



GEO-HYDROLOGICAL ASSESSMENT OF GROUNDWATER RECHARGE BY SHAFT AND PIT METHOD- A CASE STUDY OF SHREEYASH PRATISHTHAN CAMPUS, AURANGABAD, MAHARASHTRA, INDIA

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ABSTRACT

Groundwater is considered as the preferred source of water for meeting domestic, industrial and agricultural demand, due to its longer residence time in the ground, low level of contamination, wide distribution, and availability within the reach of the end user. Even the existing wells are getting dried-up due to depletion of ground water table as the natural recharge is not sufficient. Groundwater recharge is a basic imperative for efficient groundwater resource development and management, which is particularly vital for India with widely prevalent semi-arid and arid climate. In case the natural recharge is not sufficient, it has to be met through artificial recharge. To provide scientifically, appropriate locations to for constructing artificial recharge structures, each hydro-geomorphic unit will be evaluated for its recharge potential and a map showing such groundwater recharge potential information zones for appropriate recharge will be prepared. Using RS and GIS it is possible to take number of different thematic maps of the same area and overlay them on top of one another to form a new integrated layer. This study was aimed to identify the groundwater recharge potential zones, and Geohydrological assessment of ground water recharge had been made through this study. The ease of providing shafts/bores and the pits were assessed through this study. The well inventory study result shown that the level of ground water table is increase by 6.71m and that of nearby premises is increased by 3.66m these are very good and beneficial results.

Keywords: *Geographical Information System and Remote Sensing, Groundwater Recharge, Groundwater Assessment, Recharge Pit, Recharge Shaft, Recharge Wells and Well Inventory*



I INTRODUCTION

Water is essential for all dimensions of life. Water resources of country constitute of its vital assets. Over the past few decades use of water has increased and in many places water availability is falling to crisis level. More than 80 countries with 40 % of population are already facing the shortage of water. India is the largest user of groundwater resources in the world. The state of Maharashtra now again reels under the scarcity of water and frequent drought can be traced way back to historical times from 1801 years. State had faced as many as 44 episodes of droughts in the span of last 192 years. Geologically major part of state is covered by Deccan basaltic flow. Water and land are the basis things for the development of agriculture, industries and drinking water. Water table is decrease day by day due to increase in population and industries. Scarcity of water is due to highly yielding of water from earth. Soil erosion and low water table are crying evils of Satara Tanda village. Groundwater recharge is the replenishment of an aquifer with water from the land surface. It is usually expressed as an average rate of mm of water per year, similar to precipitation. In addition to precipitation, other sources of recharge to an aquifer are stream and lake or pond seepage, irrigation return flow, inter-aquifer flows, and urban recharge. In contrast to natural recharge; artificial recharge is the use of water to replenish artificially the water supply in an aquifer. Of all the factors in the evaluation of groundwater resources, the rate of recharge is one of the most difficult to derive with confidence. Estimates of recharge are normally subject to large uncertainties and spatial and temporal variability. The increasing demand for water has increased awareness towards the use of artificial recharge to augment ground water supplies. Stated simply, artificial recharge is a process by which excess surface-water is directed into the ground – either by spreading on the surface, by using recharge wells, or by altering natural conditions to increase infiltration – to replenish an aquifer. It refers to the movement of water through man-made systems from the surface of the earth to underground water-bearing strata where it may be stored for future use. Artificial recharge is a way to store water underground in times of water surplus to meet demand in times of shortage. An attempt is made towards the geo-hydrological assessment of the ground water recharge by the pits and shafts.

II MATERIALS AND METHODS

2.1 Description of Project Site

The study area named Shreeyash Technical campus at Satara Tanda in Aurangabad district of Maharashtra. The site having the Latitude is 19° 49' 05.24" N and Longitude 75° 19' 49.81"E. The area is located at outskirts of Aurangabad, Beed by-pass road at a distance of 8 km from Aurangabad City.

2.2 Climate & Rainfall

In the study area summer and winter minimum and maximum temperature ranges from 38° C to 42° C in summer season and 14°C to 29°C in winter season respectively. Avg. Wind velocity in the area is 3.5 km/hr. Average Evaporation is 4.7 mm in study area.

The study area receives its annual precipitation from south west monsoon. The average annual rainfall is 662.88 mm recorded for past 5 year from WALMI office Aurangabad. The minimum rainfall recorded 474.6 mm was in year 2012& maximum rainfall 809.10 mm in year 2013.

