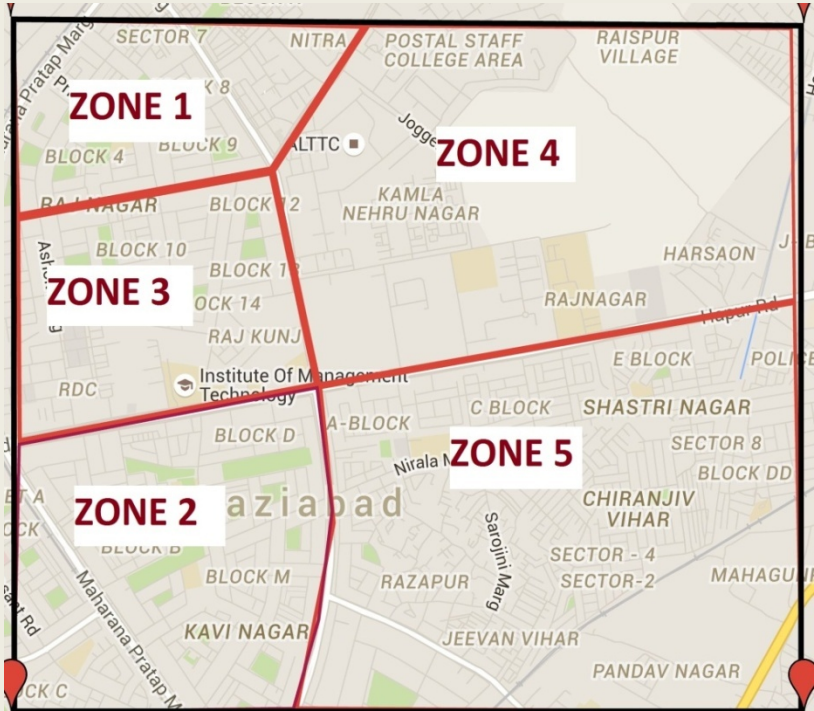




		Zone 3		
Area Type	Surface Coefficient C	Rainfall Intensity I meter/spell	Area Sq.M	Rainfall Potential Q cubic meter/spell
BUILT UP	0.85	0.025	897620	19074.43
GREEN	0.3	0.025	339580	2546.85
ROAD	0.65	0.025	131840	2142.4
PAVED	0.75	0.025	120960	2268
TOTAL Q3				26031.68

