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Rainwater Harvesting and Ground Water Recharging in Gcoeara Campus

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***Abstract*:- At the rate in which Indian population is increasing, it is said that India will surely replace China from most densely populated country in the world after 2020-2030. These will lead to high rate of consumption of most valuable resource 'water'. In order to conserve and meet our daily demands of water requirements, we need to think for alternative cost effective and relatively easier method of conversing water. During monsoons lots of water goes waste into gutters, drains. Rainwater harvesting is one of the best method fulfilling those requirements as it increases the ground water level and aquifers. The technical aspect of this report is harvesting of rainwater which is collected from rooftop which is considered to be catchment areas from all institutional buildings at Govt. college of engineering and research, awasari campus and using it for ground water table recharging.**

The campus of this institute is situated at the western end of Awasari (khurd) village, on the land provided by the Government of Maharashtra. The institute area is surrounded by the residential areas. Residential accommodation is provided to all faculty, staff and students. There are six departments and two boy's hostels and one girl hostel for the residence of students and fourteen staff quarters for faculties and staff. Hence, total strength of campus including students and staffs people will be more than 2,000 and it's still under the expansion project adding more number of students and faculty person and increasing facilities by enhancing infrastructures.

First of all, required data are collected i.e. college layout, catchment areas, hydrological rainfall data, ground water level in that area, system of collection of sewage, stromwater, ground profile, GIS analysis etc. then using this data an effective and efficient rainwater harvesting and ground water recharging system is proposed for Govt. college of engineering and research, awasari campus.

The best part of the practice of rainwater harvesting, is that in one hand it is checking one from leaning towards using groundwater as rainwater is obtained in abundance in that area. On the other hand , if remains unused or extra this rainwater collected in ponds or even in artificial tanks can be used for future consumption or for recharging aquifers to increase the ground water level.

Key words: Rainwater water Harvesting, Ground water Recharge, Recharge Pit, Pipe Joints, etc.

CHAPTER 1
INTRODUCTION

1.1. RAINWATER HARVESTING SYSTEMS AND ITS FEATURES

Rainwater Harvesting is a simple technique of catching and holding rainwater where it falls. Either, we can store it in tanks or we can use it to recharge groundwater depending upon the situation and requirement.

- Ease in constructing system in less time.
- Economically cheaper in construction compared to other sources, i.e. dams, diversion, etc. Rainwater harvesting is the ideal situation for those areas where there is inadequate groundwater supply or surface resources.
- Helps in utilizing the primary source of water and prevent the runoff from going into sewer or storm drains, thereby reducing the load on treatment plants.
- Recharging water into the aquifers which help in improving the quality of existing groundwater through dilution.

1.2. COMPONENTS OF RAINWATER HARVESTING SYSTEM

A rainwater harvesting system comprises of components for - transporting rainwater through pipes or drains, filtration, and tanks for storage of harvested water. The common components of a rainwater harvesting system are:-

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1. **Catchments:** The surface which directly receives the rainfall and provides water to the system is called catchment area. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanized iron or corrugated sheets can also be used for water harvesting.
2. **Coarse Mesh**: It prevents the passage of debris, provided in the roof.

Figure 1: Components of Rainwater Harvesting system

3. **Gutters**: Channels which surrounds edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and mostly made locally from plain galvanized iron sheet. Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed mainly depends on the construction of the house, mostly iron or timber brackets are fixed into the walls.
4. **Conduits:** Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Commonly available conduits are made up of material like polyvinyl chloride (PVC) or galvanized iron (GI).
5. **First-flushing**: A first flush device is a valve which ensures flushing out of first spell of rain away from the storage tank that carries a relatively larger amount of pollutants from the air and catchment surface.
6. **Filters**: The filter is used to remove suspended pollutants from rainwater collected from rooftop water. The Various types of filters generally used for commercial purpose are Charcoal water filter, Sand filters, Horizontal roughing filter and slow sand filter.
7. **Storage facility**: There are various options available for the construction of these tanks with respect to the shape, size, material of construction and the position of tank and they are:-

   - **Shape**: Cylindrical, square and rectangular.
   - **Material of construction**: Reinforced cement concrete (RCC), masonry, Ferro cement etc.
   - **Position of tank**: Depending on land space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like disinfection and cleaning are required to ensure the quality of water stored in the container.

8. **Recharge structures**: Rainwater Harvested can also be used for charging the groundwater aquifers through suitable structures like dug wells, bore wells, recharge trenches and recharge pits. Various recharge structures are possible - some which promote the percolation of water through soil strata at shallower depth (e.g., recharge trenches, permeable pavements) whereas others conduct water to greater depths from where it joins the groundwater (e.g. recharge wells). At many locations, existing structures like wells, pits and tanks can be modified as recharge structures, eliminating the need to construct any fresh structures. Some of the few commonly used recharging methods are recharging of dug wells and abandoned tube wells, Settlement tank, Recharging of service tube wells, Recharge pits, Soak ways /Percolation pit , Recharge troughs, Recharge trenches, Modified injection well.

1.3. OBJECTIVES OF RAINWATER HARVESTING IN GCOEARA CAMPUS

- To meet the increasing demand of water.
- To reduce the run-off which chokes the drains.
- To avoid the flooding of roads.
- To raise the underground water table.
- To reduce groundwater pollution.
- To reduce soils erosion.
- Supplement domestic water needs.

The campus of this institute is situated at the western end of Awasari (khurd) village, on the land provided by the Government of Maharashtra. The institute area is surrounded by the residential areas. Residential accommodation is provided to all faculty, staff and students. There are six departments and two boy's hostels and one girl hostel for the residence of students and fourteen staff quarters for faculties and staff. Hence, total strength of campus including students and staffs people will be more than 2,000 and it's still under the expansion project adding more number of students and faculty person and increasing facilities by enhancing infrastructures.

Thus, with this present strength and also with the expansion programmes, campus should also increase its facilities and maintenance requirements. Thus water is the most natural resource which is being always in high demands by human being and is indispensable part of the life. If this demand is not met, then it will lead to water scarcity. Now on days, water scarcity has become the most common problem in every parts of India. And, this problem is also being profoundly seen in the college hostel and staff quarters inside the campus. And, if it has not been dealt earlier with proper care then this problem will become a major hurdle in the development phase of campus and the standard of living of will declining.
Hence, keeping in view all the above problems and status of campus, Government College of Engineering and Research, Awasari (Khurd) administrative body should focus more on the water scarcity problem. Therefore, in this situation, Rainwater harvesting system can be considered as a best solution for fighting against scarcity of water inside campus. Moreover, owing to its simple technique, ease of construction & installation and low cost of investment, this technique again suites for implementation inside GCOEARA campus. Rainwater harvesting can meet potable and non-potable water demands and also control flooding. Again, this non-potable harvested rainwater can be best utilized for purpose of constructing new infrastructure building, gardening, etc. which reduces the investment to be made for filtration purpose. And in this way, campus can easily meet the potable water demand and also able to save money which is being spends for procuring potable-water. In this way potable water can be conserve and harvested rainwater plays major part in conserving it. Rainwater harvesting also helps in increasing the soil moisture condition and fertility factor of soil for plantation. Hence, this simple technique tends to increase the greenery surrounding the campus, increasing aesthetic factor for a proper residential institute to live in. Thus in that similar way, rainwater harvesting systems has endless advantages without any harmful disadvantages or if there are any, then it must be negligible.

Hence for water scarcity, Rainwater harvesting is seems to be a perfect replacement for surface & ground water as later is concerned with the rising cost as well as with ecological problems. Therefore, Rainwater harvesting is highly recommended for campus of GCOEARA.

1.4. STUDIES CARRIED OUT GLOBALLY

Today due to rising population & economic growth rate, demands for the surface water is increasing exponentially. Rainwater harvesting is seems to be a perfect replacement for surface & ground water as later is concerned with the rising cost as well as ecological problems. Thus, rainwater harvesting is a cost effective and relatively lesser complex way of managing our limited resources ensuring sustained long-term supply of water to the community. In order to fight with the water scarcity, many countries started harvesting rain. Major players are Germany (Biggest harvesting system in Germany is at Frankfurt Airport, collecting water from roofs of the new terminal which has an large catchment area of 26,800 m^2), Singapore (as average annual rainfall of Singapore is 2400 mm, which is very high and best suited for rainwater harvesting application), Tokyo (as RWH system reserves water which can be utilized for emergency water demands for seismic disaster), etc.

1.5. STUDIES CARRIED OUT IN INDIA

Today, only 2.5 per cent of the entire world's water is fresh, which is fit for human consumption, agriculture and industry. In several parts of the world, however, water is being used at a much faster rate than can be refilled by rainfall. In 2025, the per capita water availability in India will be reduced to 1500 cubic meters from 5000 in 1950. The United Nations warns that this shortage of freshwater could be the most serious obstacle to producing enough food for a growing world population, reducing poverty and protecting the environment. Hence the water scarcity is going to be a critical problem if it is not treated now in its peanut stage. Contrasting figures of water scarcity in world between two timeline (1999 & 2025) are shown in the fig. 2 & fig 3. Some of the major city where rainwater harvesting has already implemented is Delhi (Centre for Science and Environment's (CSE) designs sixteen model projects in Delhi to setup rainwater harvesting structures in different colonies and institutions), Bangalore (Rainwater harvesting at Escorts- Mahle-Goetze, Designed by S Vishwanath , Rainwater club, http://www.rainwaterharvesting.org/People/innovators-urban.html), Indore (Indore Municipal Corporation (IMC) has announced a rebate of 6 per cent on property tax for those who have implemented the rainwater harvesting work in their house/bungalow/building). Source:

The below photographs was the result shown in the website:

http://www.rainwaterharvesting.org/crisis/CrisisScarcity.html

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Figure 2: About 450 million people in 31 countries (shaded) face a serious water shortage

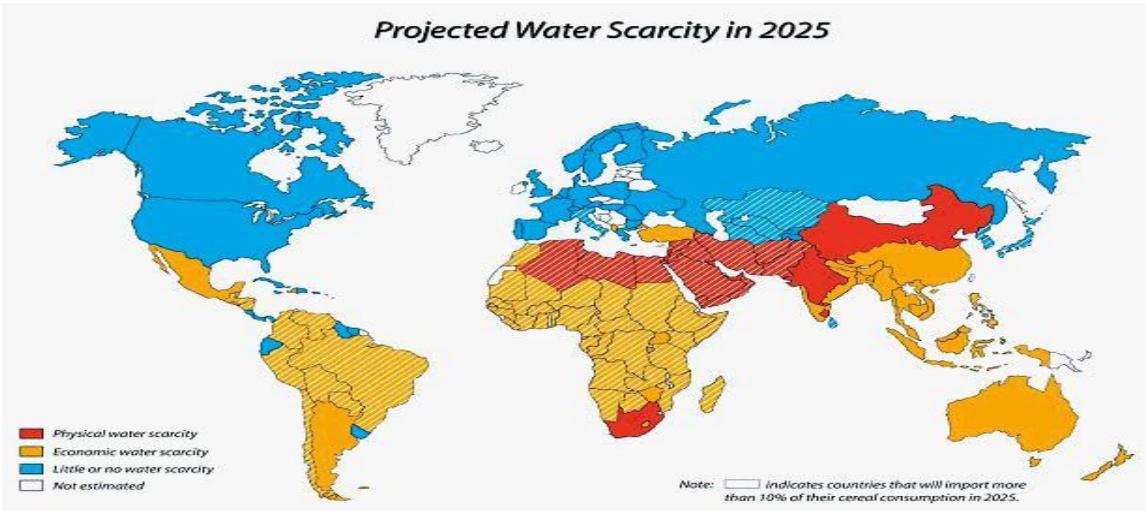

Figure 3: About 2.8 billion people in 48 countries (shaded), including India, are expected to face water shortages

CHAPTER 2

LITERATURE REVIEW

2.1 Ayog J. L., Bolong, N. and Makinda J. (2015):

This study highlights the findings from a preliminary feasibility investigation in the proposed rainwater harvesting systems in University Malaysia Sabah, in support of the Eco- Campus initiative. Since its inception was on 7th February 2013, the initiative strives to promote the blend of campus development and ecological sustainability. Hence, in line with this aspiration, rooftop rainwater harvesting (a form of green infrastructure) was introduced to selected residential colleges in the campus and assessed for its potential in supplying untreated water for non-consumptive activity as well as in reducing the water bill. For the purpose of rainwater tank design, the roof catchment area is needed to estimate the tank size, which then be multiplied with the average annual rainwater yield from the nearest rainfall gauging station. The percentage of water yield over rainwater demand is then calculated to estimate how much does the harvested rainwater could cater the water demand of the consumers. The water bill saving is calculated by multiplying the latest water tariff and the volume of the harvested rainwater, while the water demand is approximated by multiplying the number of users in the colleges with the average water use per person. The supply-demand assessment is performed to determine the potential impact of rainwater harvesting system installation in replacing paid, treated water for non-potable use in these premises. It is hoped by promoting green infrastructures in the campus to conserve natural resources as presented in this study aids the university in achieving its sustainable campus status by the year 2018.

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This preliminary assessment on the proposed rainwater harvesting system in University Malaysia Sabah brings out the potential of using this method in line with the Eco- Campus initiative. Rooftop rainwater harvesting is considered to be a form of green infrastructure due to its contribution to sustainable water resources management. The results of the study shows that the installation of rainwater harvesting system in residential buildings in Kolej Kediaman Kampung E and Kolej Kediaman Sri Angkasa can reduce the dependence of treated pipe water up to 21,985 m^3 per year and save water bills up to RM 25,579.89 annually. If rainwater harvesting system is to be properly installed, uncertainties such as the number of consumers, average consumption per person and range of uses should be addressed.

2.2 Utsav R. Patel, Manjurali I. Balya, Harshad M. Rajgor (2014):

India is land of versatile whether where inconsistency in rain is frequent. So as an option of having a back-up for water needs, one system becomes necessary which provides much saving of water; would be helpful in reducing wastage of water. Although rainwater harvesting (RWH) is gaining popularity as a sustainable water saving system in urban as well as rural areas, estimating required storage area for water remains an important design challenge so we have design an effective plan by which we can collect rain water into a storage for a particular campus and we also design by which we can collect water to the ground and use it for a domestic purpose. Present paper majorly focuses on Rooftop rainwater harvesting (RRWH) of the study area as Sankalchand Patel Sahakar Vidhyadham (S.P.S.V.) Campus, Visnagar. The prime objective of this paper is to fulfill the scarcity of the water in the campus and then it need to be use it for domestic & drinking water supply.