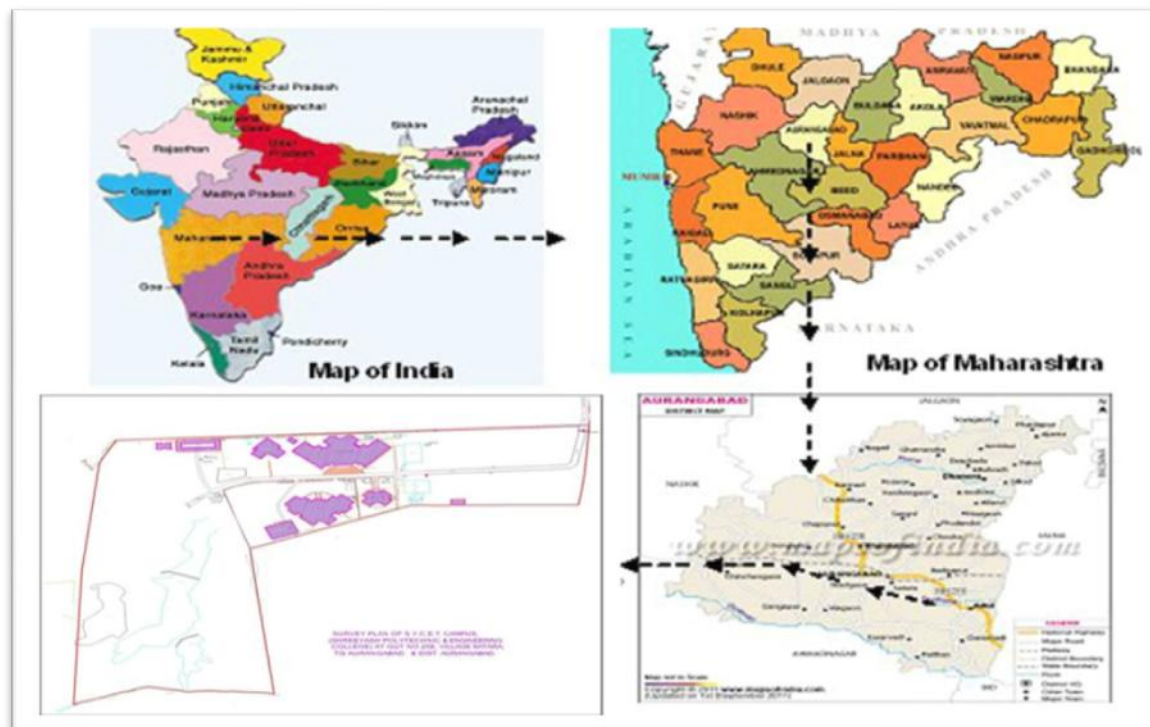


Figure 1: map of Aurangabad district showing location of the study area.

2.3 Geology

The major part (95%) of district constitutes a sequence of basaltic lava flows (Deccan trap) while alluvium occupies a small Portion. 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 is controlled by variation in geo-hydrological properties of these basaltic flows.

2.4 Morphometric Survey

The SOI Toposheet no. 47 M/5 and IRS P6 Satellite data is used to prepare the DEM and contour map of area were digitized and analyzed in Arc-GIS environment.

2.5 Well inventory survey- Investigation of 4 well, its depth, static water level, depth of water level, pumps used for drawing water, pumping hours etc. work is done in area.

2.6 Geology of Area

The master litholog of the area covered about 40.54m (RL 570.45 to RL 611.28 m) thick portion which shows different flows of basalts i.e. compact basalt, amygdaloidal basalt, jointed and unjointed basalt, etc.

Flow No.01: This flow is the compact basalt showing porphyritic texture, occurring in the well sections W1 and W2 in the low laying area. The top portion of the flow is unjointed. The presence of Phenocrysts of plagioclase may cause to percolation of water. The maximum thickness of the flow is 10.95 m observed from RL 570.45 m to RL581.40 m.

Flow No.02: The flow is Amygdaloidal basalt traced in well no. W1, W2, W3, W4. The flow is unjointed Amygdaloidal Basalt. Maximum thickness of flow is 4.57 m. The flow starts from RL 581.40 to RL 585.97 m.