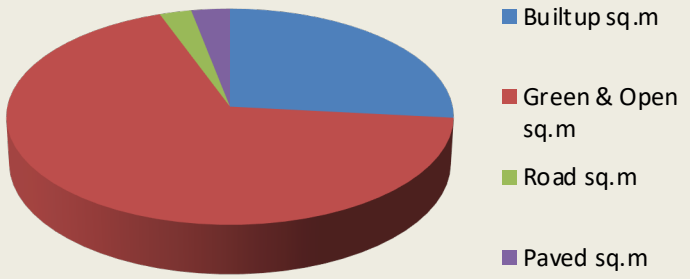
Area Distribution in Zone 3

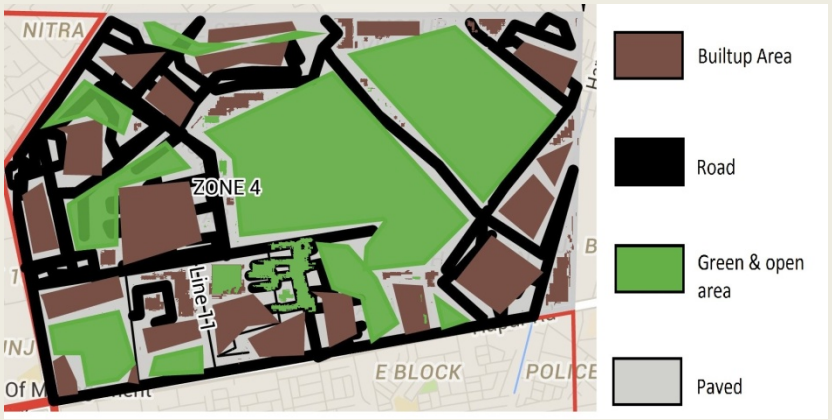


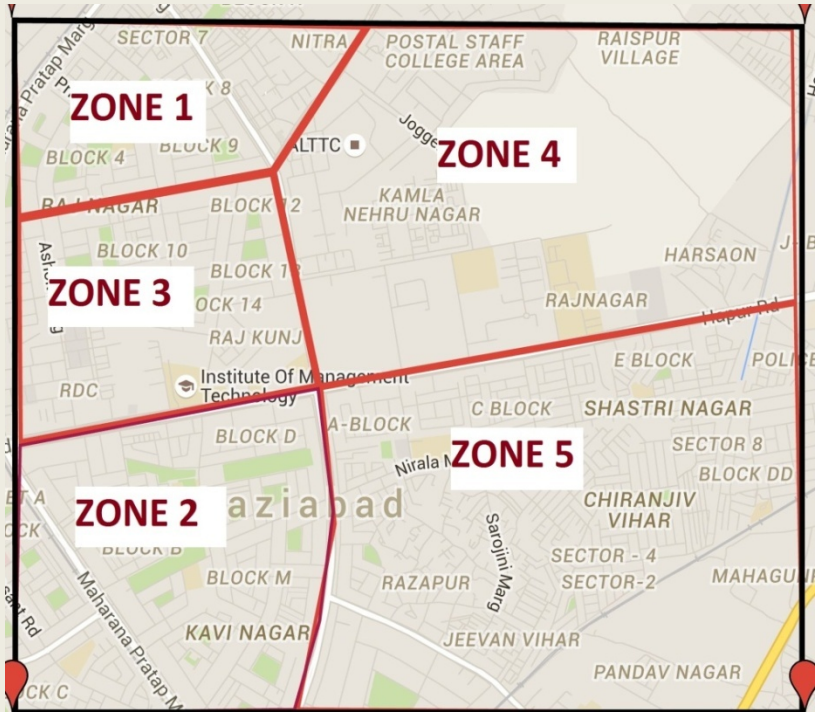


		Zone 4		
Area Type	Surface Coefficient C	Rainfall Intensity I meter/spell	Area Sq.M	Rainfall Potential Q cubic meter/spell
BUILT UP	0.85	0.025	988290	21001.16
GREEN	0.3	0.025	2914600	21859.5
ROAD	0.65	0.025	93960	1526.85
PAVED	0.75	0.025	113150	2121.563
TOTAL Q4				46509.08

Area Distribution in Zone 4

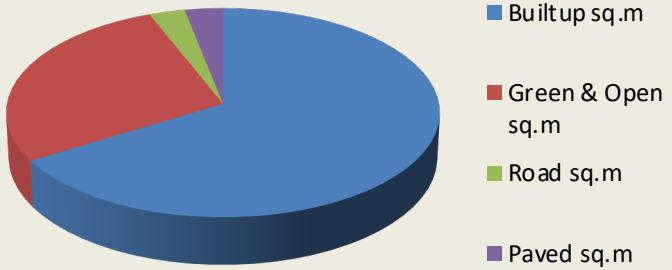


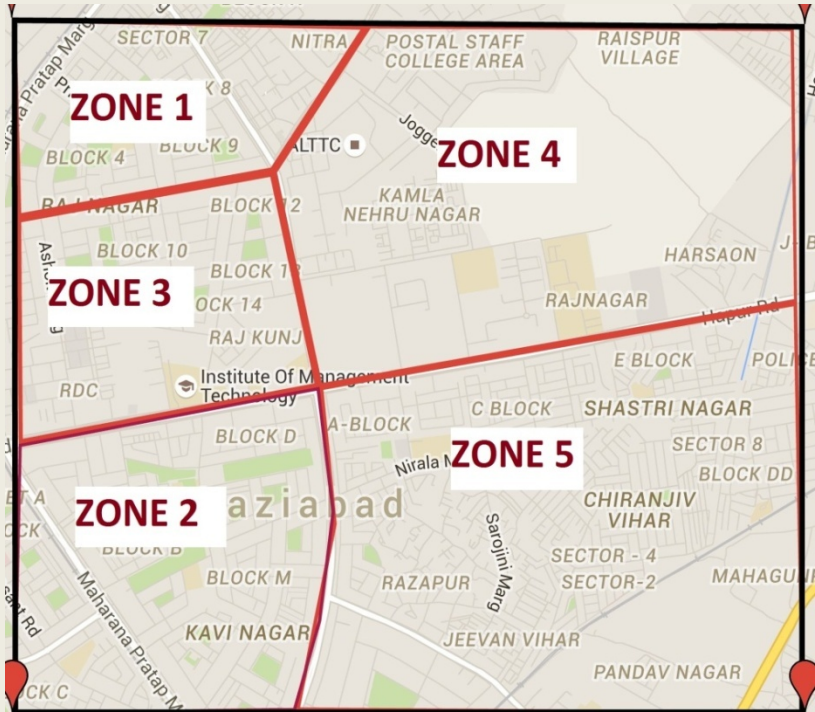




		Zone 5		
Area Type	Surface Coefficient C	Rainfall Intensity I meter/spell	Area Sq.M	Rainfall Potential Q cubic meter/spell
BUILT UP	0.85	0.025	2857080	60712.95
GREEN	0.3	0.025	1048490	7863.675
ROAD	0.65	0.025	98992.4	1608.627
PAVED	0.75	0.025	1110960	105437.6
TOTAL Q5				175622.9

Area Distribution in Zone 5





GROUND WATER QUALITY

- Ground water is suitable for drinking and domestic uses in respect to all constituents except for total Hardness & Nitrate.
- High nitrate values due to indiscriminate use of fertilizer.
- The Arsenic content has not been detected in the ground water of the district.
- Hexavalent chromium impurity is too found

GROUND WATER RELATED ISSUES AND PROBLEMS

- The river stretch remains dry, except during rains. During winter and summer seasons, river flow is mainly limited to industrial effluents discharged from various industries located in Ghaziabad .

- Due to illegal entry of industrial and domestic wastewater, Hindon River water is polluted.

- The groundwater decline is at much rapid phase

- No groundwater extraction is allowed without prior permission of Central Ground Water Board (CGWB).