Campus detailing was done under this project and we have details below:

a. Average annual rainfall ranges between 700-800 mm/annum.

b. S.P.S.V. campus = 68.5 acres (277209.66 m^2)
c. Total catchment area = 31342.28 m^2(7.745 acres)
d. Total quantity of rainfall = 26671.37 m^2

Hence it was finally concluded that implementation of RAINWATER HARVESTING PROJECT to the campus of S.P.S.V. will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface. By implementation in water harvesting project in S.P.S.V. campus we can make little noble cause for rain water conservation which will be beneficial to the students of campus. It may also helpful to the campus. Our campus will become an example to others for rain water harvesting and if our campus would apply this than surely it will be in benefit. This paper fulfilled with all aspect of improving the water scarcity problem in the S.P.S.V. campus by implementing ancient old technique of rainwater Harvesting.

CHAPTER 3

METHODOLOGY AND DATA COLLECTION

3.1 METHODOLOGY

3.1.1. HYDROLOGICAL ANALYSIS

On the basis of experimental evidence, Mr. H. Darcy, a French scientist enunciated in 1865, a law governing the rate of flow (i.e. the discharge) through the soils. According to him, this discharge was directly proportional to head loss (H) and the area of cross-section (A) of the soil, and inversely proportional to the length of the soil sample (L). In other words,

$$\boxed{Q \propto \frac{H}{L} . A}$$

Q = Runoff (m^3/s) H = Head loss (m)
L = length of the soil sample (m)
A = Area of cross-section of the soil(m^2)

Here,

H/L represents the head loss or hydraulic gradient (I), K is the co-efficient of permeability Hence, finally,

$$Q = K.\ I.\ A.$$

Similarly, based on the above principle, water harvesting potential of the catchment area was calculated.

The total amount of water that is received from rainfall over an area is called the rainwater legacy of that area. And the amount that can be effectively harvested is called the water harvesting potential. The formula for calculation for harvesting potential or volume of water received or runoff produced or harvesting capacity is given as:-

Harvesting potential or Volume of water Received (m^3)
= Area of Catchment (m^2) X Amount of rainfall (mm) X Runoff coefficient

Runoff coefficient for any catchment is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. Runoff coefficient accounts for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all contribute to reducing the amount of runoff. Runoff coefficient varies from 0.5 to 1.0. In present problem statement, runoff coefficient is equal to 1 as the rooftop area is totally impervious. Eco-Climatic condition (i.e. Rainfall quantity & Rainfall pattern) and the catchment characteristics are considered to be most important factors affecting rainwater Potential. Given below the table showing the value of runoff coefficient with respect to types of surface areas:-

Sr. No.	Type of Area	Value of K		
		Flat land 0-5 % slope	Rolling land 5%-10% slope	Hilly land 10%-30% slope
1.	Urban areas	0.55	0.65	-
2.	Single family residence	0.30		
3.	Cultivated areas	0.5	0.6	0.72
4.	Pastures	0.30	0.36	0.42
5.	Wooden land or forested areas	0.30	0.35	050

Table 1: Value of Runoff Coefficient

Source: Table 7.31, Chapter Hydrology and runoff computation, Irrigation Engineering & Hydraulic Structure, by Garg, S.K.

3.1.2. METHODS FOR GROUND WATER RECHARGING

<u>Method 1. Spreading Basins:</u>

This method involves surface flooding of water in basins that are excavated in the existing terrain. For effective recharge highly permeable soils are suitable and maintenance of a layer of water over the highly permeable soil is necessary. When direct discharge is practised the amount of water entering the aquifer depends on three factors—the infiltration rate, the percolation rate, and the capacity for horizontal water movement.

At the surface of aquifer, however, clogging occurs by deposition of particles carried by water in suspension or in solution, by algae growth, colloidal swelling and soil dispersion, microbial activity, etc. Recharge by spreading basins is most effective where there are layer below the land surface and the aquifer and where clear water is available for recharge.

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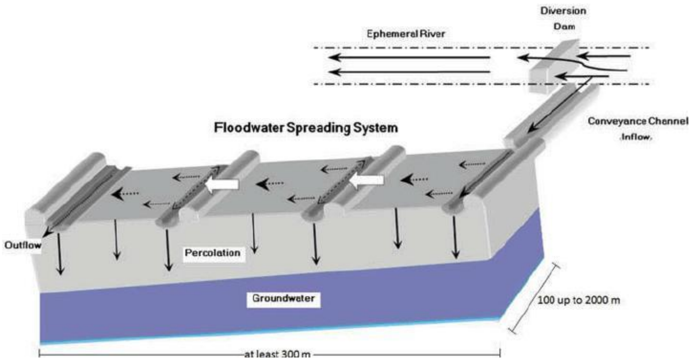

Figure 3: Spreading Basins

Method 2. Recharge Pits and Shafts:

Conditions that permit surface flooding methods for artificial recharge are relatively rare. Often lenses of low permeability lie between the land surface and water table. In such situation artificial recharge systems such as pits and shafts could be effective in order to access the dewatered aquifer. The rate of recharge has been being found to increase as the side slope of the pits increased.

Unfiltered runoff water leaves a thin film of sediments on the sides and bottom of the pits, which require maintenance in order to sustain the high recharge rates. Shafts may be circular, rectangular or square cross-section and may be back filled by porous materials.

Excavation may be terminating above the water table. Recharge rates in both shafts and pits may decrease with time due to accumulation of fine-grained materials and the plugging effect brought by microbial activity.

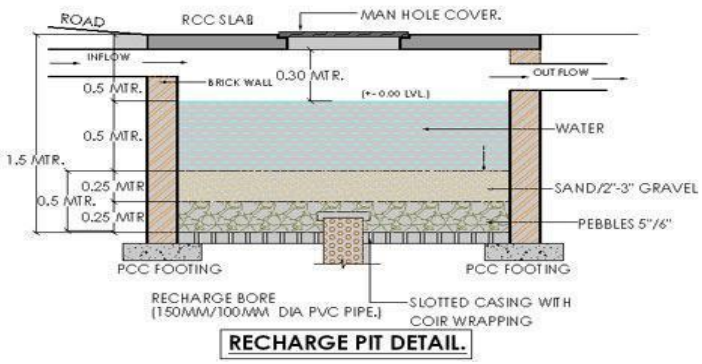

Figure 4: Recharge Pit

Method 3. Ditches:

A ditch is described as a long narrow trench, with its bottom width less than its depth. A ditch system is designed to suit topographic and geological condition that exists at the given site. A layout for a ditch and flooding recharge project could include a series of trenches running down the topographic slope.

The ditches could terminate in a collection ditch designed to carry away the water that does not infiltrate in order to avoid pounding and to reduce the accumulation of fine materials.

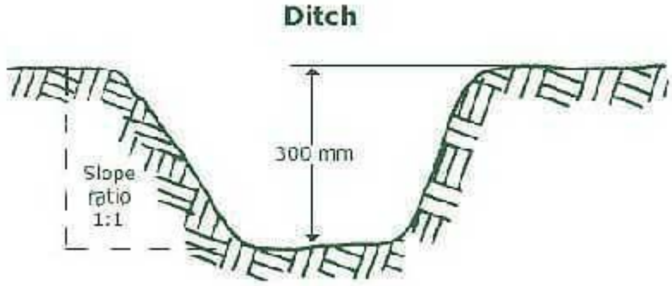

Figure 5: Recharge Pit

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Method 4. Recharge Wells:

Recharge or injection wells are used to directly recharge the deep-water bearing strata. Recharge wells could be dug through the material overlaying the aquifer and if the earth materials are unconsolidated, a screen can be placed in the well in zone of injection.

Recharge wells are suitable only in areas where thick impervious layer exists between the surface of the soil and the aquifer to be replenished. They are also advantageous in areas where land is scarce. A relatively high rate of recharge can be attained by this method. Clogging of the well screen or aquifer may lead to excessive buildup of water level in the recharge well.

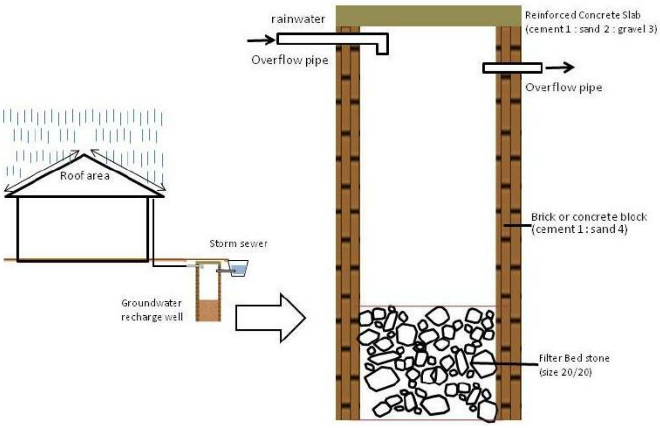

Figure 6: Recharge Well

Method 5. Harvesting in Cistern from Hill Sides:

In this method construction of small drains along contours of hilly area are done so that the runoff in these drains are collected in a cistern, which is located at the bottom of a hill or a mountain. This water is used for irrigation or for drinking purpose and the water is of good quality.

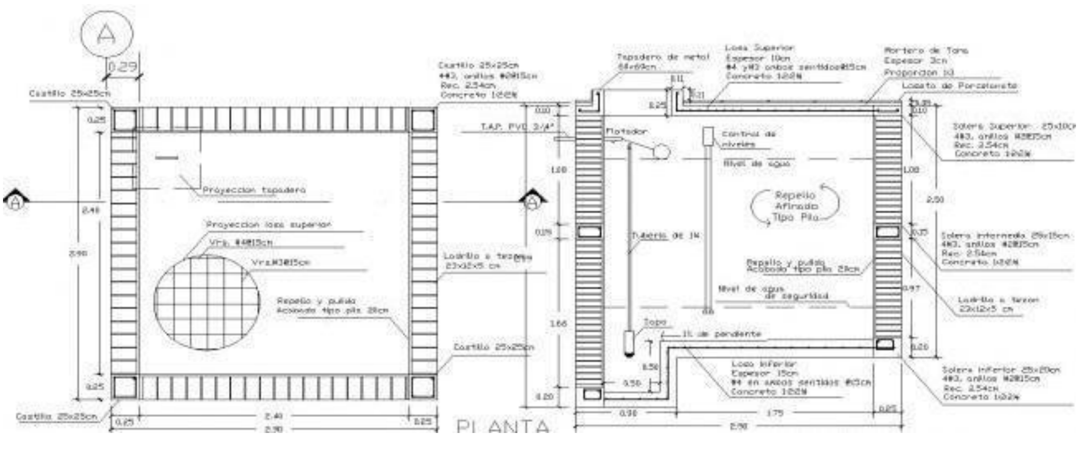

Figure 7: Cistern

Method 6. Subsurface Dams:

Ground water moves from higher-pressure head to lower one. This will help in semi-arid zone regions especially in upper reaches where the ground water velocity is high. By exploiting more ground water in upper reaches more surface water can be utilized indirectly, thereby reducing inflow into lower reaches of supply. Ground water is stored either in natural aquifer materials in sub-surface dams or in artificial sand storage dam.

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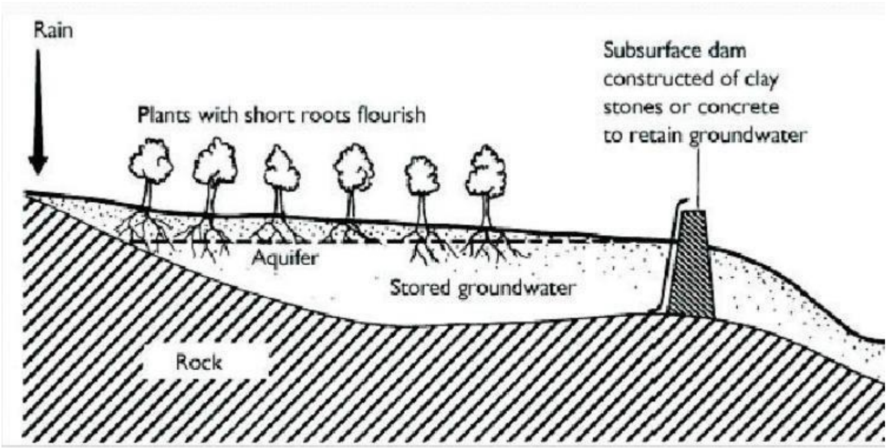

Figure 8: Subsurface Dam

3.2. DATA COLLECTION
3.2.1. RAINFALL DATA COLLECTION

GCOEARA, Awasari (kh.) is located at 73.96 E longitude and 18.98 N latitude in Pune district of Maharashtra at an elevation of about 656 meters above mean sea level. It has a tropical climate and receives high rainfall during Southwest monsoon (June-September) and retreating Northeast monsoon (October-November). Average annual rainfall of last 34 years ranges between 750-780 mm.

The average Annual rainfall data are being taken from the National Data Centre NDC under India Meteorological Department, Pune. Again it's followed that, Awasari is a small village and thus has a uniform average rainfall throughout the village in all location. Thus Annual rainfall data of the "Ghodegaon" village is given below in the table no.1 which is assumed to be same for the station of GCOEARA campus.