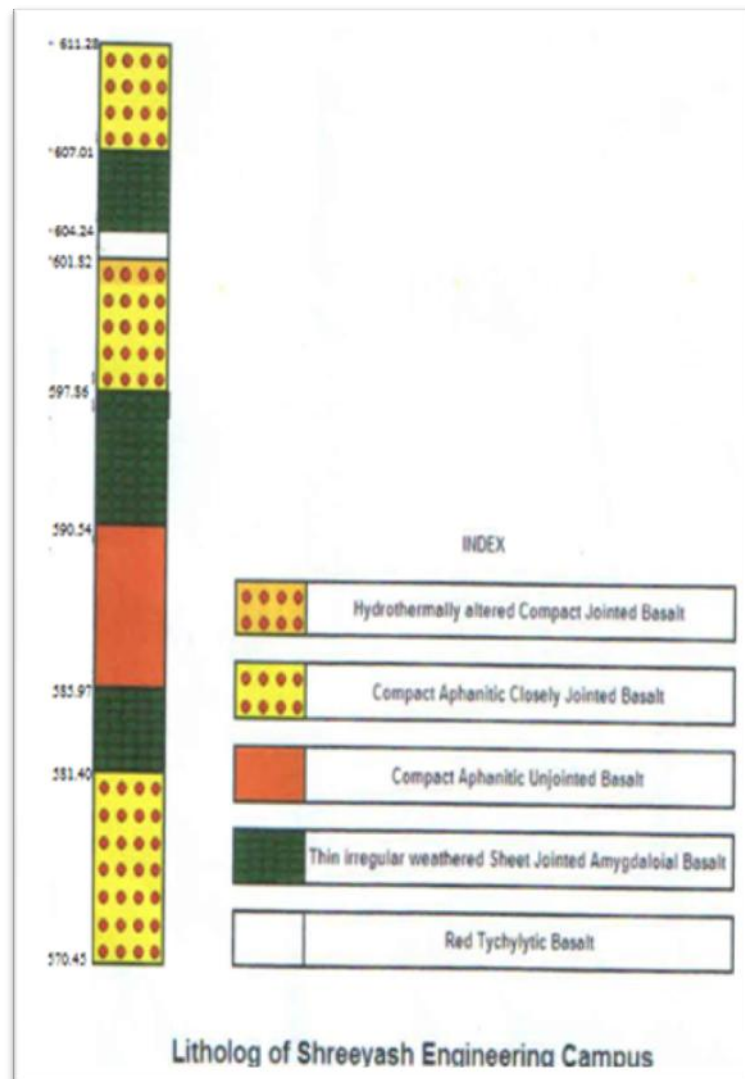


Figure 2: Lithology Map of Shreeyash campus- the study area.

Flow no.03: The flow Unjointed Compact basalt Showing Aphanitic Texture. It traced in well no W1, W2 and W4. Maximum thickness of flow is 4.57 m, flow Start from RL 585.97 to RL 590.54 m.

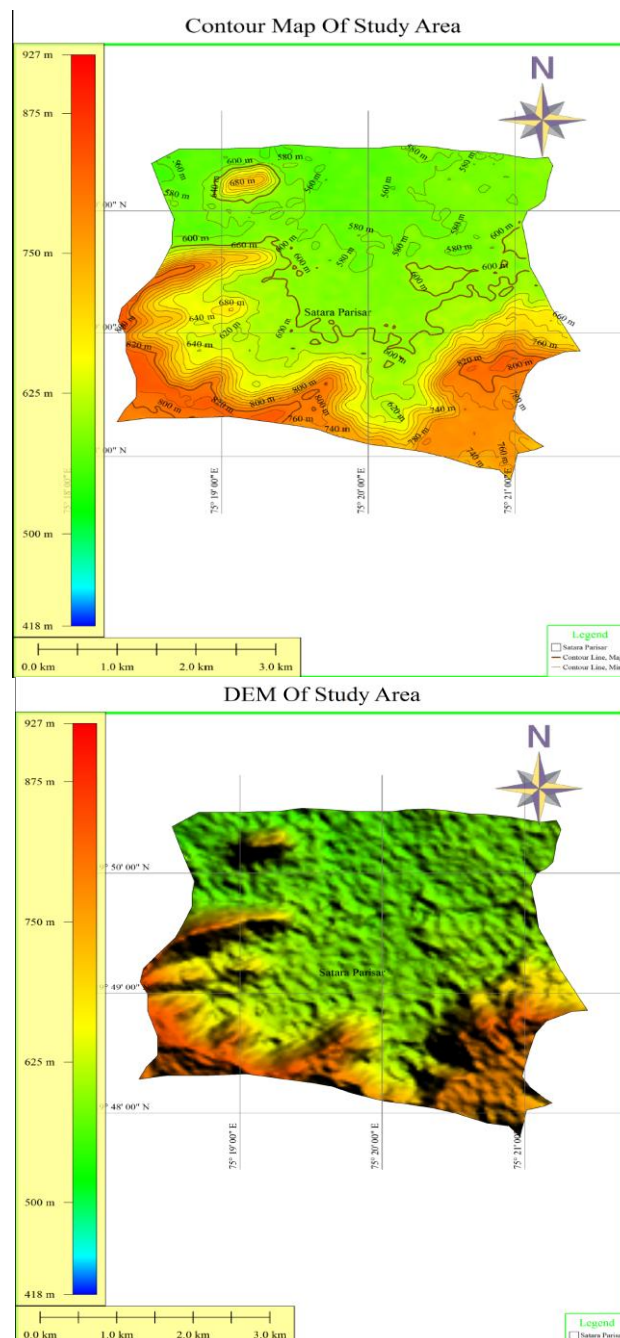
Flow No.04: The flow is irregular sheet jointed amygdaloidal basalt with small to medium sized amygdaloids filled with silica and zeolites. Flow is deeply weathered and has developed closely spaced sheet jointing. It is traced in well no.W1, W2, W3 and W4. The basal portion is aphanitic compact Basalt. Thickness of the flow is 7.32 m. The flow starts from RL 590.54 to RL 597.86 m.