(O-Requirement)

Type	Number of Unit*	Population**	Requirement/Capita/Day	Total Requirement (L/Day)
Residential	2362	703823***	135 L	95016105
Institutional	15	15750***	45 L/Head	708750
Commercial	22	22000***	70 L/Seat	1540000
Hospital	6	900***	70 L/Head	63000

O = 3552,46,67,080 L/Year
= 3,55,24,667 cu.m/yr

(I-Availability)

- **Ground Water Availability (I1)**
  I1= Plot Area X Ground Water Fluctuation X Specific Yield
  = 12000000 X 0.5 X 16%**= 960000 cubic meter**

- **Rain Water Availability (I2)**
  I2= CIA
  = 0.64 X 0.7 X 12000000
  =5376000 cubic meter

- **Recycled Water Availability (I3)**
  I3= 70% O – Horticulture water requirement
  = (0.7X **3552,46,67,080**) - (5L/sq.m. X 4439610 sq.m)
  = 24845068910 L /Year
  24845068.9**cubic meter**

ANALYSIS OF STAGE OF WATER DEVELOPMENT

TYPE	FORMULA	PERCENTAGE	STAGE OF WATER DEVELOPMENT
Stage of Water Development with respect to ground water **(SWD1)**	(O/I1) x100	3700%	Black
Stage of Water Development with respect to ground water and rain water **(SWD2)**	(O/I1+I2) x100	560%	Black
Stage of Water Development with respect to ground water ,rain water and recycled water **(SWD3)**	(O/I1+I2+I3) x100	114%	Black

Distribution of Areas in Various Zone

	Builtup sq.m	Green & Open sq.m	Road sq.m	Paved sq.m	Total Area of zone sq.m
Zone 1	930080	94270	120320	105330	1250000
Zone 2	1019180	562670	299868	278282	2160000
Zone 3	897620	319580	131840	120960	1470000
Zone 4	988290	2514600	93960	113150	3710000
Zone 5	2257080	948490	98992.4	105437.6	3410000
Total Area sq.m	6092250	4439610	744980.4	723159.6	12000000

Calculation of number of structures for Built up Area

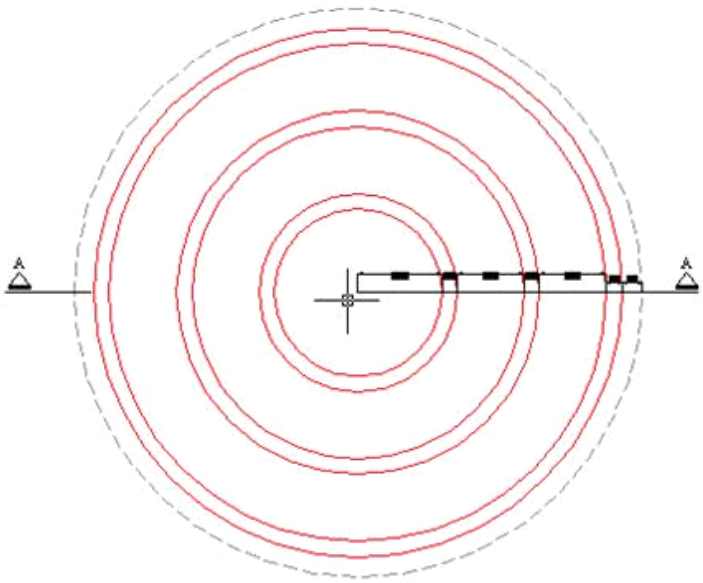
Zone	q1 (built up)	q1 After deducting Losses (30%)	n (No. of structures for roof top rainwater harvesting)	Total No. of structures to be designed (10% of n)	Type of Structure proposed
1	197642	138349	1761	176	Type 8
2	216576	151603	1930	193	Type 8
3	190744	133521	1700	170	Type 8
4	210012	147008	1871	187	Type 8
5	479630	335741	4274	427	Type 8

Calculation of number of structures for Road & Paved

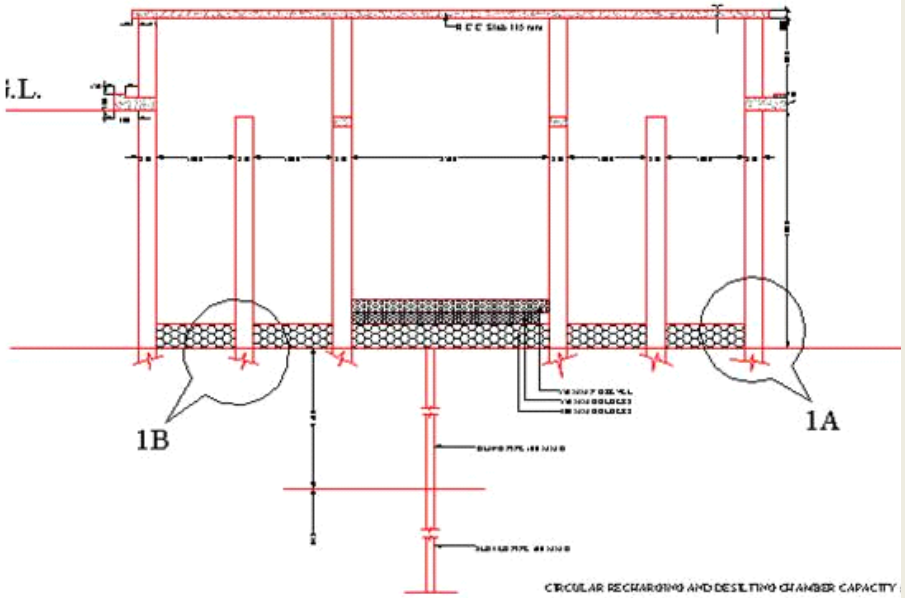
Zone	q3+q4 (road + paved)	q3+q4 After deducting Losses (30%)	n (No. of structures for surface rainwater harvesting)	Total No. of structures to be designed (10% of n)	Type of Structure proposed
1	39489	27642	244	24	Type 1
2	101176	70823	626	63	Type 1
3	44240	30968	274	27	Type 1
4	36244	25371	224	22	Type 1
5	35775	25043	221	22	Type 1