ANNUAL RAINFALL DATA:

CAT	= Catchment Number
LA	= Latitude in Degrees N
LO	= Longitude in Degrees E
ARF	= Total Annual Rainfall in mm
NOB	= No. of Observations in a year

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Sr. No.	DISTRICT	STATION	CAT	LA	LO	YEAR	ARF	NOB
1.	PUNE	GHODEGAON	307	19	73	1978	589.0	365
2.	PUNE	GHODEGAON	307	19	73	1979	743.8	365
3.	PUNE	GHODEGAON	307	19	73	1980	620.3	366
4.	PUNE	GHODEGAON	307	19	73	1981	741.9	365
5.	PUNE	GHODEGAON	307	19	73	1983	1006.4	365
6.	PUNE	GHODEGAON	307	19	73	1984	1561.4	366
7.	PUNE	GHODEGAON	307	19	73	1986	638.1	365
8.	PUNE	GHODEGAON	307	19	73	1987	754.4	365
9.	PUNE	GHODEGAON	307	19	73	1988	746.9	366
10.	PUNE	GHODEGAON	307	19	73	1989	548.6	365
11.	PUNE	GHODEGAON	307	19	73	1990	875.9	365
12.	PUNE	GHODEGAON	307	19	73	1991	799.6	365
13.	PUNE	GHODEGAON	307	19	73	1992	969.4	366
14.	PUNE	GHODEGAON	307	19	73	1993	861.2	365
15.	PUNE	GHODEGAON	307	19	73	1994	854.1	365
16.	PUNE	GHODEGAON	307	19	73	1995	963.4	365
17.	PUNE	GHODEGAON	307	19	73	1996	1531.2	366
18.	PUNE	GHODEGAON	307	19	73	1998	1105.4	365
19.	PUNE	GHODEGAON	307	19	73	1999	794.3	365
20.	PUNE	GHODEGAON	307	19	73	2000	552.3	365
21.	PUNE	GHODEGAON	307	19	73	2001	832.1	364
22.	PUNE	GHODEGAON	307	19	73	2003	421.8	362
23.	PUNE	GHODEGAON	307	19	73	2004	735.1	366
24.	PUNE	GHODEGAON	307	19	73	2005	1025.0	365
25.	PUNE	GHODEGAON	307	19	73	2006	1338.3	365
26.	PUNE	GHODEGAON	307	19	73	2007	830.9	364
27.	PUNE	GHODEGAON	307	19	73	2008	735.0	366
28.	PUNE	GHODEGAON	307	19	73	2009	732.3	365
29.	PUNE	GHODEGAON	307	19	73	2010	823.4	365
30.	PUNE	GHODEGAON	307	19	73	2011	836.0	365
31.	PUNE	GHODEGAON	307	19	73	2012	616.6	366
32.	PUNE	GHODEGAON	307	19	73	2013	816.3	365
33.	PUNE	GHODEGAON	307	19	73	2014	584.6	365
34.	PUNE	GHODEGAON	307	19	73	2015	800.3	365
35.	PUNE	GHODEGAON	307	19	73	2016	700.4	366

Table 2: Annual Rainfall Data of Ghodegaon (1978-2016)

3.2.2. GROUND WATER LEVEL DATA COLLECTION

The data about the average ground water table level of last 6 years (2012-2017) is obtained from Central Ground Water Board, Nagpur which is as follows:

Sr. No.	SITE NAME	WATER LEVEL (m)	DATE
1.	Awasari Khurd-1	-7.75	03/11/2012
2.	Awasari Khurd-1	-6.95	04/01/2013
3.	Awasari Khurd-1	-11.25	24/05/2013
4.	Awasari Khurd-1	-4.43	23/01/2014
5.	Awasari Khurd-1	-10.1	12/11/2014
6.	Awasari Khurd-1	-10.3	22/01/2015
7.	Awasari Khurd-1	-7.45	24/08/2015

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8.	Awasari Khurd-1	-3.7	13/11/2015
9.	Awasari Khurd-1	-3.7	13/11/2015
10.	Awasari Khurd-1	-8.5	13/01/2016
11.	Awasari Khurd-1	-3.5	07/05/2016
12.	Awasari Khurd-1	-4.8	29/08/2017

Table 3: Ground Water Level Data

3.2.3. COLLEGE SURVEY WITH PROJECT GUIDE

For the of purpose of knowing the college campus more precisely and for analysing the method to be adapted for successful implementation of Rain Water Harvesting and Ground Water Recharging in GCOEARA Campus we have conducted a basic survey in the guidance of Prof. R. P. Thanedar Sir (Project Guide)

- **Date:** 24 Sept. 2018
- **Observations:**

1. The working sewage system of college is of combined type which - carries both sewage as well as storm water.
2. The rough location for the recharge pit has been finalised.
3. The college terrain has sloppy nature

- **Conclusions:**

1.We had concluded to provide another parallel system to carry rain water to the recharge pit.

2. We had also concluded to separate sewage and rain water drainage pipes at the point of mixing.

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3.2.4. COLLEGE LAYOUT

We have carried out the survey to locate college campus boundaries for better and effective setting out of piping system.

- **Date:** 4 Oct. 2018
- **Instruments used:** Prismatic Compass, Measuring Tape, Tripod Stand, Ranging Rod, etc.
- **Procedure:**

1. We have considered the departmental building as the base point and the location of other buildings are noted down with reference to it.

2. We have fixed the instrument station at suitable points of departmental building and the angle made with the corner of other building whose location has to be set is noted down.

3. Afterwards we have measured the distance between the instrument station and point of measurement with 30 m measuring tape.

4. With the help of above data we have drawn college layout in Auto CAD software.

3.2.5 MANUAL CONTOURING

We have carried out the contour survey on the hill behind the college campus for setting out the contours.

- **Date:** 30 Oct. 2018
- **Instruments used**: Transit theodolite, levelling staff, ranging rod , 30 m measuring tape, chain, arrows, pegs, chalk, tripod stand.
- **Type of method used:** Radial Contouring
- **Procedure:**

1. We first fixed suitable instrument station from where each boundary points of hills can easily be located and measured.

2. Then we divided the divide radial area surrounding instrument in strips of measuring angle of 20’ each.

3. Each line of sight is ranged and ranging rods are rowed at interval of 5 m on that line.

4. Level of each ranging rod point is measured with the help of transit theodolite and benchmark was assumed to be equal to 100.000 m.

5. Reduced levels are calculated based on that readings.

6. Contour intervals both vertically and horizontally are fixed and based on that approximate contour map is prepared.

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3.2.6 GIS ANALYSIS

A geographic information system (GIS) is computer software that allows our young students, researchers and investigators to manage and manipulate interactions between data and geographic locations. GIS technology has the sophistication to go beyond mapping as simply a data management tool. GIS can integrate georeferenced imagery as data layers or themes and link them to other data sets to produce geospatial representations of data. These geographical pictures not only depict geographic boundaries but also offer special insight to students and researchers across disciplines such as health, economics, agriculture, and transportation.

Thus, in the present case, Global Mapper, Google Earth Pro and AutoCAD is being chosen as the software for carrying out the GIS analysis. Our aim is to convert the scanned map of the GCOEARA campus into a digital elevation model map, which gives detail distinct information on the variation in the elevation of different regions of surface giving clear idea on the surface topology. The high contour lines on the digital elevation model denotes surfaces of high altitudes i.e. Mountainous region and low lining contour lines denotes the surfaces with low altitudes such as valley region.

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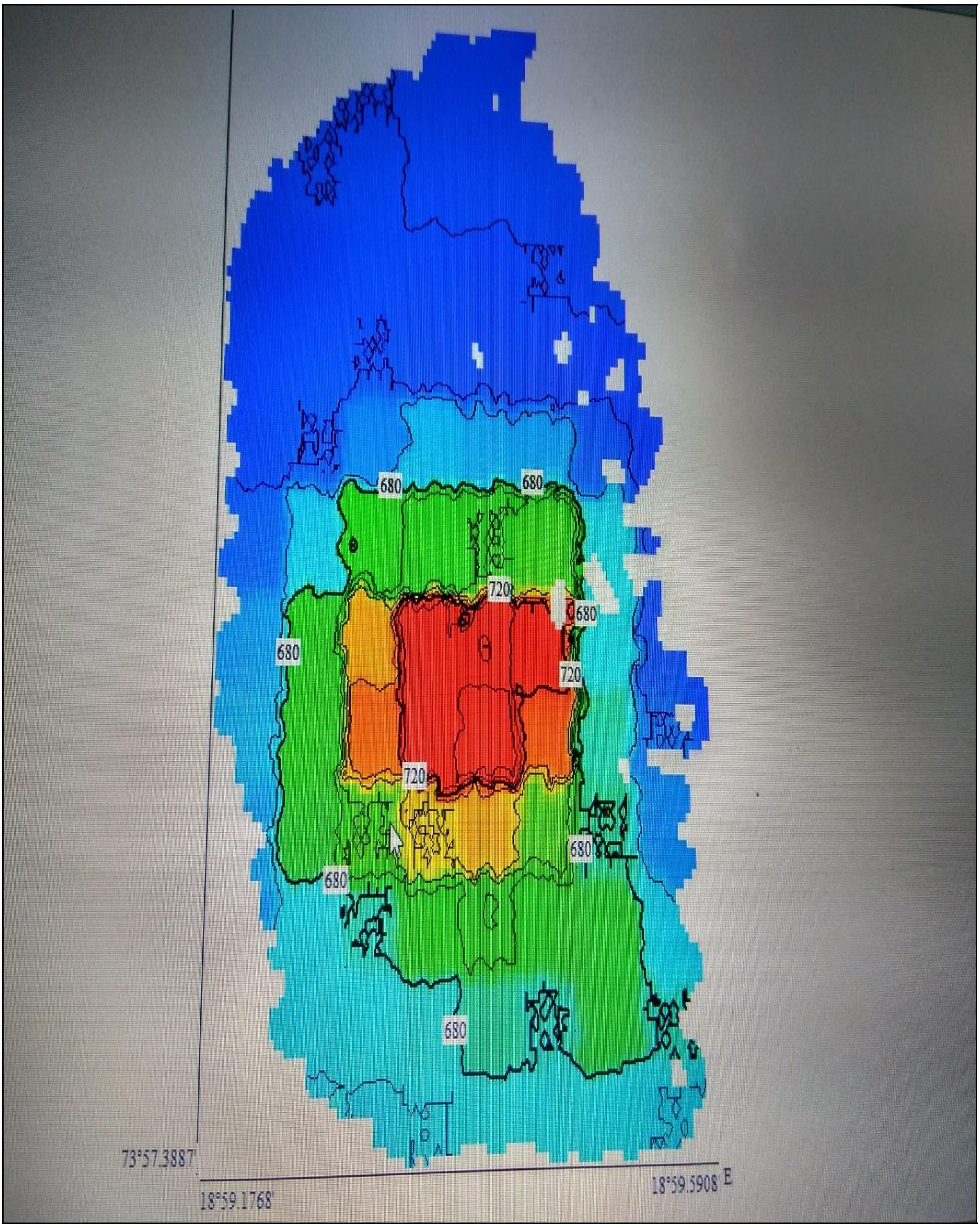

Figure 10: Digital Elevation Model of GCOEARA Campus

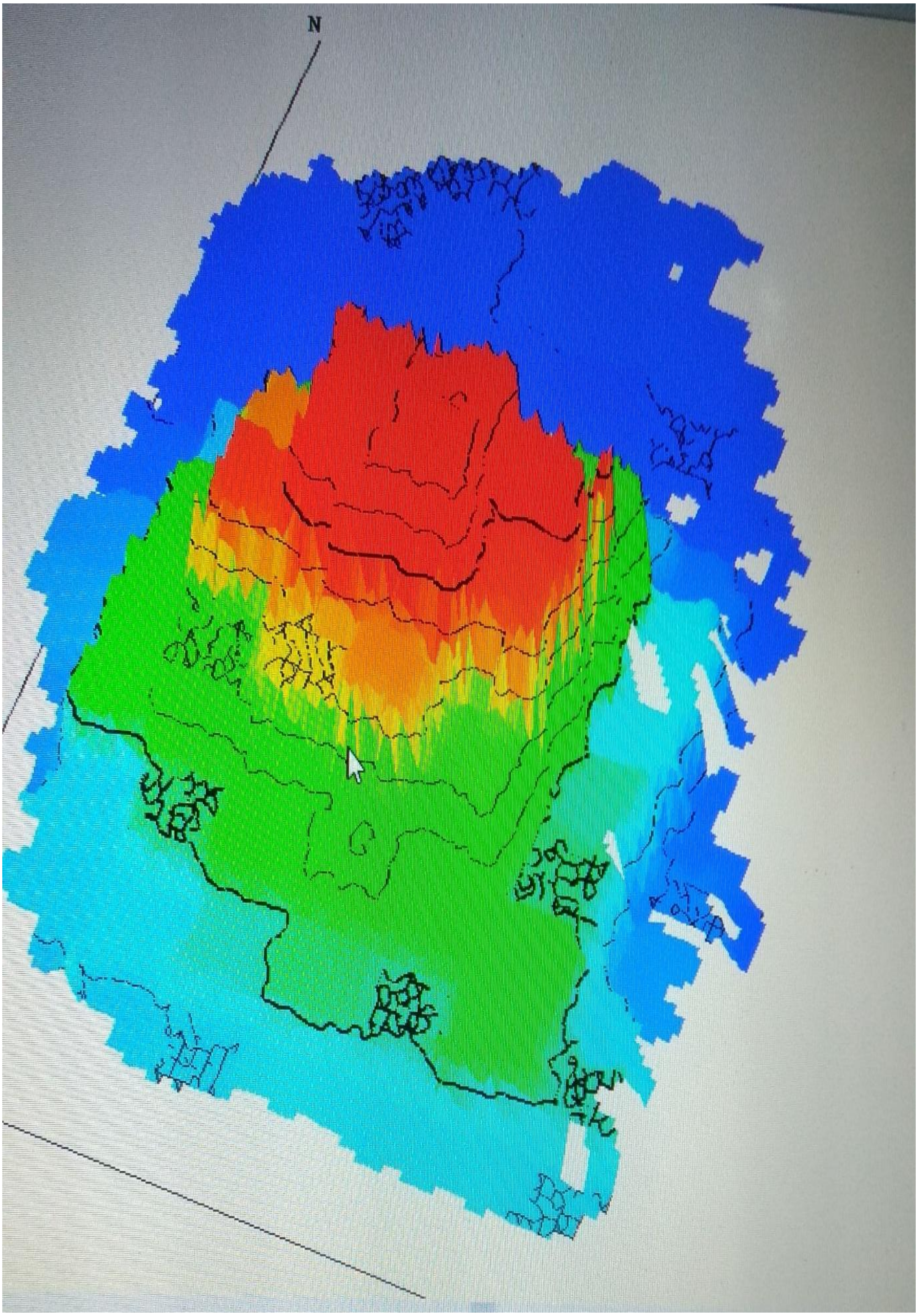

Figure 11: Digital Elevation Model of Hill

3.2.7 DETERMINATION OF CATCHMENT AREA AND MARKING OF INLET OF RAINWATER DRAINAGE PIPE

The rooftop surface is nothing but the catchment area which receives rainfall. Catchment areas of the different hostels and Institutional departments are measured. This measurements was done by manually with the help of reinforced fibre tape which is the simplest technique known as 'Tape Survey'. The roof areas of various buildings are as following:

Sr. No.	Building Name	Rooftop area (sq. m)
1	All Departments	9555.7
2	Admin	1585.1
3	Workshop	1148.1
4	Hostel A	713.4
5	Hostel B	713.4
6	Mess	1520.81
	Total Area	14155.6

Table 4: Roof Top Area Available

3.3 CALCULATION OF NET RAINWATER COLLECTION

The total volume of the rainwater available from any rooftop survey is a product of total rainfall and the surface area of collection. Runoff coefficient is usually applied to account for infiltration, evaporation and other losses and it varies from 0.8 to 0.95. In order to estimate the average annual monsoon rainfall data for location needed to be used and using table 1 of IS 15797:2008 (Roof Top Rainwater Harvesting – Guidelines.