Flow No.05: The flow is Sheet jointed Amygdaloidal basalts. The flow is broadly jointed and joints are not interconnected with each other and top portion of the flow is hydrothermally altered. The thickness of flow is 3.96 m. The flow starts from RL 597.86 to 601.82 m. The thickness of flow is 2.13 m. The flow start from RL 597.86 to RL 595.73 m.

Flow No.06: The flow is Compact aphanitic Basalt. Top portion of the flow is hydrothermally altered. The top and base of flow occupied by Red bole. The Maximum thickness of the flow is 2.44 m. The flow starts from RL 601.82 to RL 604.26 m.

Flow No.07: This flow is Irregular Amygdaloidal Basalt underlined by the Red bole. Top 4 m portion of the flow is hydrothermally altered. The total thickness of the flow is 2.75 m. the flow start from RL604.26 to RL 607.01 m. This flow is traced at vertical cut section of hills situated at South-West of the Shreeyash campus.

Flow No.8: This flow is compact aphanitic hard black colour basalt showing closely jointing. The top portion is sheeted where the middle portion shows amygdales. The total thickness of the flow is 4.27 m. The flow starts from RL 607.01 to RL 611.28 m.



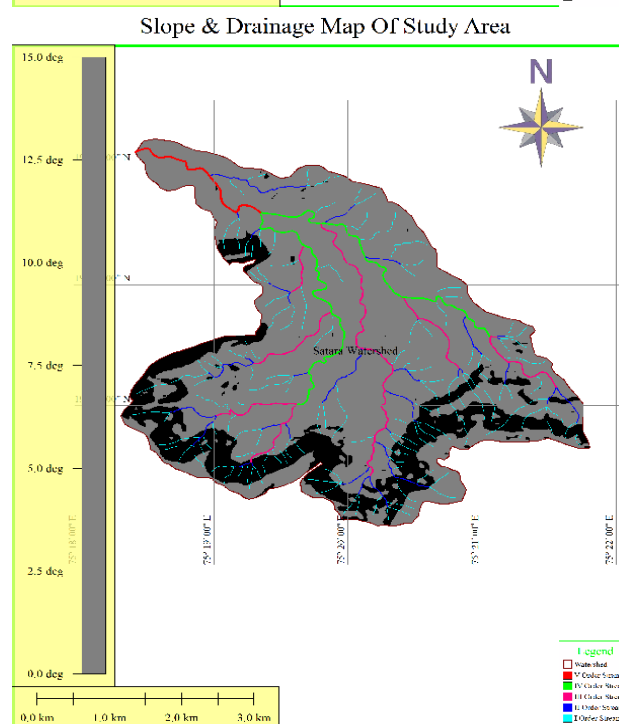
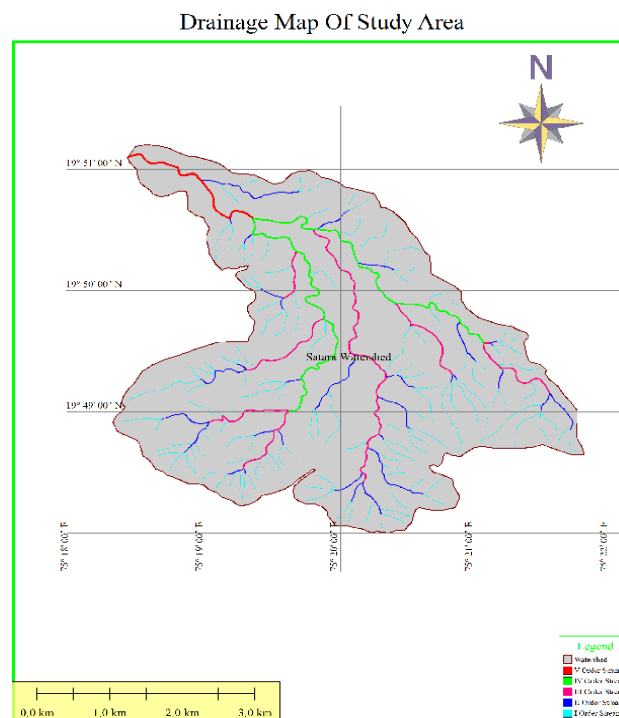


Figure 3: Map showing the Contour, DEM, Drainage map and slope & drainage map of the study area.