SELECTED STRUCTURES FOR RECHARGING RAIN WATER – SURFACE RAIN WATER- ROAD AND PAVED AREA

Type 1
Circular Injection Well



PLAN



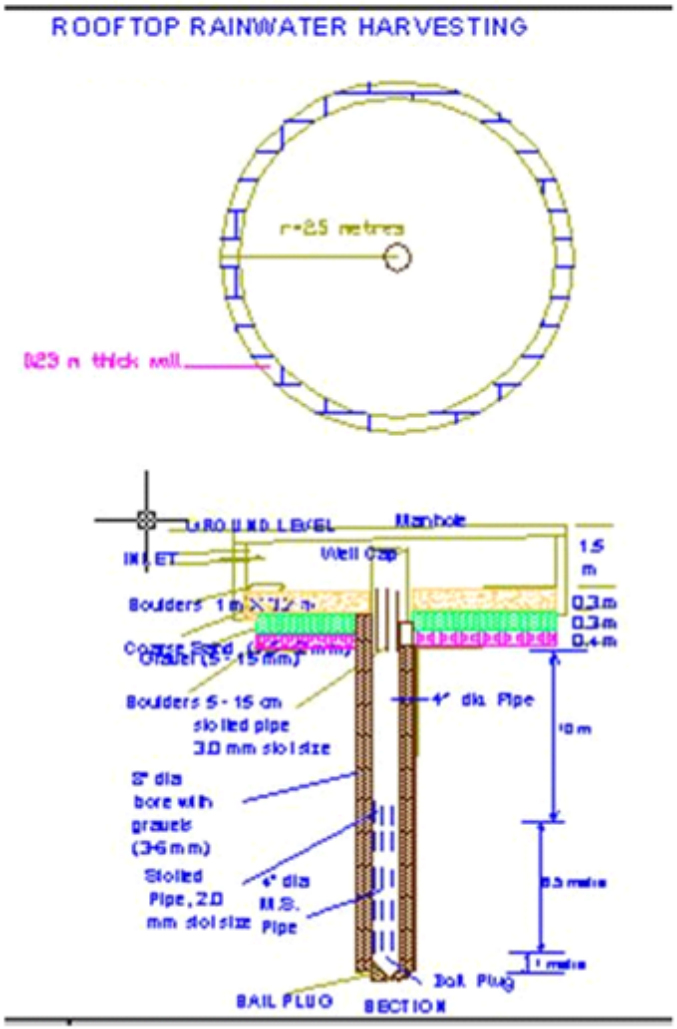
SECTION AT A-A

Dimensions:
Radius- 3 m.