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Sr. No	Name of Building	Volume of Water Available (cu m)	Percolation Coefficient	Net Volume Of Rainwater Available (cu m)
1	Admin	1053.77	0.9	948.393
2	Hostel A	474.27		426.843
3	Hostel B	474.27		426.843
4	Workshop	763.26		686.934
5	Mess	292.44		263.196
6	All Deparments	6352.63		5717.367
Total				8469.6

Table 5: Calculation of Rainwater Collection

Note: Here percolation coefficient for concrete pavement surfaces is considered equal to 0.9

Sr. No.	Roof Top Area (sq m)	Rainfall (mm)												
		100	200	300	400	500	600	800	1000	1200	1400	1600	1800	2000
		Water Availibilty (cu m)												
1	20	1.6	3.2	4.8	6.4	8	9.6	12.8	16	19.2	22.4	25.6	28.8	32
2	30	2.4	4.8	7.2	9.6	12	1404	19.2	24	28.8	33.6	38.4	43.2	48
3	40	3.2	6.4	9.6	13	16	19.2	25.6	32	38.4	44.8	51.2	57.6	64
4	50	4	8	12	16	20	24	32	40	48	56	64	72	80
5	60	4.8	9.6	14	19	24	28.8	38.4	48	57.6	67.2	76.8	86.4	96
6	70	5.6	11	17	22	28	33.6	44.8	56	67.2	78.4	89.6	101	112
7	80	6.4	13	19	26	32	38.4	51.2	64	76.8	89.6	102	115	128
8	90	7.2	14	22	29	36	43.2	57.6	72	86.4	101	115	130	144
9	100	8	16	24	32	40	48	64	80	96	112	128	144	160
10	150	12	24	36	48	60	72	96	120	144	168	192	216	240
11	200	16	32	48	64	80	96	128	160	192	224	256	228	320
12	250	20	40	60	80	100	120	160	200	240	280	320	360	400
13	300	24	48	72	96	120	144	192	240	288	336	384	430	480
14	400	32	64	96	128	160	192	256	320	384	448	512	576	640
15	500	40	80	120	160	200	240	320	400	480	560	640	720	800
16	1000	80	160	240	320	400	480	640	800	960	1120	1280	1440	1600
17	2000	160	320	480	640	800	960	1280	1600	1920	2240	2560	2880	3200
18	3000	240	480	720	960	1200	1440	1920	2400	2880	3360	3840	4320	4800

Table 6: Roof Top Rainwater Harvesting

Source: Table 1, IS 15797:2008 (Roof Top Rainwater Harvesting – Guidelines)

3.4 DETERMINATION OF GEOLOGICAL DATA

The entire area is covered by Deccan trap basalt of cretaceous Eocene age. A total of 29 basaltic flows including 15 of aa type and 14 of compound type have been noticed within 1636 m thick lava pile exposed between elevation 10 m above MSL (near Pen) and 1646 above MSL (Kalsubai Hill).The flows have been observed to thickness, thin or pinched out locally and also change character from compound to simple.

Along western flanks of hill (0.775) located 2km NNW of Avasari Khurd, another tube is observed. It trends N-S measures about a km in length and 50m width. The megacryst basalt coreletable to the host flow forms the core of tube. Mafic nodules are also noticed in the core portion.

The lava tubes noticed at these localities are restricted to flow no.17 i.e. the M3 and are in further to have been lava supply routes for it.

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LOCALITY INDEX							
	Latitude 'N			Longitude 'E			
LOCALITY	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Toposheet No.47
Avasari Kh.	18	58	20	73	57	45	47F13

Table 7: Geological Data

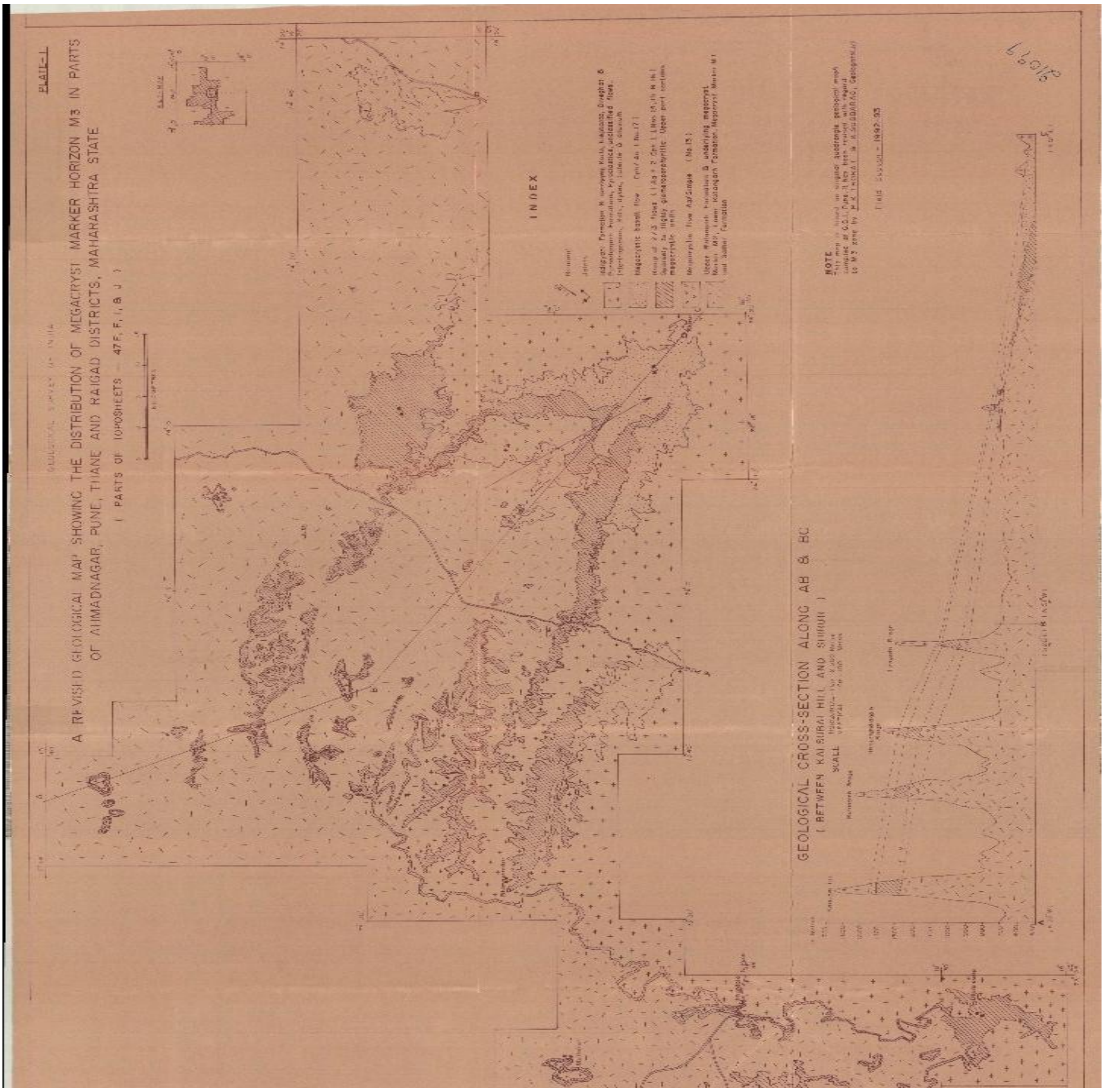

Figure 12: Revised Geological Map Showing the Megacryst Marker Horizon

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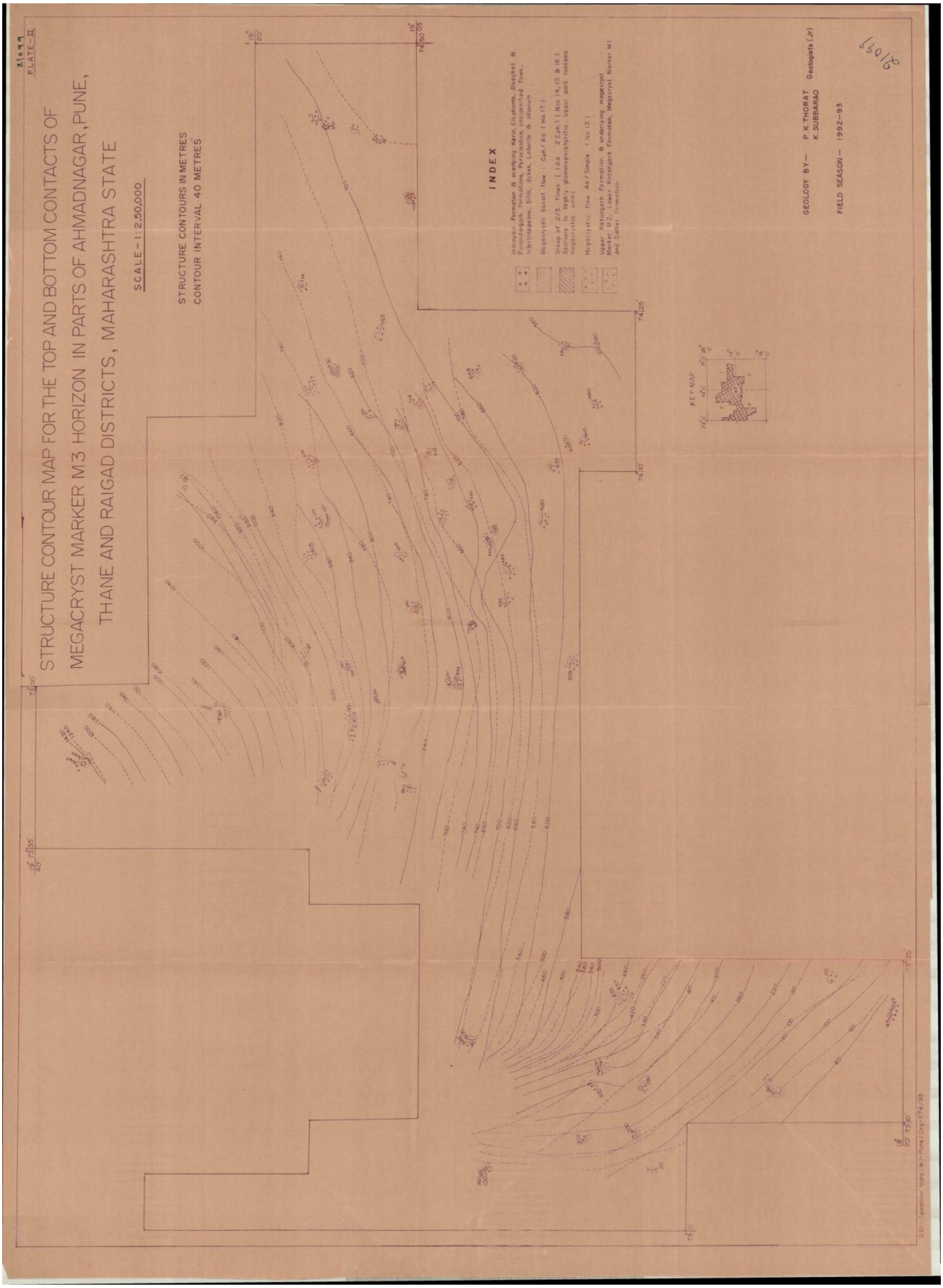

Figure 13: Structure Contour Map for the Top and Bottom Contacts of Megacryst Marker Horizon

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CHAPTER 4

EXPERIMENTAL ANALYSIS

4.1 DETERMINATION OF SOIL ABSORPTION CAPACITY

- ***PERCOLATION TEST:***

Percolation test is done to determine the absorption capacity of soil. This test is important for the design of septic system. This test is also carried out while purchasing land, to understand the behaviour of soil under moisture conditions. This test is also called as perc test. Every country may have different regulation for the exact calculation of length of line, depth of pit, etc. but the procedure for the percolation test is same. In India, this test is carried out as per IS2470- Part-II.

As per IS2470- Part-II, the percolation rate is time required in minutes for water to fall 25 mm in the test-hole. A test in trial pits at more than one place in the area should be undertaken to permit deriving an average figure for percolation rate.

- ***PROCEDURE FOR PERCOLATION TEST:***

1. Percolation test is done to determine the permeability of soil at the depth at which the effluent needs to be disposed.

2. A 100 to 300mm diameter or side of a circular or a square hole is bored to the required depth of proposed absorption test. The bottom of the hole is carefully scratched to remove any smeared soil surface and to provide a natural soil interface into which water may percolated.

3. All the lose material is removed from the hole and coarse sand or fine sand of 50mm thickness is added to protect the bottom of the bore from scouring.

4. Water is then poured up to a minimum depth of 300mm over the gravel. This test shall be carried out during the wettest season of the year to make sure that the soil has ample opportunity to swell. The percolation of the soil is determined after 24 hours of the adding water in the bore. If the water remains in the test hole after the overnight swelling period, the depth is adjusted to 150 mm over the gravel. Then from fixed reference point the drop in water level is noted over a 30 minute period. This drop shall be used to calculate the percolation rate.

5. If no water remains in the hole, water is added to bring the depth of the water in the hole till it is 150 mm over the gravel. From a tied reference point, the drop in water level is measured at 30 minutes intervals for 4 hours, refilling 150 mm over the gravel as necessary. The drop that occurs during the final 30 minutes period is used to calculate

the percolation rate. The drops during prior periods provide information for possible modification of the procedure to suit local circumstances.

6. In sandy soils or other porous soils in which the first 150 mm of water seeps away in less than 30 minutes after the overnight swelling period, the time interval between measurement is taken as 10 minutes and the test run for one hour. The drop that occurs during the final 10 minutes is used to calculate the percolation rate.

7. Percolation Rate -Based on the final drop, the percolation rate, that is, the time in minutes required for water to fall 25 mm, is calculated.

LOCATION	DEPTH OF WATER (mm)	PERCOLATION TIME (sec)	RATE OF PERCOLATION (cm/hr)	VOL. OF WATER IN PIT (ml)	PERCOLATION RATE (lit/hr)
Boys Hostel B	130	1456	130/24.27 =32.16	1021	2.52

Table 8: Percolation Test Observations

CHAPTER 5

5.0 CASE STUDY

LOCATION: SAMARTH GROUP OF INSTITUTIONS COLLEGE OF ENGINEERING BELHE.TAL.AMBEGAON DIST.PUNE **DATE OF VISIT:** 19 February 2019

We had visited Samarth Group of Institution College of engineering Belhe for the case study purpose. Because of earlier and effective implementation of rainwater harvesting. Where prof. Satpute sir (HOD Of Civil Engineering Dept.) and Asst. Prof. Shelke Sir had guided us about the effective working of the RWH system. The following particular are observed.

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OBSERVATIONS:

• Artificial pond

- Capacity : 80,00,000 lit

- Area : 505.85 sq. m

• Underground Storage tank

- Capacity : 75,000 lit

• Effective pipe connection system used for the conveyance of rain water from the college building to the artificial pond.

• We also came to know about harvested rainwater distribution in their campus.

• They also implemented fish culture in artificial pond.

Underground Storage Tank

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Artificial Pond

CHAPTER 6

DESIGN OF RWH COMPONENTS

6.1 DESIGN OF RECHARGE PIT

- In alluvial areas where permeable rocks are exposed on the land surface or at shallow depths, recharge pits are suitable artificial recharge of water collected from rooftop.