2.7 Data and Observation table:

TABLE 1 Rooftop area details of campus

Names	Roof top Areas (m ²)
College campus	217465.00
Engineering College rooftop area	5581.11
Polytechnic College rooftop area	3705.23
Pharmacy College rooftop area	960.61
Canteen & poly. workshop rooftop area	1112.95
Engineering workshop rooftop area	1086.33
Boys hostel rooftop area	1416.18
Staff quarter rooftop area	2401.16
Total Rooftop area	16263.57

TABLE 2 Details of percolation pits

Pits/ Pond	Location	Length (m)	Width (m)	Depth (m)	Volume(m ³)
Po 1	Pharmacy college	35	23	3	2415
Po 2	Boys hostel	38	20	3	2280
P1	Parking (fill agg. & sand)	4	4	5	80
P2	Stage	4	5	10.5	30
P3	Polytechnic	2.5	2	2.5	12.5
P4	Boys hostel	6	3.5	1.7	35.7
P5	Road junction	6	4.5	1.7	45.9
P6	Near well	4	7	3	84
P7	Near well be side	6	2.25	2.5	33.75
				Total	5017

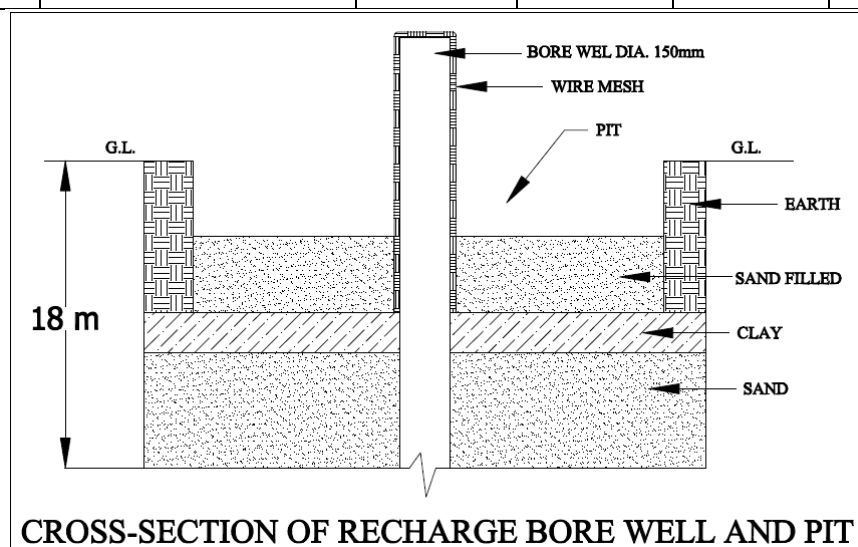


Figure 4: Cross-section of recharge bore well



TABLE 3 Bore holes/ recharge shafts

Bore/ shaft No.	Location	Elevation (m)	Dia (m)	Depth (m)	Area (m ²)	Volume (m ³)
B1	Near Pharmacy college pond	601	0.15	18.28	0.01767	0.3230
B2	Near Pharmacy college pond	601	0.15	18.28	0.01767	0.3230
B3	Pharmacy college	600	0.15	18.28	0.01767	0.3230
B4	Stage	599	0.15	18.28	0.01767	0.3230
B5	Boys hostel	602	0.15	18.28	0.01767	0.3230
B6	Road junction	602	0.15	18.28	0.01767	0.3230
B7	Polytechnic	600	0.15	18.28	0.01767	0.3230

III RESULT AND DISCUSSION

TABLE 4 Well Inventory Survey of Shreeyash Campus in satara parisar.

Dug well no.:			W1	W2	W3	W4
Elevation (m)			601	600	600	598
Depth of well (m)			18.28	18.28	18.28	19.81
water level bgl (m)	2013	April	14.62	14.02	13.62	14.02
		Dec	7.92	8.83	8.3	8.83
	2014	April	13.71	12.8	12.4	12.71
		Dec	8.53	7.92	7.64	7.92
	2015	April	14.62	14.02	14.62	14.62
		Dec	7.31	7.01	7.02	7.02
	2016	April	15.23	14.62	15.62	14.62
		Dec	3.04	1.82	1.62	1.02
Yielding of water (in hrs)	2013	Rainy	overflow	overflow	overflow	overflow
		Winter	1.5	2	2	2
		summer	Dry	Dry	Dry	Dry
	2014	Rainy	overflow	overflow	overflow	overflow
		Winter	2	3.5	3	3
		summer	Dry	Dry	Dry	Dry
	2015	Rainy	overflow	overflow	overflow	overflow
		Winter	2.5	2	2	2
		summer	Dry	Dry	Dry	Dry
	2016	Rainy	overflow	overflow	overflow	overflow
		Winter	5.2	5	4.9	5
		summer	3.5	3.8	3.2	3.3



Fluctuation(m)	2013	-	6.7	5.19	5.32	5.19
	2014	-	5.18	4.88	4.76	4.79
	2015	-	7.31	7.01	7.6	7.6
	2016	-	12.19	12.8	14	13.6

In the above table details about elevation, depth of dug well, water table level, yielding of water in different season and fluctuation has been discussed. There are 3 dug wells in the campus premises and 1 about 500m away from campus which is used for agricultural as well as domestic purpose. During surface survey and well inventory survey 4 dug wells are selected as observation wells depending upon topography, geography, drainage, hill ranges which may covers three sides of the campus. On the basis of above data the average depth of dug well is about 18.29m and the average water table depth below ground level in winter and summer season of 2013 and 2014 is 14.63m, 7.92m, 13.72m and 8.53m respectively. In rainy season, water table level is very high and in winter season water table level decreases up to 10.65-12.20m and during summer maximum dug wells become dry. Hence campus is facing water scarcity problem during summer season for drinking purpose also. But after adopting artificial recharge method i.e. the pits & bores/shafts for ground in summer 2015, the water table depth below ground level in winter and summer season of 2016 is 3.04m, 15.24m respectively.