RECHARGE STRUCTURES

SELECTED STRUCTURES FOR RECHARGING RAIN WATER – ROOF TOP RAIN WATER

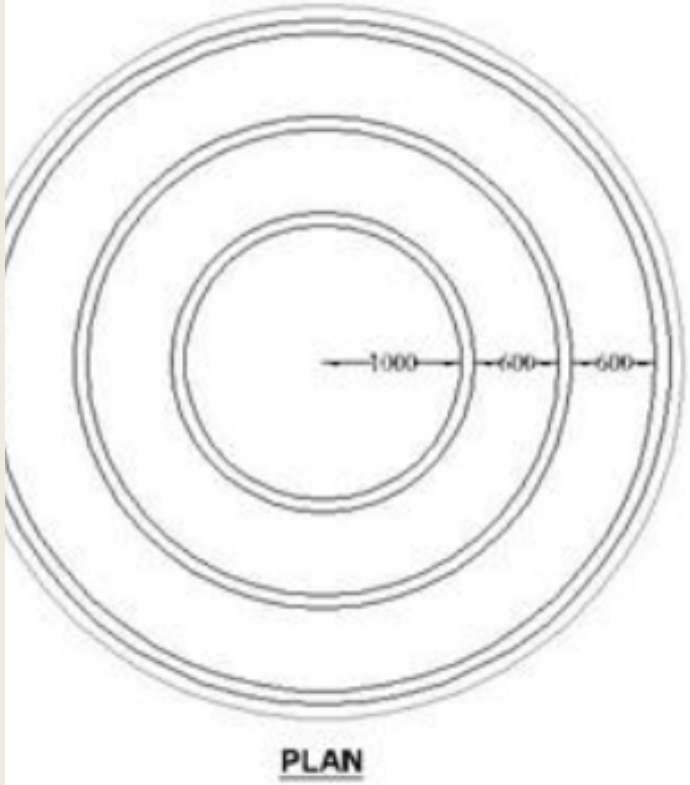
Type 8

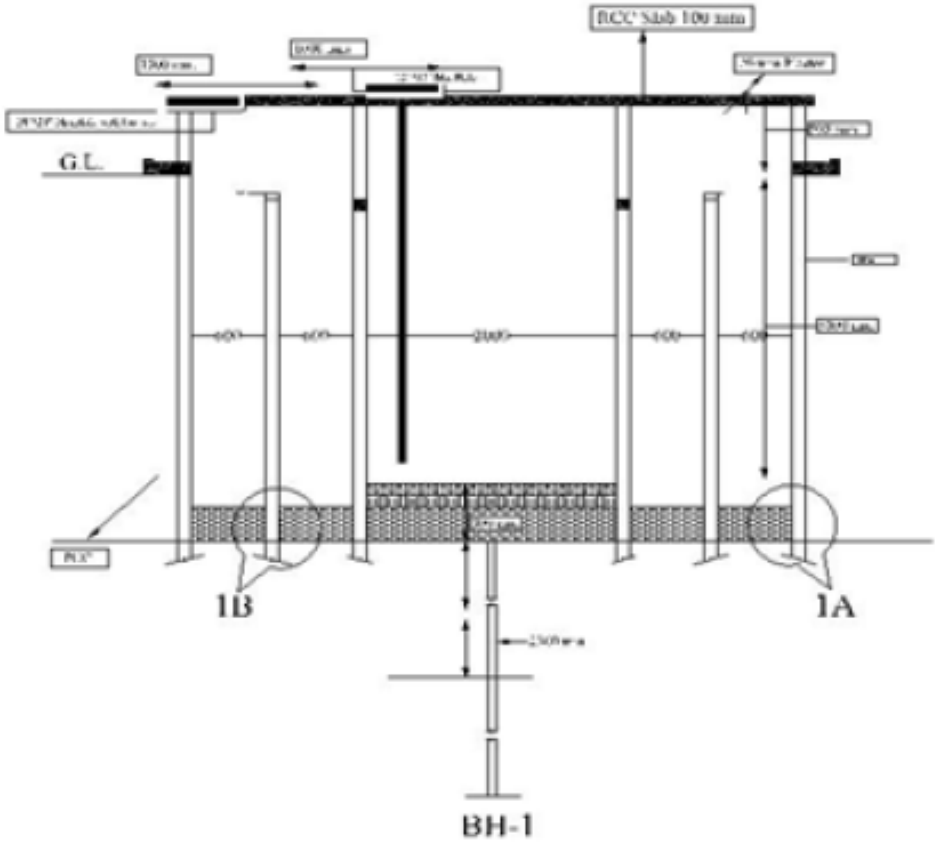


Dimensions:

Radius- 2.5 m.