- The technique is suitable for building having roof are of 100 sq m. The recharge pits are constructed for constructing the shallow aquifers.

- Recharge pits of may be any shape and size and are generally constructed 1 to 2 m wide and 2 to 3 m deep which are backfilled with boulders (5 to 20 cm), Gravels (5 to 10 mm) and coarse sand (1.5 to 2 mm) in graded form – boulders at bottom, gravels in between and coarse sand at the top so that silt content that will come with runoff will be deposited on the top of the coarse sand layer and can easily be removed. For smaller roof areas, pit may be filled with broken bricks/cobbles.

- A mesh should be provided at the roof so that leaves or any other solid waste/debris are prevented from entering the pit.

• **Design Calculations** :-

- Net volume of water collected = 8469.576 cu m

- Assume 10% conveyance losses = 0.9x8469.576 = 7622.62 cu m

-

- Assume effective rainfall season for 90 Days = 7622.62/90 = 84.7 Area of percolation pit = πr2L cu m /Day

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= $\pi \times 0.1^2 \times 0.13$

= 4.084×10^{-3} cu m

- Rate of percolation in terms of volume = $2.52 / 4.084 \times 10^{-3}$

= 617.03 lit/hr/cu m

= 14808.76 lit/day/cu m

= 14.81 cum/day/cu m

- Volume of percolation pit = Daily Rainfall Volume Collected / Daily Percolation Rate

= 84.7/14.81

= 5.72 cu m 6 cu m

Total volume of recharge pit required = 6 cu m

- Assume Dia. of percolation pit to be equal to 1.8 m

- Volume of percolation pit h

$6 = \pi \times 0.9 \times 0.9 \times h$

h = 2.36

- Assume 10 % free board

h = 1.1 x 2.36 = 2.6 m

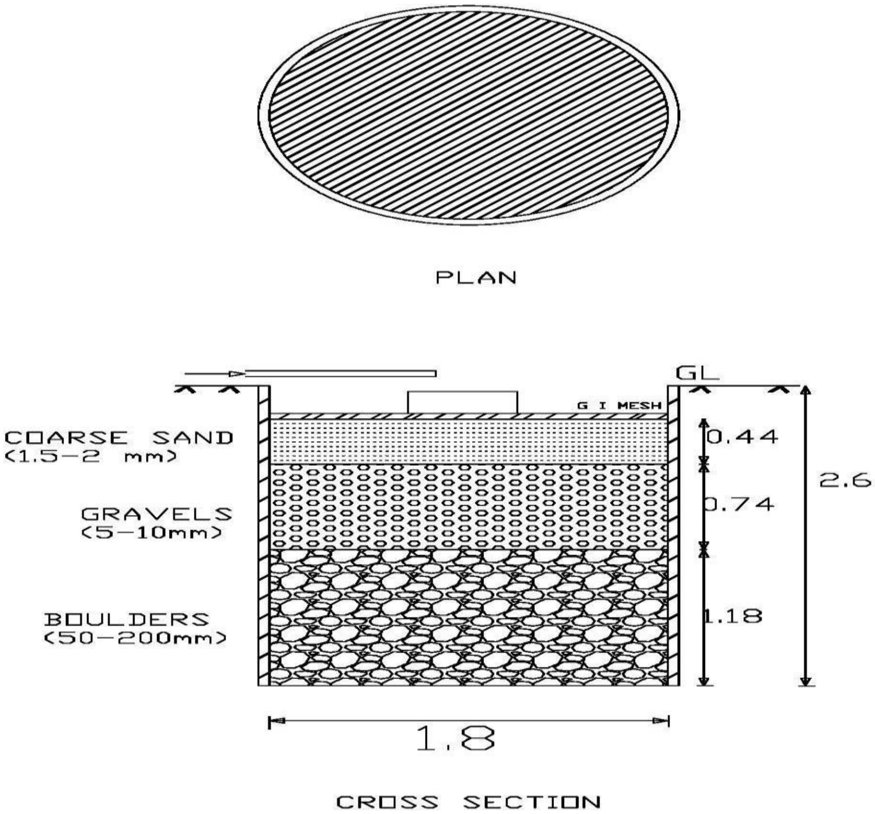

Figure 14: Recharge Pit

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6.2 DESIGN FEATURES OF BOREWELL

A bore well is a well of 4 ½” to 12” in diameter into the earth of retrieving water. In this 4 ½” to 5 ½” bore well are commonly for the domestic purposes while 6 ½” and more for the commercial/ industrial purposes. A bore well is cased in the region of loose subsoil strata open in the hard rock or in the crystalline rock.

An ancient techniques utilized driving of tubes inside the earth to drill well using mud or water as a liquid media. Then after the invention of diesel engines, rotary drilling was used to remove cores out of the earth. There are several methods used for drilling bore well. Most commonly used are compressor drilling, manual drilling and rotary drilling.

- Diameter of bore well =300 mm
- Depth =100 feet (30.28 m)
- 1.5 HP Submersible pump
- Casing =20 feet (6 m)
- Bore pipe (20 feet each) = 4 nos.
- Lider Control Panel/Starter = 1

6.3 DESIGN OF PLUMBING UNITS

Plumbing is any system that conveys fluids for a wide range of applications. Plumbing uses pipes, valves, plumbing fixtures, tanks and other apparatuses to convey fluids.

Following are the various plumbing units used in the Rainwater Harvesting System.

Figure 15: Plumbing System Components

1.3.1 FIXATION OF PIPE DIAMETER

- Net volume of rainwater available annually = 8469.6 m^3
- Net volume of rainwater available per day considering 90 days of effective rainfall season = 94.10 m^3/day
- Net volume of rainwater available per hour = 3.795 m^3/hour = 3.8 m^3/hour
- Net volume of rainwater available per second = 0.0011 m^3/sec
- i.e. Gross discharge rate coming out of pipe outlet = 0.0011 m^3/sec
- Now, Assuming velocity of water flowing through pipe = 1 m/sec
- Using continuity equation, Q = A.V

D = 0.037 m = 3.7 cm = 1.5 inch

- But, for unforeseen climatic calamity and to ease the fining of piping system we are providing F.O.S. = 2.5
- D = 1.5 × 2.5 = 3.75 inch = 4 inch

Similarly, for pipes collecting and conveying the gross collected water from different buildings assuming F.O.S. = 1.5

Pipe diameter D= 4×1.5= 6 inch

6.3.2 DESIGN SPECIFICATIONS FOR WORKSHOP BUILDING

No.	Offset side	Offset Distance (m)
1.	Front Side	3
2.	Rear Side	1.5
3.	Right Hand Side	2
4.	Left Hand Side	2

	4 inch pipe		6 inch pipe	
Type of joint	90 elbow	T-reducer	90 elbow	T-joint
No.	40	18	4	1

Pipe Size	Length (m)
4 inch Dia. Pipe	80.7
6 inch Dia. Pipe	176.5

Table 9: Design Specifications for Workshop Building

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6.3.3 DESIGN SPECIFICATIONS FOR ADMIN BUILDING

No.	Offset side	Offset Distance (m)
1.	Front Side	2.1
2.	Rear Side	2.0
3.	Right Hand Side	2.1
4.	Left Hand Side	2.7

	4 inch pipe		6 inch pipe		
Type of joint	90 elbow	T-reducer	90 elbow	Y- Joint	Connector
No.	24	12	2	2	2

Pipe Size	Length (m)
4 inch Dia. Pipe	46.4
6 inch Dia. Pipe	113.3

Table 10: Design Specifications for Admin Building

6.3.4 DESIGN SPECIFICATIONS FOR HOSTEL A BUILDING

No.	Offset side	Offset Distance (m)
1.	Front Side	4
2.	Rear Side	0.5
3.	Right Hand Side	1.5
4.	Left Hand Side	1.5

	4 inch pipe		6 inch pipe			
Type of joint	90 elbow	T-reducer	90 elbow	T-joint	Y- Joint	Connector
No.	20	8	3	-	1	6

Pipe Size	Length (m)
4 inch Dia. Pipe	26.3
6 inch Dia. Pipe	104

Table 11: Design Specifications for Hostel A Building

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6.3.5 DESIGN SPECIFICATIONS FOR HOSTEL B BUILDING

No.	**Offset side**	**Offset Distance (m)**
1.	Front Side	1.5
2.	Rear Side	0.5
3.	Right Hand Side	2.1
4.	Left Hand Side	1.5

	4 inch pipe		**6 inch pipe**			
Type of joint	90 elbow	T-reducer	90 elbow	T-joint	Y- Joint	Connector
No.	20	8	3	1	1	6

Pipe Size	**Length (m)**
4 inch Dia. Pipe	26.3
6 inch Dia. Pipe	104

Table 12: Design Specifications for Hostel B Building

6.3.6 DESIGN SPECIFICATIONS FOR MESS BUILDING

No.	**Offset side**	**Offset Distance (m)**
1.	Front Side	4.0
2.	Rear Side	1.4
3.	Right Hand Side	0.8
4.	Left Hand Side	2.3

	4 inch pipe		**6 inch pipe**			
Type of joint	90 elbow	T-reducer	90 elbow	T-joint	Y- Joint	Connector
No.	22	10	6	1	1	-

Pipe Size	**Length (m)**
4 inch Dia. Pipe	16.2
6 inch Dia. Pipe	133.3

Table 13: Design Specifications for Mess Building

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6.3.7 DESIGN SPECIFICATIONS FOR DEPARTMENTAL BUILDING

No.	**Offset side**	**Offset Distance (m)** (Outer Side)	**Offset Distance (m)** (Inner Side)
1.	Front Side	2.5	Rainwater Drainage Piping System is already existed
2.	Rear Side	2.5	
3.	Right Hand Side	2.5	
4.	Left Hand Side	2.5	

- For outer side

	4 inch pipe		**6 inch pipe**			
Type of joint	90 elbow	T-reducer	90 elbow	T-joint	Y- Joint	Connector
No.	80	46	2	1	4	22

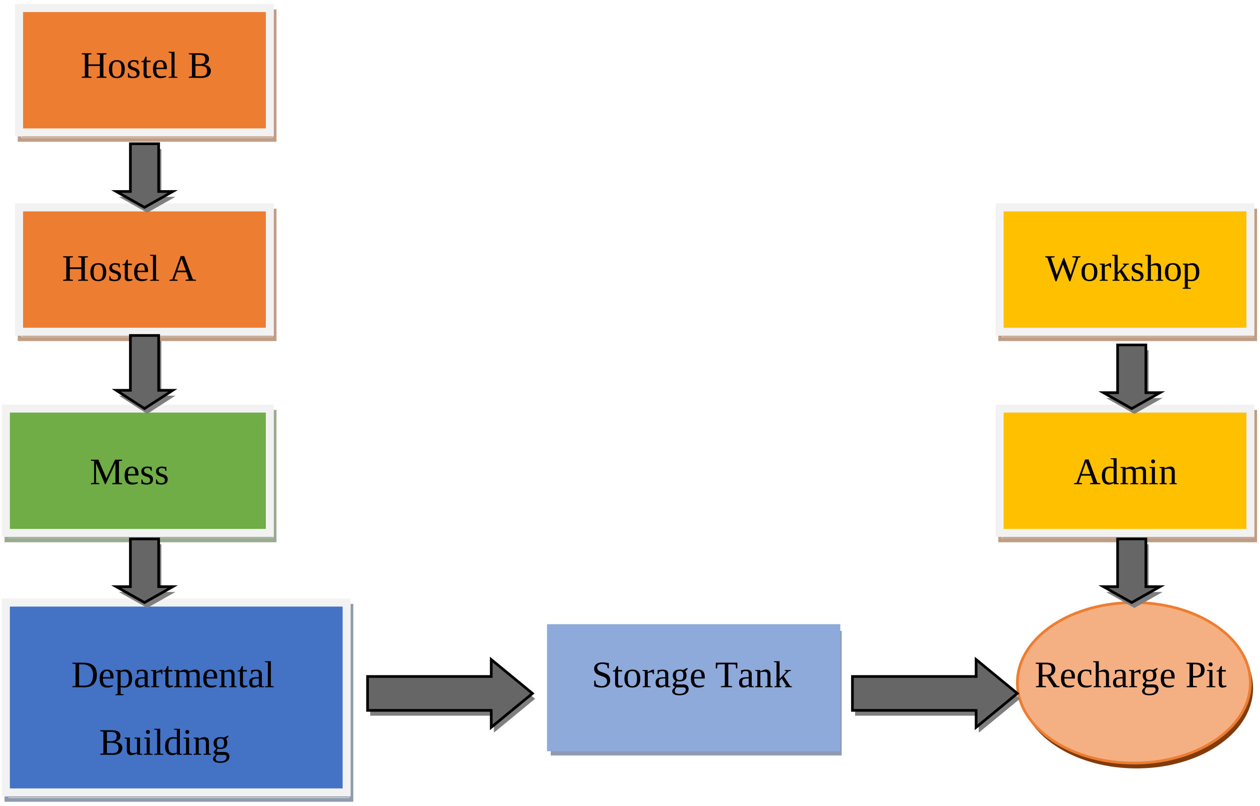
- For Inner side

	4 inch pipe		**6 inch pipe**			
Type of joint	90 elbow	T-reducer	90 elbow	T-joint	Y- Joint	Connector
No.	12	6	1	-	-	08

Pipe Size	**Length (m)** (Outer Side)	**Length (m)** (Inner Side)
4 inch Dia. Pipe	376.5	23.5
6 inch Dia. Pipe	1013	-

Table 14: Design Specifications for Departmental Building

6.3.8 RAINWATER FLOW SYSTEM



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CHAPTER 7
ESTIMATING AND COSTING

7.1 BORE WELL

Abstract of Quantities					
Item No.	Particulars of Items	Quantity	Rate (Rs.)	Per	Amount (Rs.)
1	Identification of Borewell Points	-	500	acre	500
2	Drilling (300 mm Dia.)	100	60	feet	6000
3	Casing (for first 20 feet depth)	20	200	feet	4000
4	Crompton 1.5 HP Submersible Water Pump	1	15000	unit	15000
5	Lider Control Panel/Starter	1	2750	unit	2750
6	Cable wire from motor to starter	100	50	feet	5000
7	Insertion of Bore Pipes (20 Feet)	4	625	unit	2500
8	3 phase service wire	-	1000	lumpsum	1000
9	Gate valve & other Miscellaneous items	-	1500	lumpsum	1500
10	Fixing charges of electrician and labours	-	2500	lumpsum	2500
Total					40750