Mainly, recharge by shaft method is adopted for ground recharge is very effective on highly basaltic ground rock. Also pits are very much helpful for providing the runoff water from ground.

Geological survey provides a systematic knowledge of occurrence, composition, character and properties of rocks of Shreeyash campus. On the basis of surface geo-hydrological survey and well Inventory survey data preparation of litholog and geological maps has been prepared indicating various water levels after and before adopting artificial recharge method in the area. Their geo-hydrological characters favorable or unfavorable for percolation of water are being discussed here. The groundwater availability quantitatively is limited. Availability of groundwater depends on proportion of rainfall which percolates in to the rocks in general but in Deccan trap availability of the groundwater depends on a numbers of factors along with rainfall are geological, geomorphological, geohydrological and infiltration rates.

Geological; Geo-hydrological & water table Survey of Shreeyash campus, Aurangabad in satara parisar watershed carried out during April-2013 to dec2013, April-2014 to dec-2014, April-2015 to dec-2015, April-2016 to Dec-2016. Initially surface survey & then well inventory survey is carried out at Shreeyash campus. In campus 4 dug wells are selected as an observation wells depending upon topography, geography; river system and hilly ranges which may cover three sides of college. In each dug well water table, total yielding of water in winter & summer, total numbers of basaltic flows present in section of wells. Elevation of each dug well is determined with the help of GPS. Depending upon these Geo-hydrological character & geography of area litholog, water table graph of campus is prepared; from litholog of campus Geology Map of campus is prepared. On the basis of geological suggestion 7 bore holes were driven upto depth 10m. Three pits were excavated having size 10m x 10m x 10m. In winter 2015 the pits were excavated. After excavating shafts and pits the water table in year 2016 had increased by 6.70m. After adopting this method the problems in the campus

premises had been solved. Due to this the surrounding area water level of campus premises had also increased by 3.04m-3.65m.

TABLE 5 Glimpse in rainy season of the Groundwater Recharge structures at Shreeyash Campus Aurangabad.

Situation before the GW recharge	Situation after the GW recharge
 W1 water level is much bgl	 W1 water level bgl
 Po1 position before	 Po1 position after
 Po2 position before	 Po2 position after

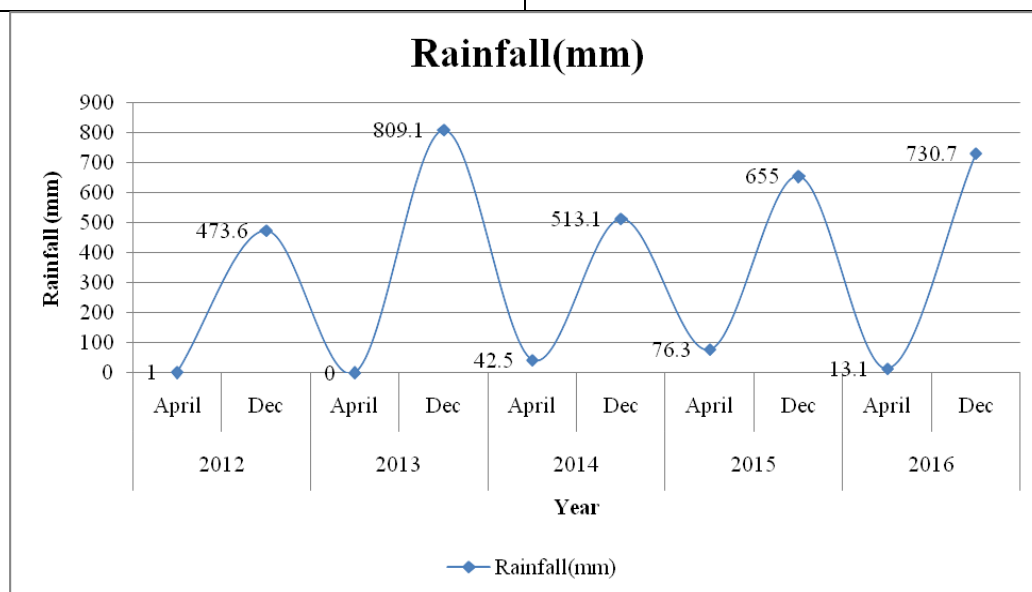
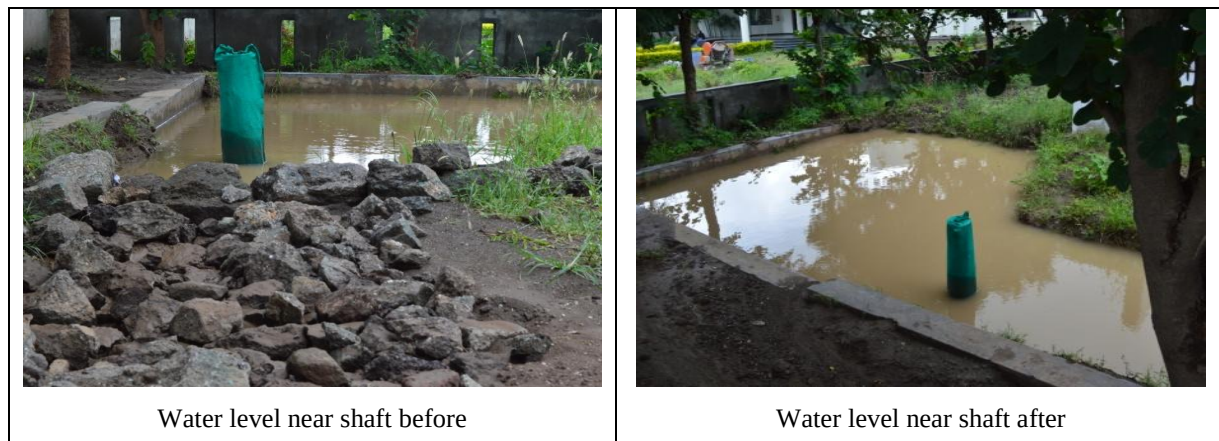