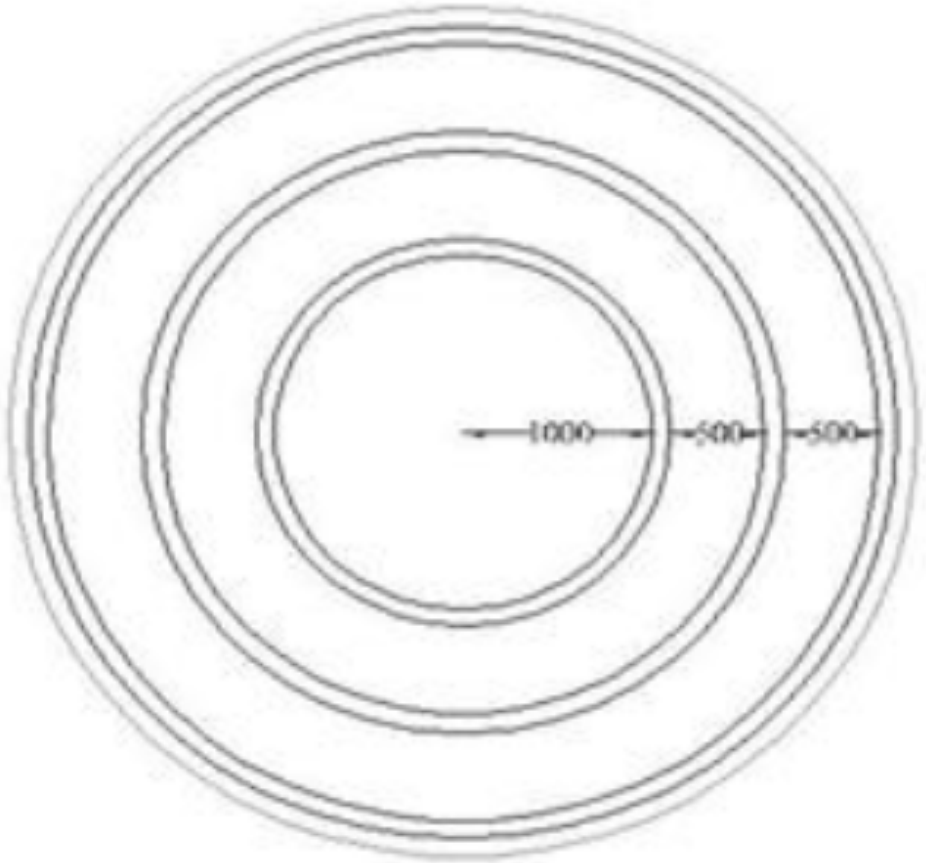
For Group Housing





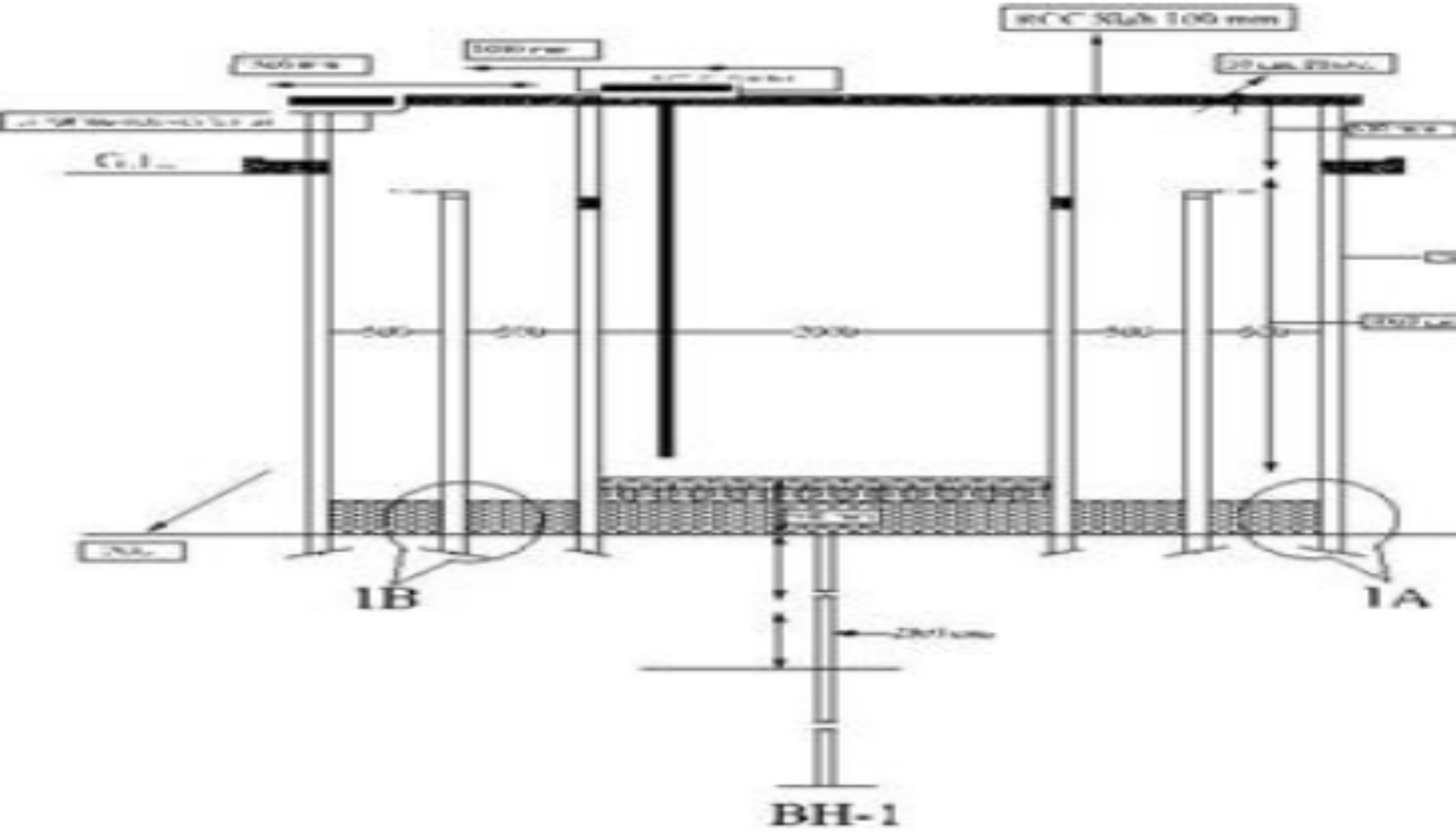
Plan and sectional elevation of injection well