Table 15: Abstract of Bore Well

7.2 RECHARGE PIT

Measurement Sheet							
Item No.	Particulars of Items	SSR Item No.	No.	Length	Breadth	Depth	Quantity
1	Excavation	21.02	1	πxR^2xH=πx0.9x0.9x2.6			6 cu m
2	Brick Masonry	27.01	1	πxDxLxt=πx1.8x2.6x0.1			1.47 cu m
3	Stone boulders of size range 5 cm to 20 cm	48.51	1	πxR^2xH=πx0.9x0.9x1.18			3 cu m
4	Gravels of size range 5 mm to 10 mm	48.52	1	πxR^2xH=πx0.9x0.9x0.74			1.88 cu m
5	Fine aggregate of size range 1.5 mm to 2 mm	48.53	1	πxR^2xH=πx0.9x0.9x0.44			1.12 cu m
6	Providing G.I. chicken wire mesh at the roof to exclude leaves or any solid debris	-	1	πxR^2=πx0.9x0.9			2.8 sq m

Table 16: Quantity2 Estimation of Recharge Pit

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Abstract of Quantities						
Item No.	Particulars of Items	SSR Item No.	Quantity	Rate (Rs.)	Per	Amount (Rs.)
1	Excavation	21.02	6 cu m	143	cu m	858
2	Brick Masonry	27.01	1.47 cu m	6272	cu m	9220
3	Stone boulders of size range 5 cm to 20 cm	48.51	3 cu m	712	cu m	2136
4	Gravels of size range 5 mm to 10 mm	48.52	1.88 cu m	1063	cu m	1998
5	Fine aggregate of size range 1.5 mm to 2 mm	48.53	1.12 cu m	948	cu m	1062
6	Providing G.I. chicken wire mesh at the roof to exclude leaves or any solid debris	-	2.8 sq m	150	sq m	420
	Total					15694

Table 17: Abstract of Recharge Pit

7.3 PLUMBING SYSTEM

Abstract Sheet						
Sr. No.	Plumbing Particulars	Nos.	Length (m)	Rate (Rs)	Per	Amount (Rs)
1	Pipe (4 Inches)	-	641.7	143	m	91763.1
2	Pipe (6 Inches)	-	747.5	298	m	222755
3	Elbow (4 Inches)	215	-	128	unit	27520
4	Elbow (6 Inches)	16	-	385	unit	6160
5	Y-Joint (4 Inches)	12	-	150	unit	1800
6	Y-Joint (6 Inches)	7	-	400	unit	2800
7	T-Joint (4 Inches)	112	-	177	unit	19824
8	T-Joint (6 Inches)	8	-	570	unit	4560
9	Coupler	42	-	94	unit	3948
10	Coupler	18	-	125	unit	2250
11	Reducer Coupler (4 x 6 Inches)	6	-	173	unit	1038
	Total					384418.1

Table 18: Abstract of Plumbing System

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TOTAL COST = BORE WELL + RECHARGE PIT + PLUMBING SYSTEM

= 40750 + 15694 + 384418

= Rs. 440862

NET COST = TOTAL COST + EXCAVTION AND BACKFILLING COST @ 10% OF PLUMBING COST + CONTINGENCIES @ 5% OF TOAL COST

= 440862 + 0.1 X 384418 + 0.05 X 440862

= **Rs. 501347**

CHAPTER 8

FUTURE FORECASTING:

- Storing rainwater will help in recharging the aquifer i.e. bore well.
- It will help in preventing campus flooding due to excess rain.
- The stored rainwater may be used for gardening, drinking and flushing purposes.
- It will also help to tackle the scarcity of water in summer season.
- Up to 66000 litres of water can be stored and excess water will be diverted to recharge pit.
- It will also help in satisfying nearby agricultural land water requirements due to rise in ground water level in the area.
- Campus will get another source of water to fulfil daily water requirements.
- Recharge pit will also get water from runoff from its surroundings.
- Rainwater stored in existing tank will be helpful in fire extinguishment requirements or any other such accidental requirements.
- The rainwater which will percolate in recharge pit will get filtrated due to different filtration layers provided in recharge pit and G.I. wire mesh on top of it.
- It will prevent flooding of rooftop areas of buildings in GCOEARA campus.
- Percolated rainwater may be used any time of the day using bore well provision.
- Unnecessary wastage of rainwater (natural source of water) will be eliminated.

CONCLUSION

This project report deals with all aspects of improving the water scarcity problem in the GCOEARA campus by implementing ancient old technique of Rainwater Harvesting. We can draw out a conclusion that a huge amount of water gets collected from the rooftop surfaces of all the buildings in campus. And if, this project is being done seriously and implemented to the campus (behind Admin building) then has a huge harvesting potential.

The other component of the harvesting systems such as Piping, Recharging Pit, and Storage Tank mechanism have also been reviewed and designed for the hostels and all other buildings in detail.

Hence it can be finally concluded that implementation of RAINWATER HARVESTING AND GROUND WATER RECHARGING PROJECT to the campus of GCOEARA will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface. Therefore, water is highly a precious natural resource which is always high in demand in the campus of GCOEARA and thus, RAINWATER HARVESTING AT GCOEARA campus is highly recommended.

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\# Web portal support (INTERNET)

- http://as.ori.nic/balangir/rainfall/pubNormaldtl.asp
- http://www.rainwaterharvesting.org
- http://www.tn.gov.in/dtp/rainwater.html
- http://www.aboutrainwaterharvesting.com
- http://www.rainwaterharvesting.org/People/innovators- urban.html
- wikipedia.com

\# Software Used

- Google Earth Pro (Version 7.1.7.2602)
- Global Mapper (Version 20.0)
- TCX Converter (Version 2.0)
- QuikGrid (Version 5.3)
- AutoCAD (Version 2018)
- SketchUp Pro 2014 (14.0.4900)
- Microsoft office 2013

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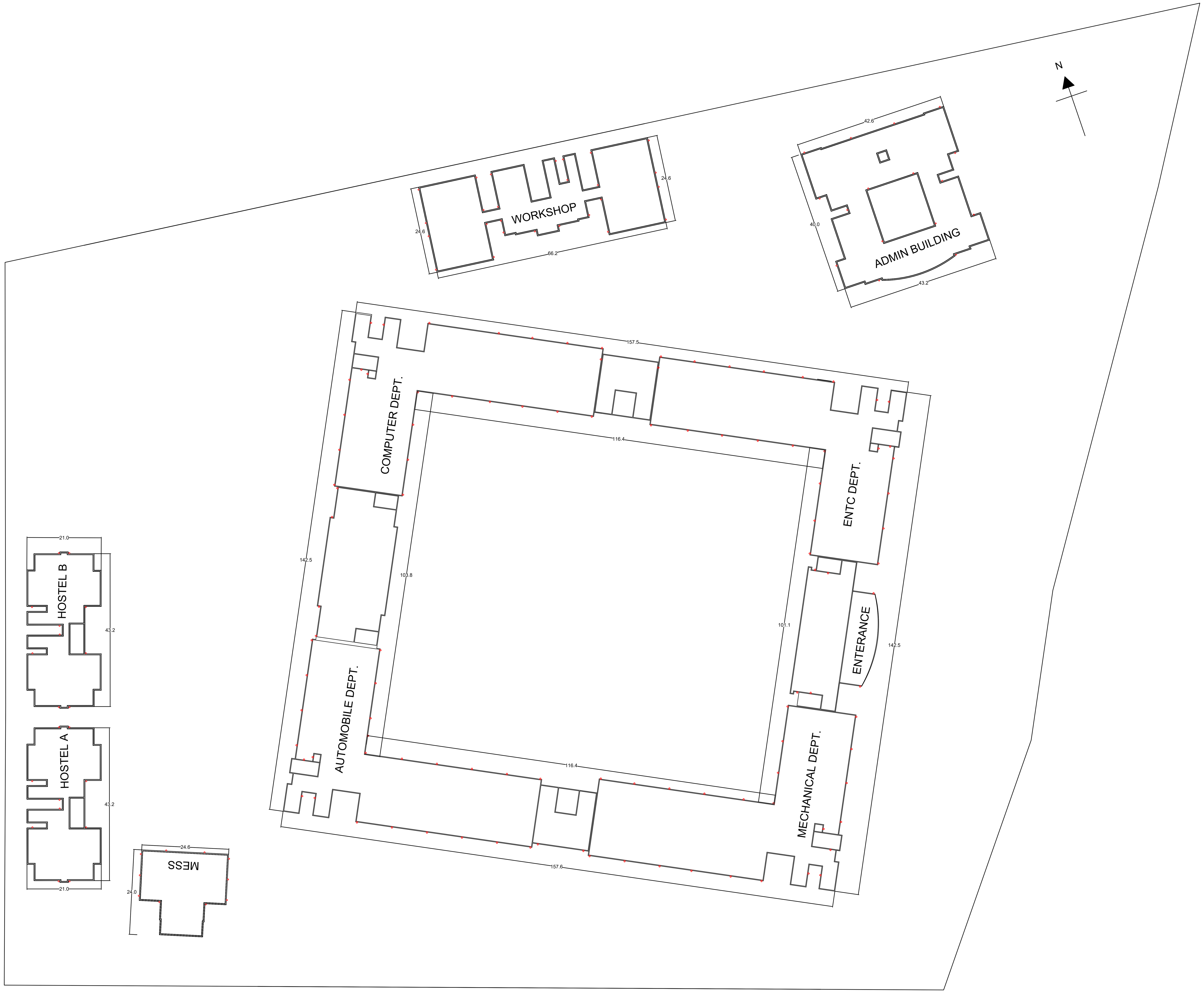

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SHEET TITLE : GCOEARA LAYOUT PLAN

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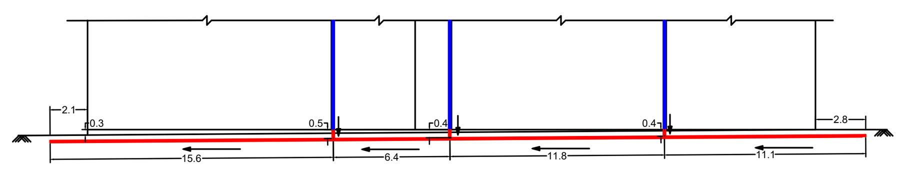

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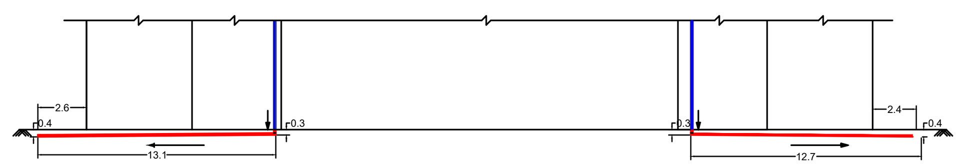

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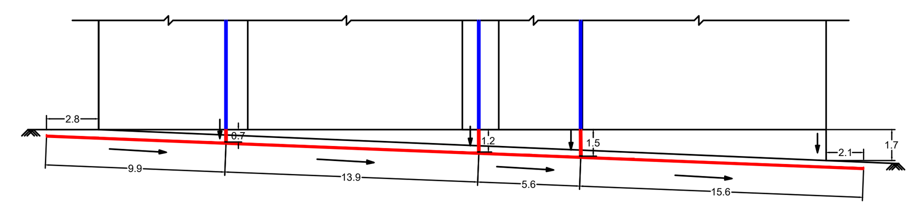

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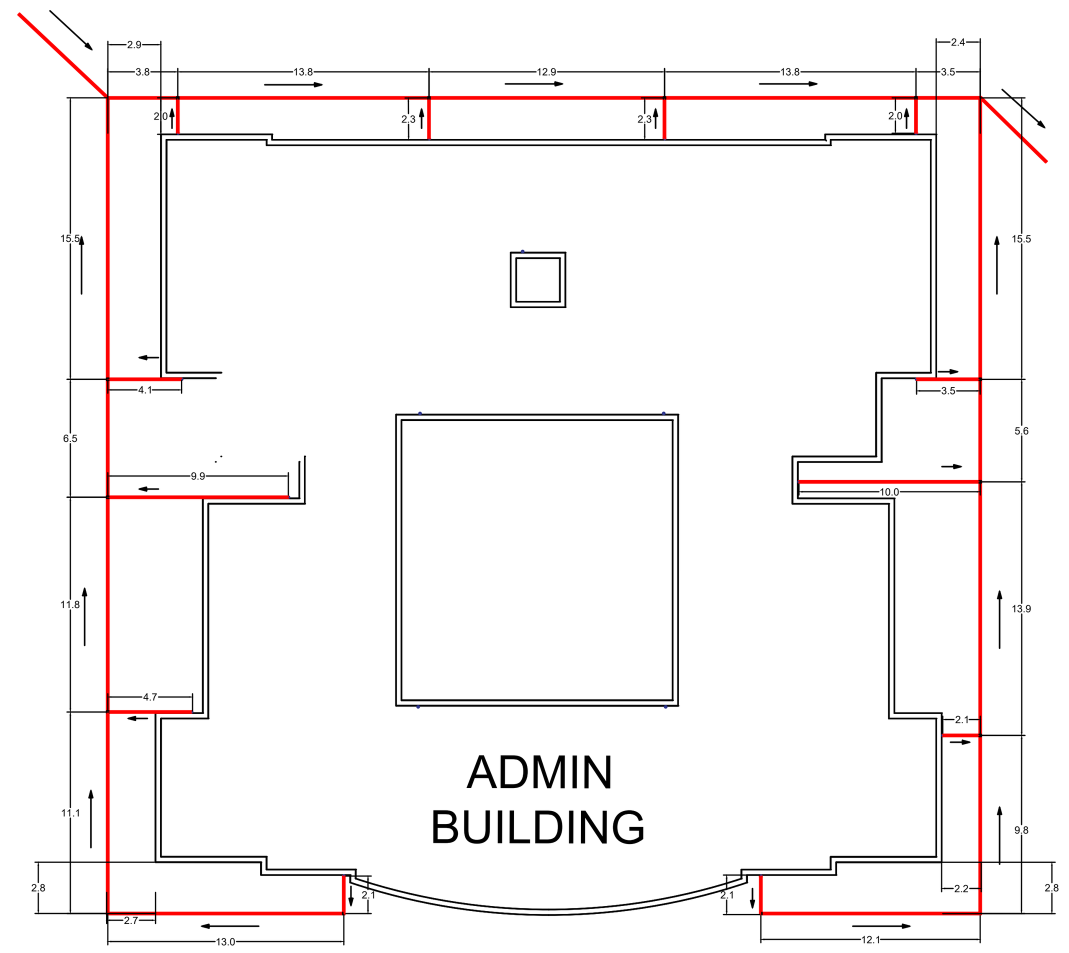
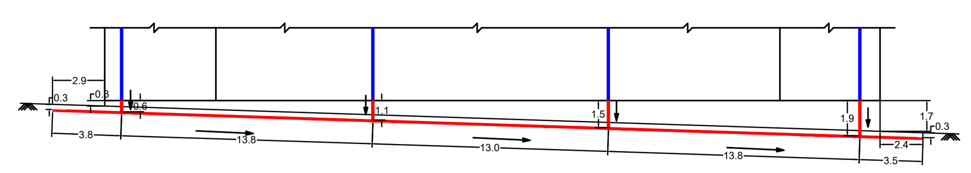