Figure 5: Pre-monsoon and post monsoon annual precipitation over the study area

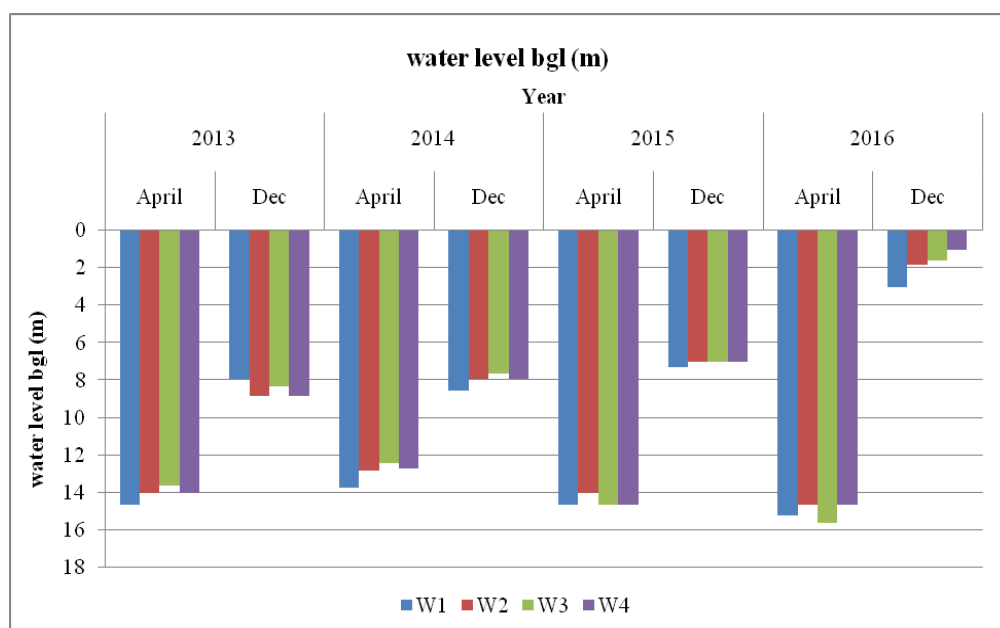


Figure 6: Graph showing water level below ground level from 2013 to 2016

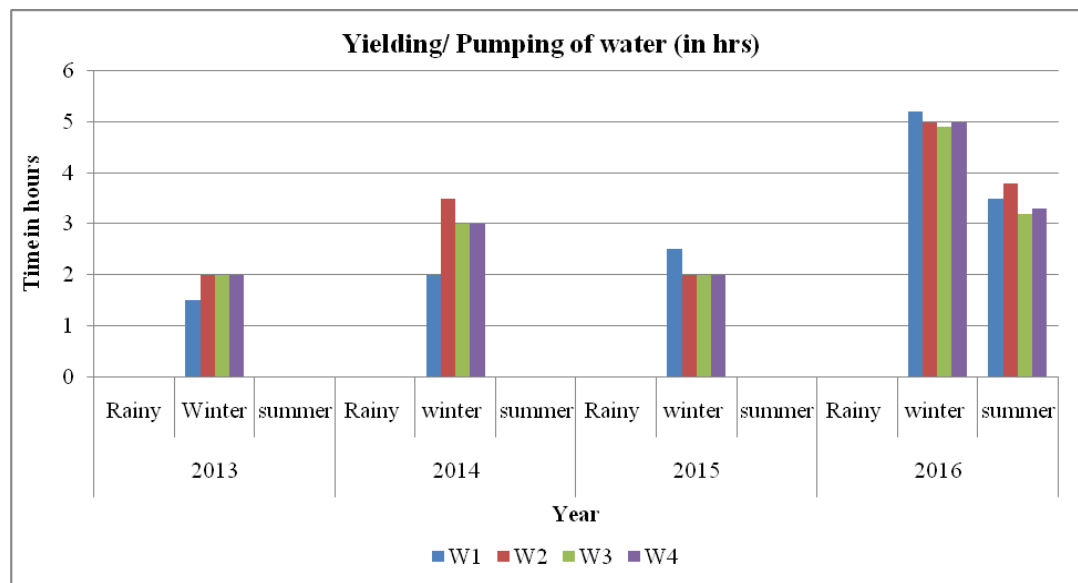


Figure 7: Graph showing Yielding/ Pumping of water (in hrs) from 2013 to 2016

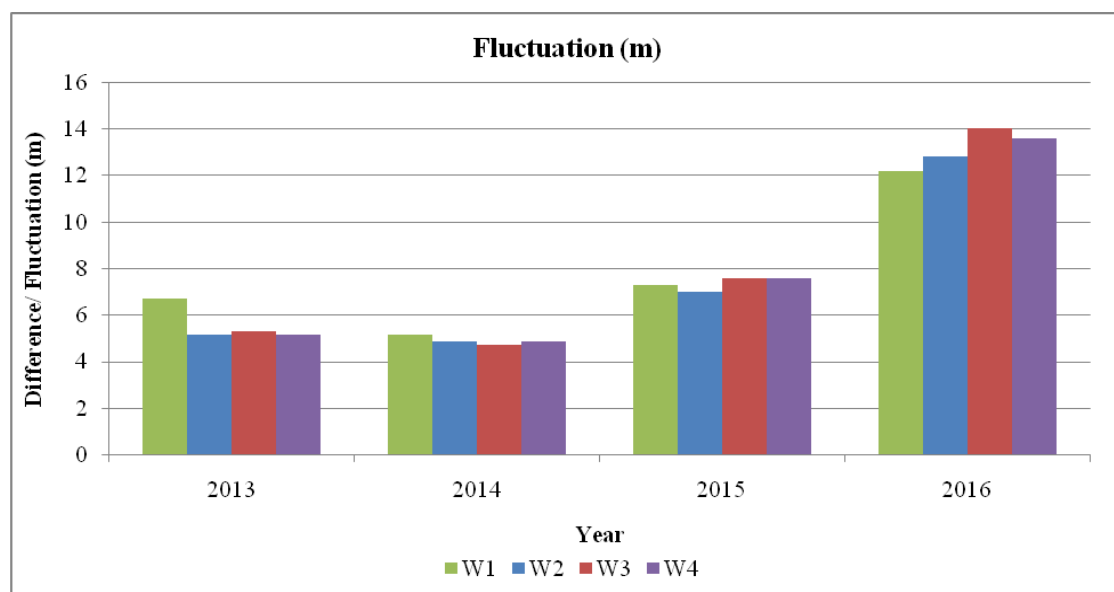


Figure 7: Graph showing Fluctuation (in m) between pre-monsoon and post monsoon

IV. CONCLUSION

Shreeyash campus occupies an area of about 217465.00 m² in satara parisar Aurangabad. The area is located at outskirts of Aurangabad geographically. The entire campus occupied by deccan basalt. shreeyash campus is in highly dissected plateau and in highly dissected plateau runoff will be more and percolation is less, on the basis of geological survey artificial recharge method i.e. shaft/bore and pit method have been implemented. in pre-monsoon of 2016 in which 7 bore holes are taken in the campus and 7 pits, having different sizes and 2 ponds were excavated to enhanced ground water level. The well inventory study result shown that the level of ground water table is increase by 6.71m and that of nearby premises is increased by 3.66m these are very good and beneficial results.

**V. ACKNOWLEDGMENT**

The authors are extremely grateful to Chairman Er. B. Mangrule, the technical Director Dr. U. B. Kalwane, Site engineer Er. Deepak Pawar, Mr. Singh sir Shreeyash campus for the Support and Encouragement to the authors during the course of this work.

TABLE 6 Appendix- A (Abbreviations)

Abbreviation	Description	Abbreviation	Description
RS	Remote sensing	P	Pit
GIS	Geographical information system	Po	Pond
SOI	Survey of India	B	Bore well
GPS	Global positioning system	m	Meter
RL	Reduced level	mm	millimeter
bgl	Below ground water level	hrs	hours
N	North	°C	Degree Celsius
S	South	m ²	Square meter
W	Well	m ³	Cubic meter
WALMI	Water & Land Management Institute	km	kilometer
DEM	Digital Elevation Model	GW	Ground water

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