- For Bunglows



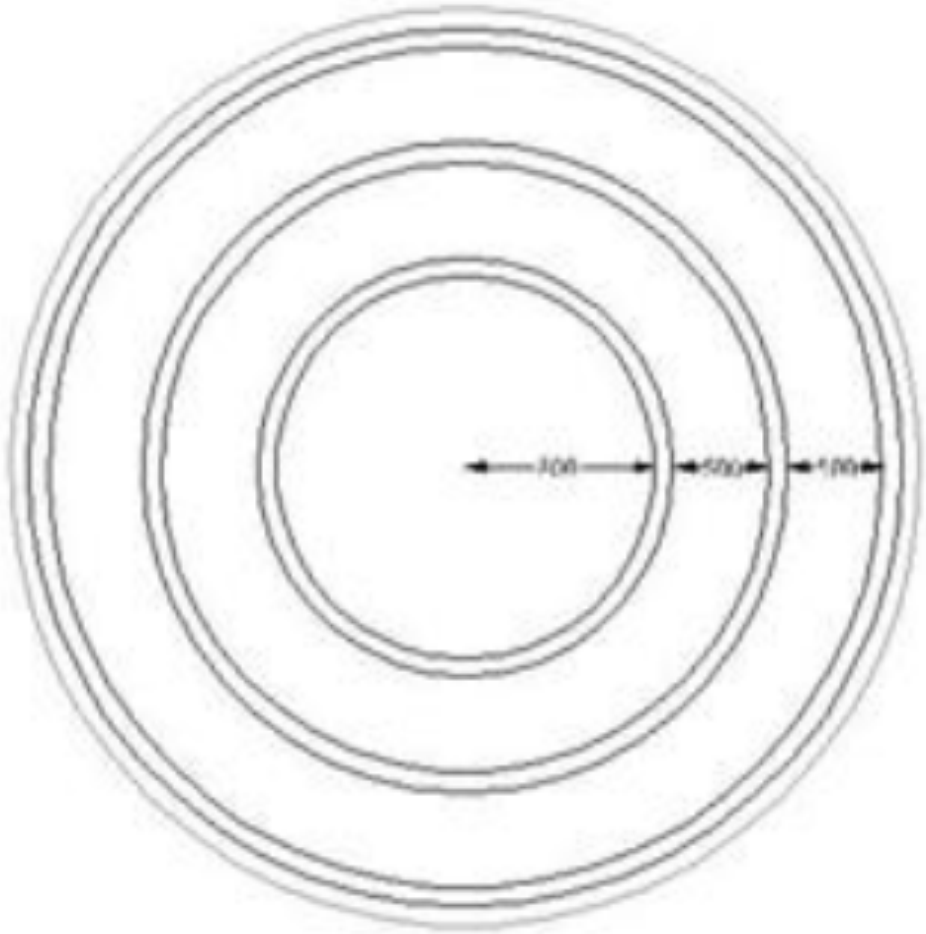
PLAN

Plan for bungalows



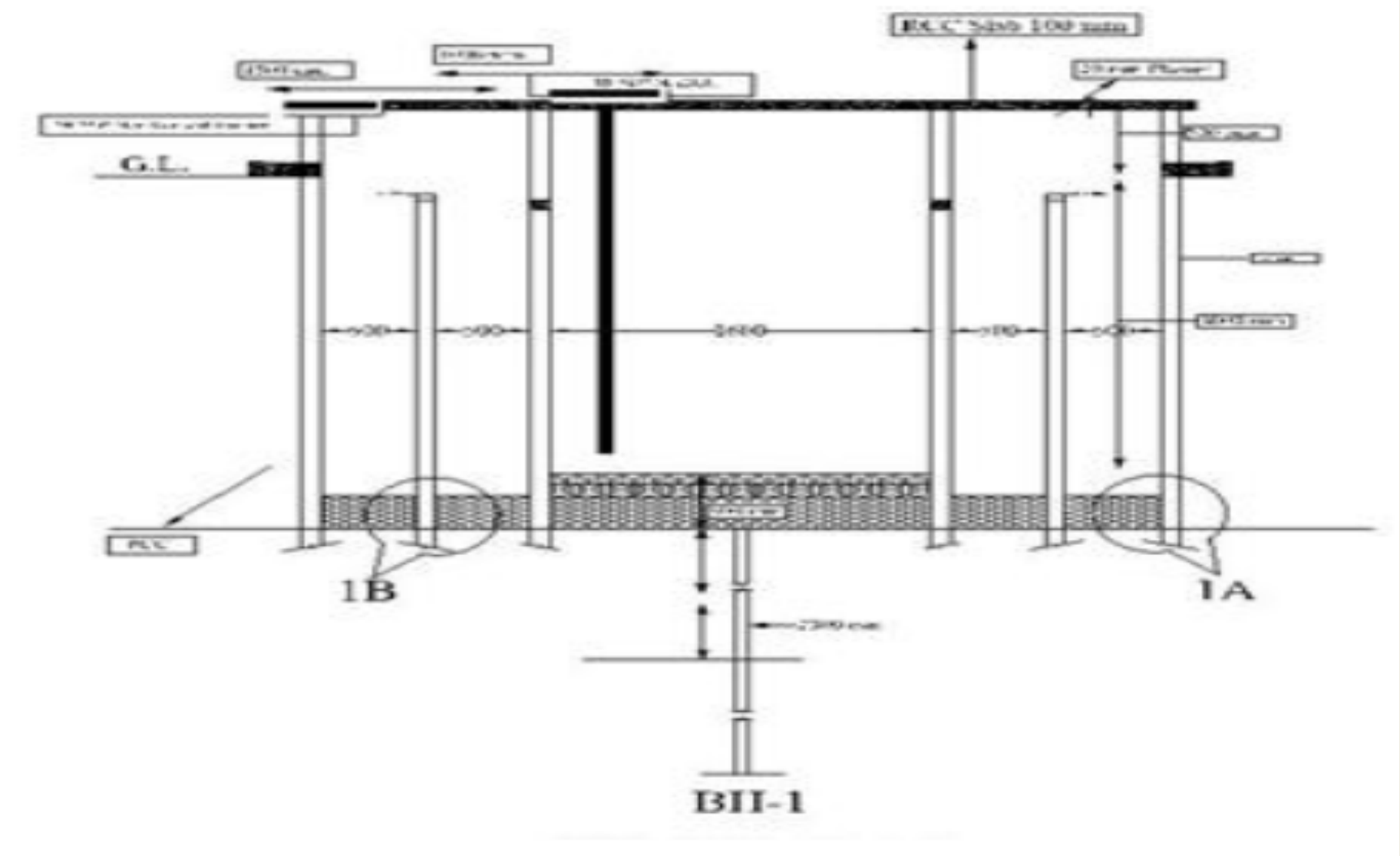
Sectional elevation

- For MIG/LIG



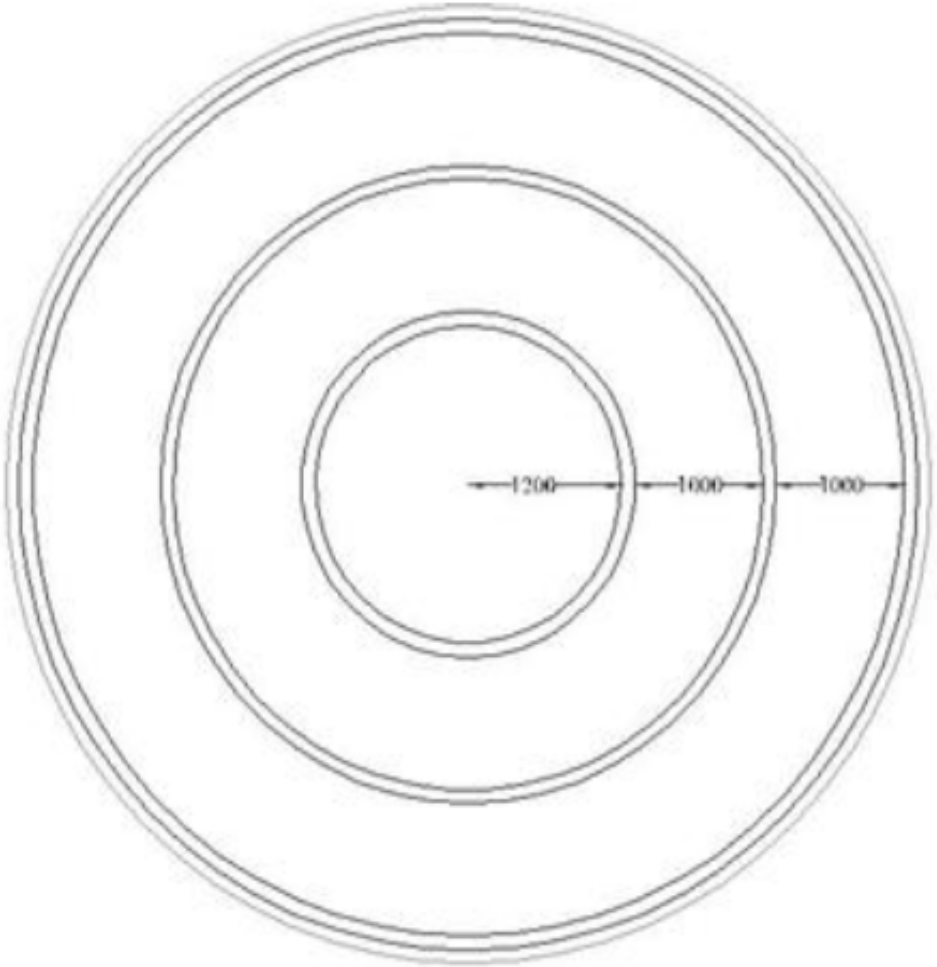
PLAN

Plan for LIG/MIG



Sectional elevation for LIG/MIG

- For Commercial, Institutional and Recreational areas



Plan for institutional areas

CONCLUSION

- The growing population and the rising demand for water have put a great deal of pressure on the natural resources. Underground water is depleting at a very fast rate and soon there will be shortage and scarcity of water all over the globe. If artificial methods are adopted then this problem can be solved. This report elaborates in detail the need and solution for the rainwater harvesting for the Indirapuram area in Ghaziabad. Rainwater harvesting will not only ensure flood control but it has other benefits like ensuring a continues dupply of water, pollution control etc.

- As per the discharge calculations for various intensities of floods we can conclude that rainwater in itself is not capable of augmenting the groundwater water table. So we need to employ rainwater harvesting structures.

RECOMMENDATIONS

- Zone wise distribution of structures should be done according to discharge calculated to augment groundwater in the area.
- Before construction of any building, proper planning should be carried out such that a watershed of the waterbodies is not disturbed.
- Apart from rainwater harvesting other methods like recycling water should also be used in every colony. This will ensure that water from kitchen and wash basins is being utilized again for irrigation and other such practices.
- Newer methods of water conservation should be adopted and scientific research should be encouraged for proper utilization of water.
- The general public should be made aware of the depleting groundwater and made conscious on the fact that fresh water is not be wasted.

REVITALISATION

- Ghaziabad's water bodies have had its important stages in its history. With the increasing development and industrial set-up here, most water bodies fell into disrepair or complete abandonment. Polluted water and contaminated land—legacies of factories along the Hindon and other water bodies—further drove people away from the shoreline.
- To enhance and preserve the unique qualities of these water bodies, there should be techniques to promote the development of lively, pedestrian-friendly, mixed-use riverfronts in and adjacent to municipal centers while conserving forests, farms, wetlands, and fields, and providing for a continuous public greenway corridor along the river. This land-use pattern will allow riverfront communities to accommodate and benefit from new development in ways that increase economic viability, enhancing main streets and community life while protecting the water body's ecology and aesthetics.

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thank
you!