PLAN



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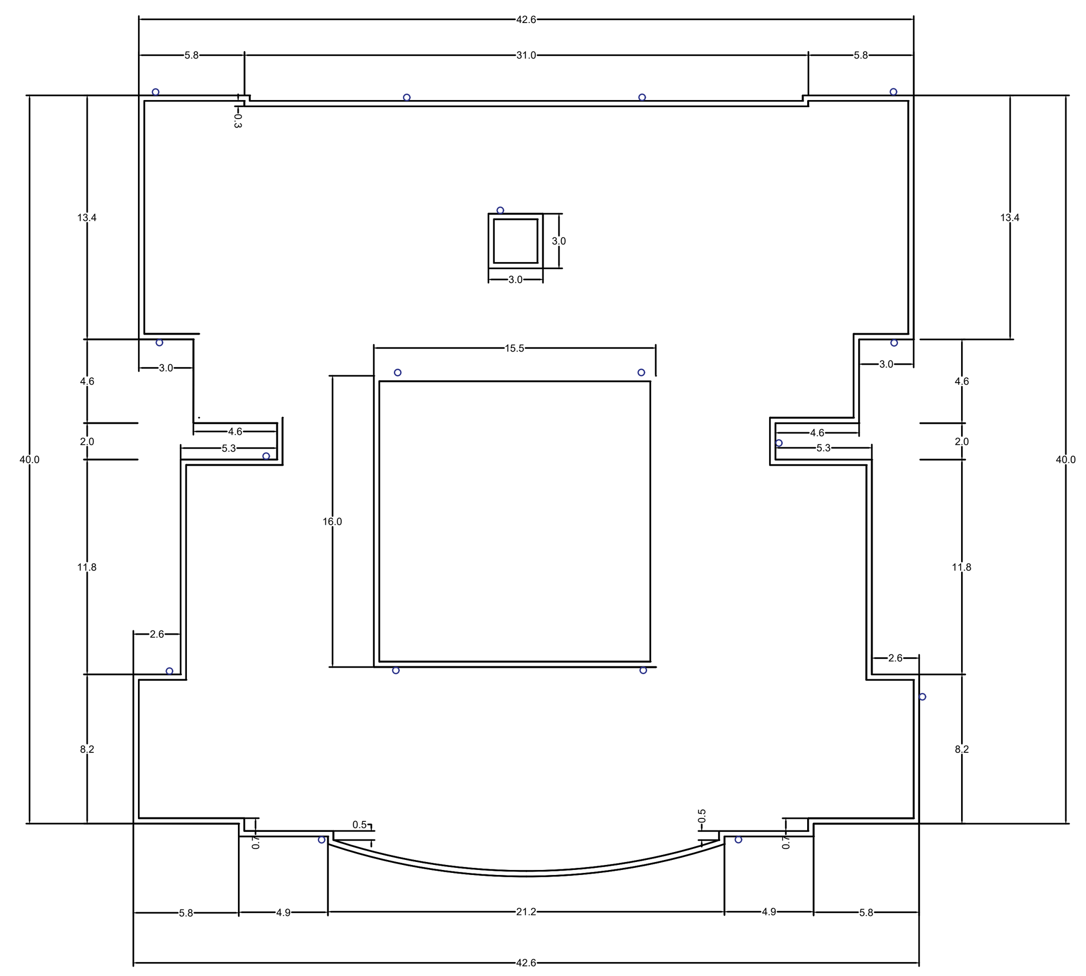

EXISTING ROOF WATER DRAINAGE SYSTEM

(blue line)	EXISTING PIPE SYSTEM
(red line)	PROPOSED PIPE SYSTEM

PROJECT TITLE : RWH AND GROUND WATER RECHARGING IN GCOEARA

SHEET TITLE : PROPOSED RWH SYSTEM - ADMIN BUILDING

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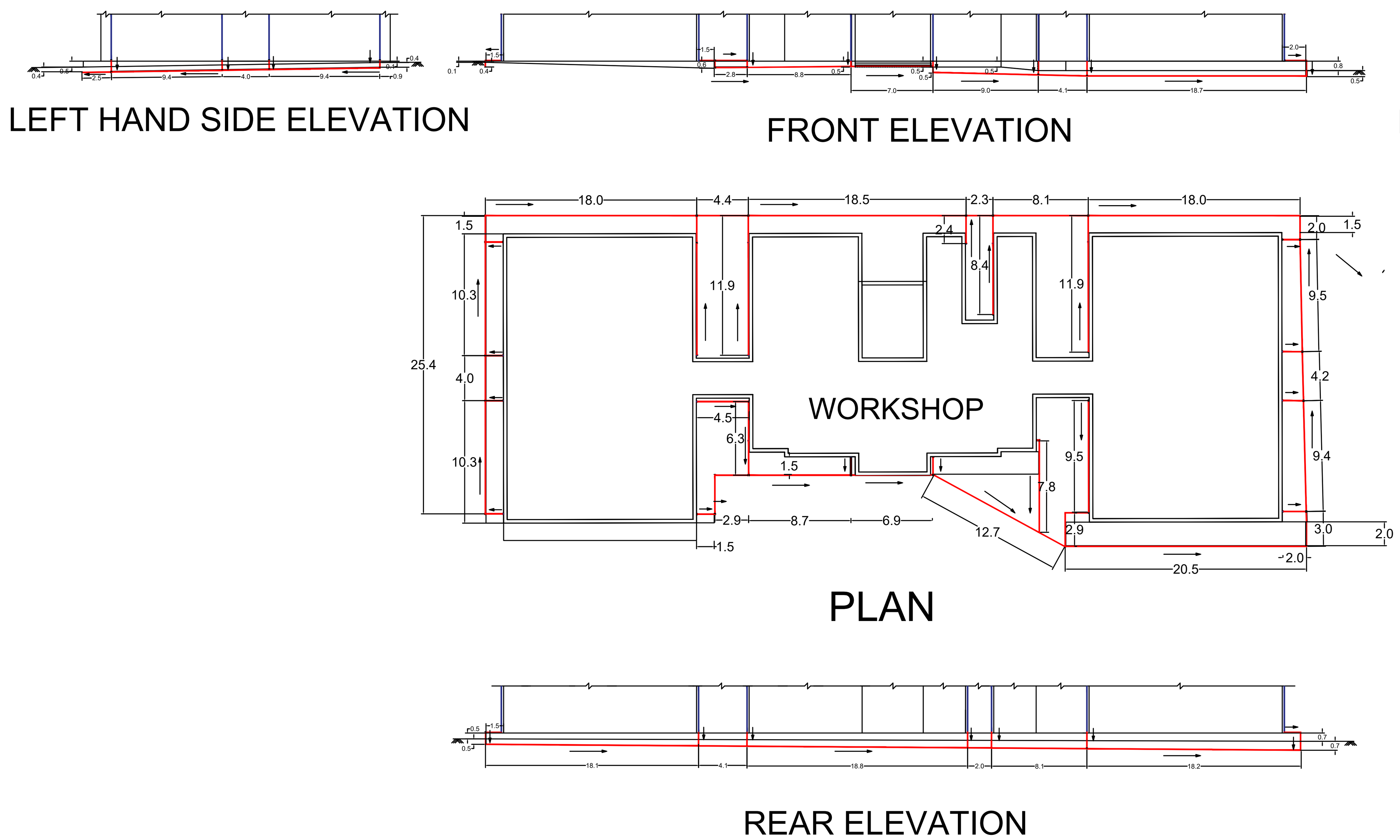

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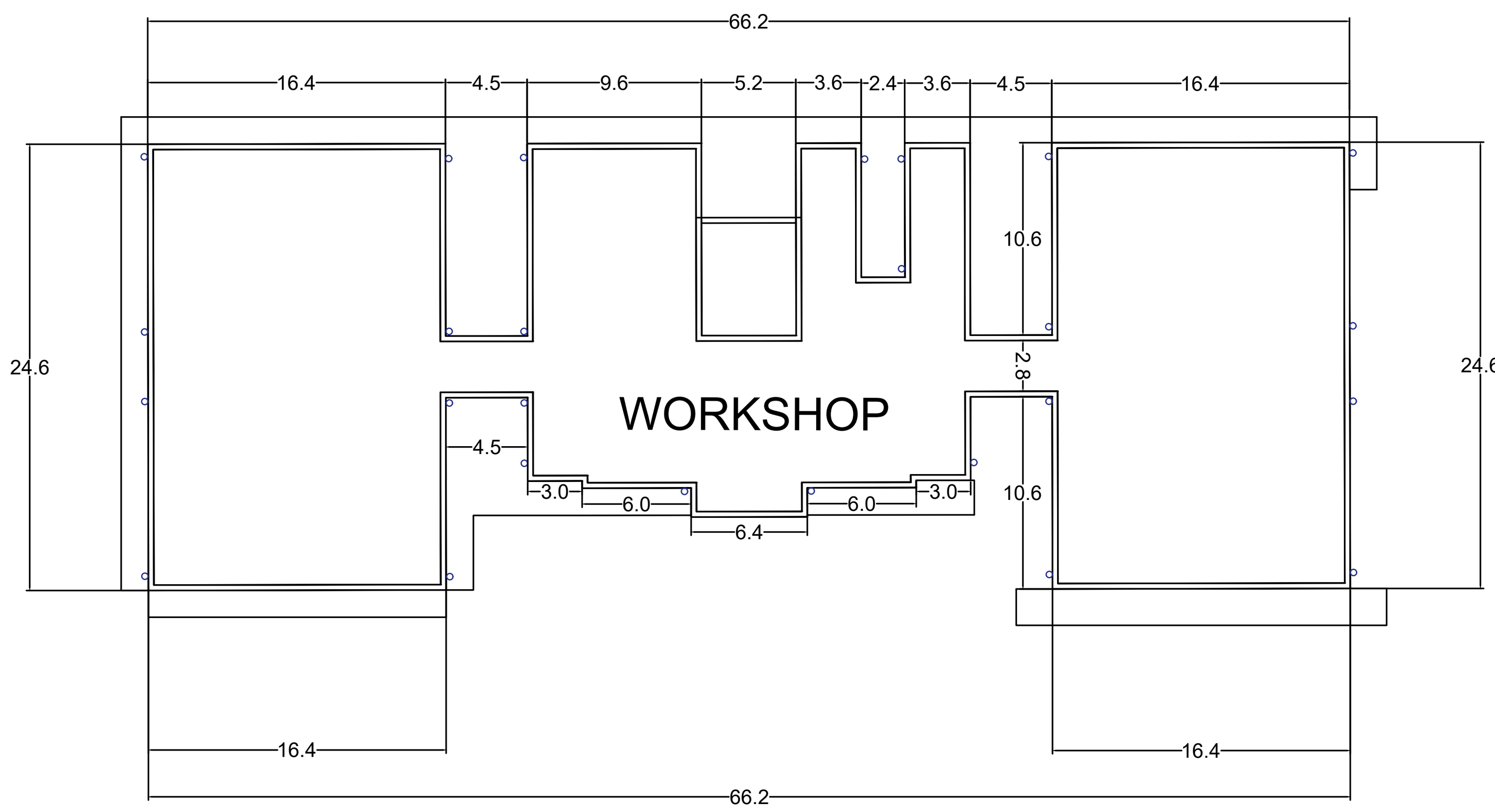

EXISTING ROOF WATER DRAINAGE SYSTEM

	EXISTING PIPE SYSTEM
	PROPOSED PIPE SYSTEM

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SHEET TITLE : PROPOSED RWH SYSTEM - WORKSHOP

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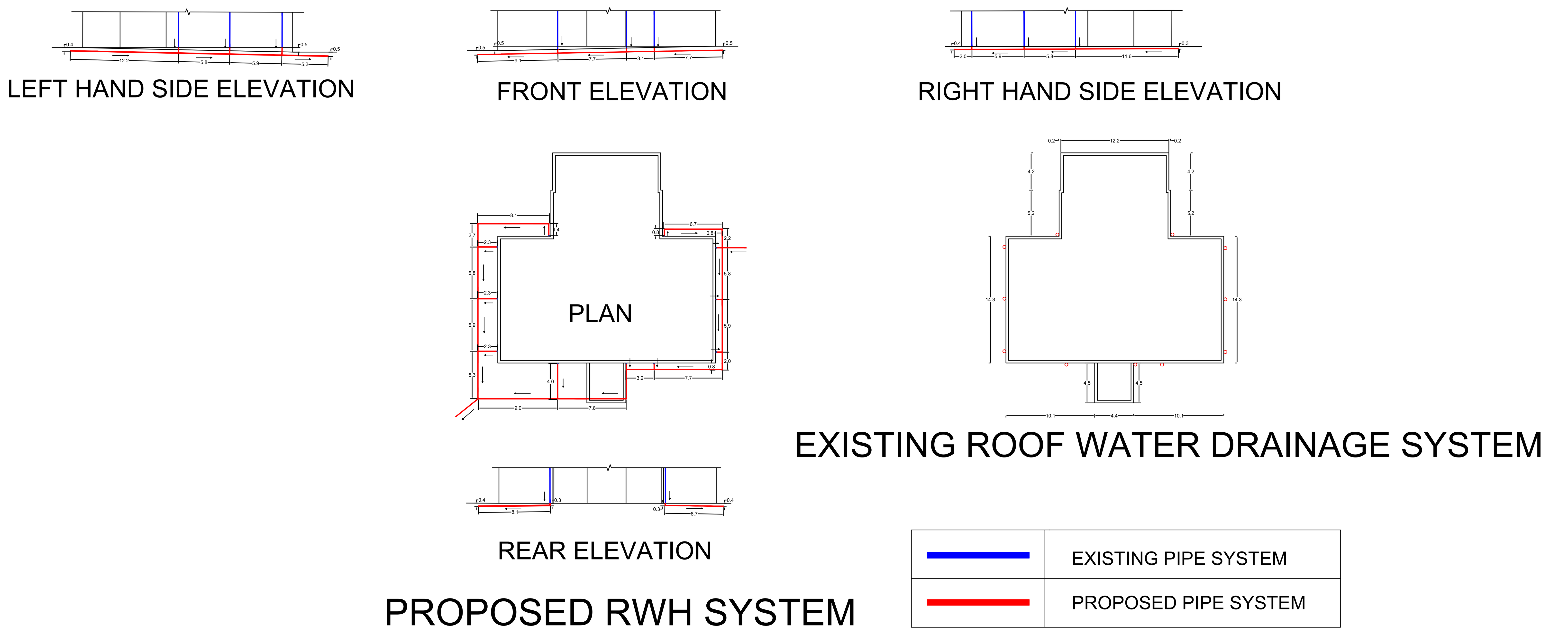

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SHEET TITLE : PROPOSED RWH SYSTEM - MESS

GOVT. COLLEGE OF ENGG. AND RESEARCH, AWASARI (KHURD)		
PROJECT TITLE : RWH AND GWR IN GCOEARA CAMPUS		
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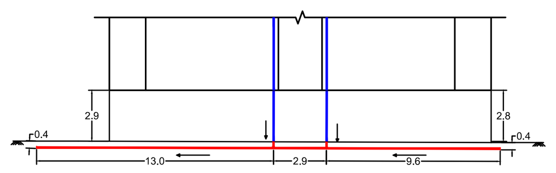

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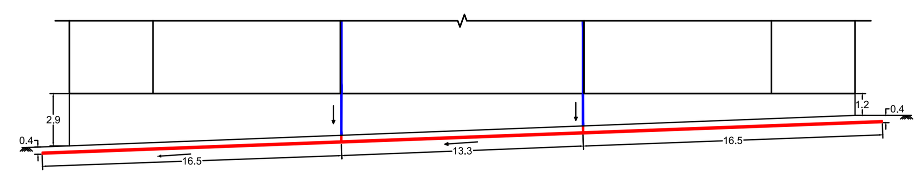

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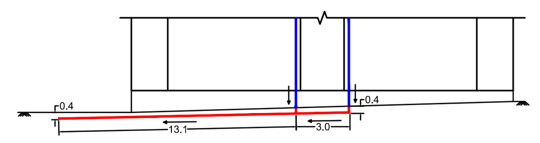

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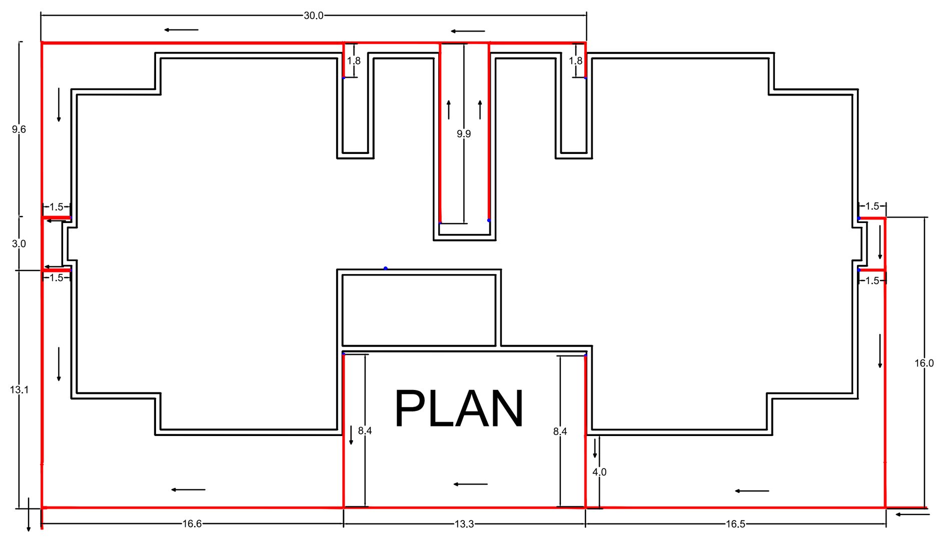

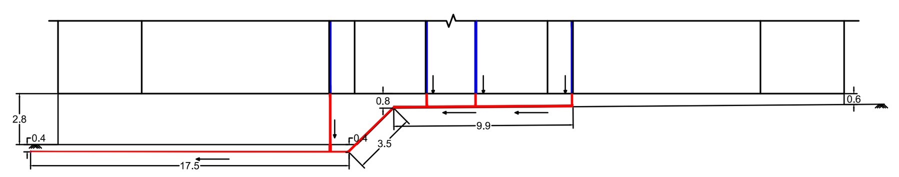

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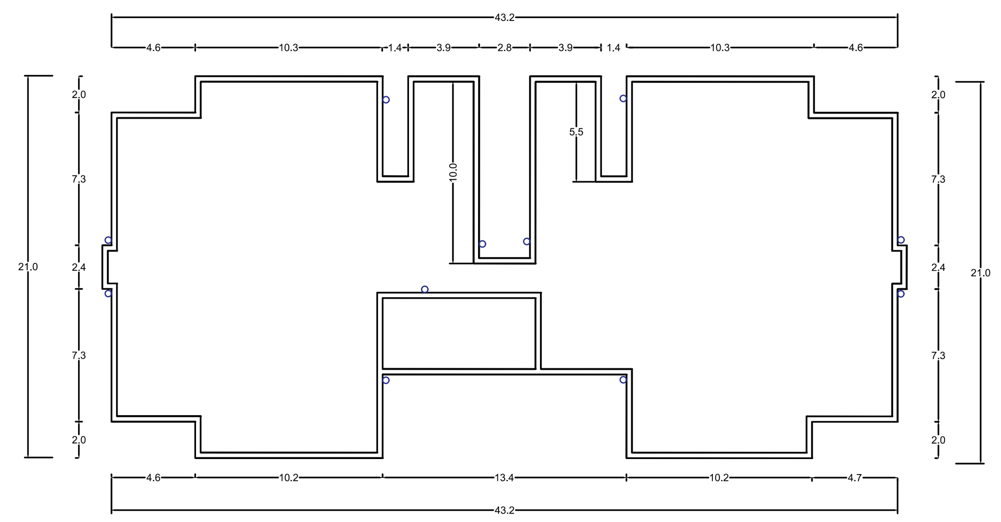

EXISTING ROOF WATER DRAINAGE SYSTEM

	EXISTING PIPE SYSTEM
	PROPOSED PIPE SYSTEM

PROJECT TITLE : RWH AND GROUND WATER RECHARGING IN GCOEARA

SHEET TITLE : PROPOSED RWH SYSTEM - HOSTEL A

GOVT. COLLEGE OF ENGG. AND RESEARCH, AWASARI (KHURD)		
PROJECT TITLE : RWH AND GWR IN GCOEARA CAMPUS		
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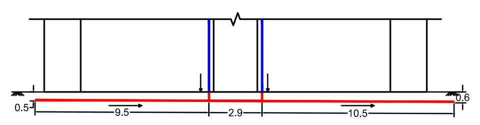

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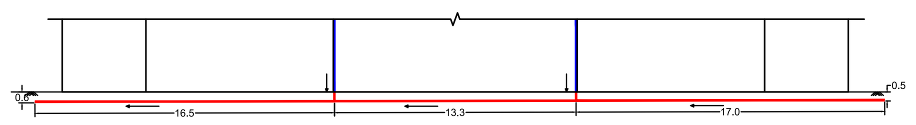

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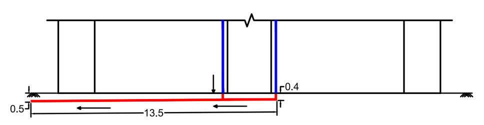

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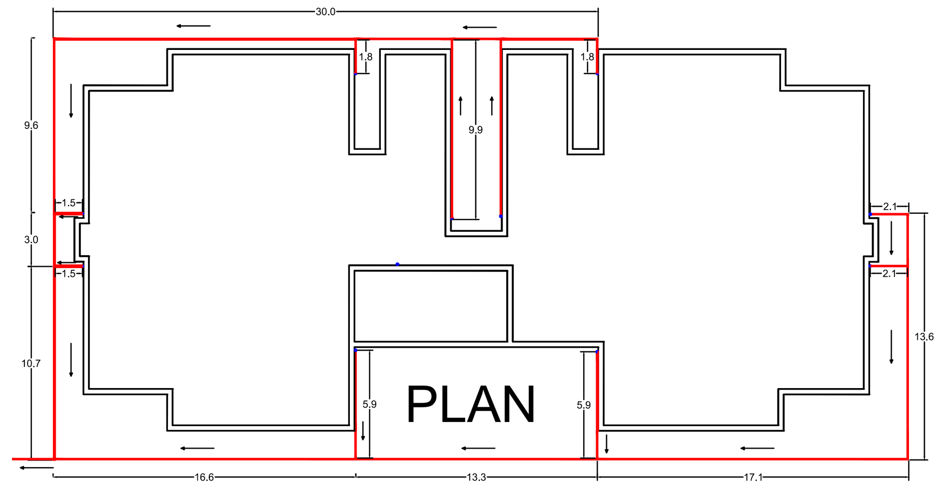

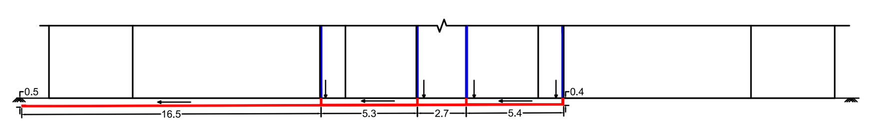

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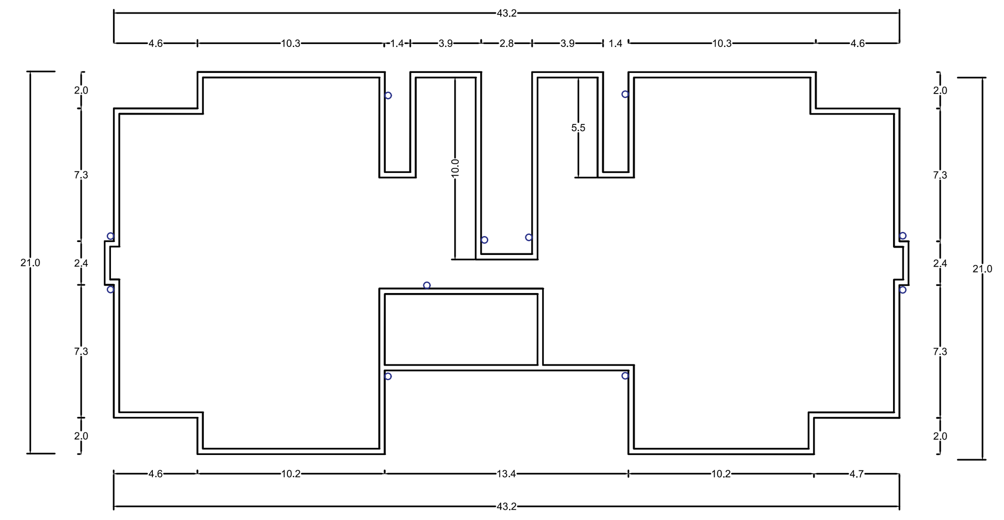

EXISTING ROOF WATER DRAINAGE SYSTEM

PROPOSED RWH SYSTEM

	EXISTING PIPE SYSTEM
	PROPOSED PIPE SYSTEM

PROJECT TITLE : RWH AND GROUND WATER RECHARGING IN GCOEARA

SHEET TITLE : PROPOSED RWH SYSTEM - HOSTEL B

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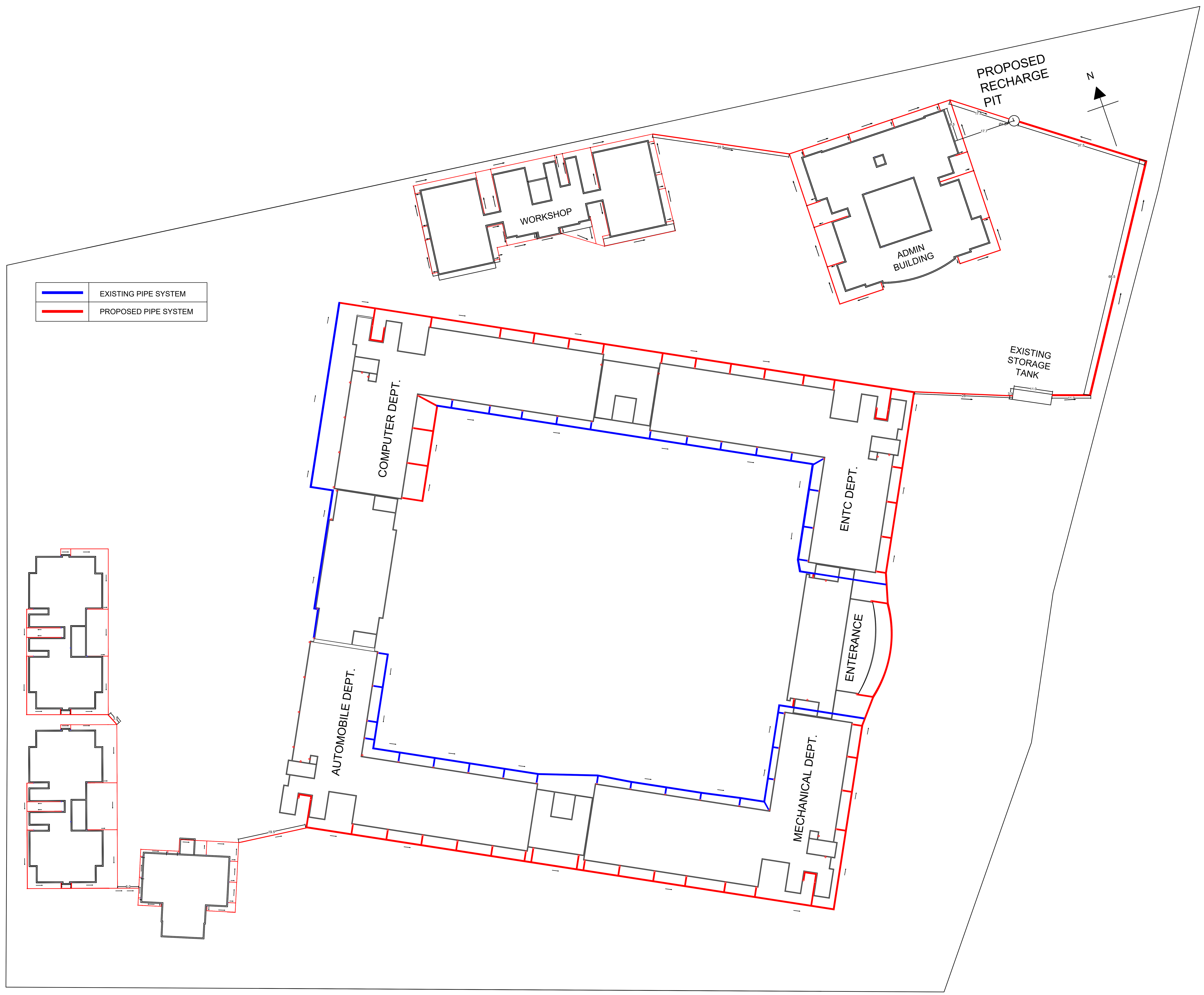

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