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RAIN WATER HARVESTING – A CAMPUS STUDY

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ABSTRACT

Water scarcity is serious problem throughout the world for both urban & rural community. Urbanization, industrial development & increase in agricultural field & production has resulted in overexploitation of groundwater & surface water resources and resultant deterioration in water quality. The conventional water sources namely well, river and reservoirs, etc. are inadequate to fulfill water demand due to unbalanced rainfall.While the rainwater harvesting system investigate a new water source. The aim of the present study is to use rainwater and thus taking close to the concept of nature conservation. In this study, the rain water harvesting (RWH) system is analyzed as a alternative source of water at campus of IIMT College of Engineering, Greater Noida in the state of Uttar Pradesh, India. The expected outcome of the study is the development of rainwater harvesting system for catchment area of campus from parking area, workshop area, some of the electronics department area upto Hostel 'A'. The result analysis shows that the present RWH system is having the storage 30,96,816 litres/year and construction cost of Rs.5 lakhs respectively and is reasonably well in comparison with conventional water sources. The developed system satisfies the social requirements and can be implemented in rural areas by considering almost all the technical aspect.

Keywords: Catchment, Rain water harvesting, Recharge pit, QGIS.

I. INTRODUCTION

Rainwater harvesting is a technology used to collect, convey and store rain water for later use from relatively clean surfaces such as a roof, land surface or rock catchment. RWH is the technique of collecting water from roof, Filtering and storing for further uses. Rainwater Harvesting is a simple technique of catching and holding rainwater where its falls. Either, we can store it in tanks for further use or we can use it to recharge groundwater depending upon the situation. RWH system provides sources of soft, high quality water reduces dependence on well and other sources and in many contexts are cost effective. RWH system is economically cheaper in construction compared to other sources, i.e. well, canal, dam, diversion, etc.

1.1 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 details of the components of rainwater harvesting system has shown in figure 1.

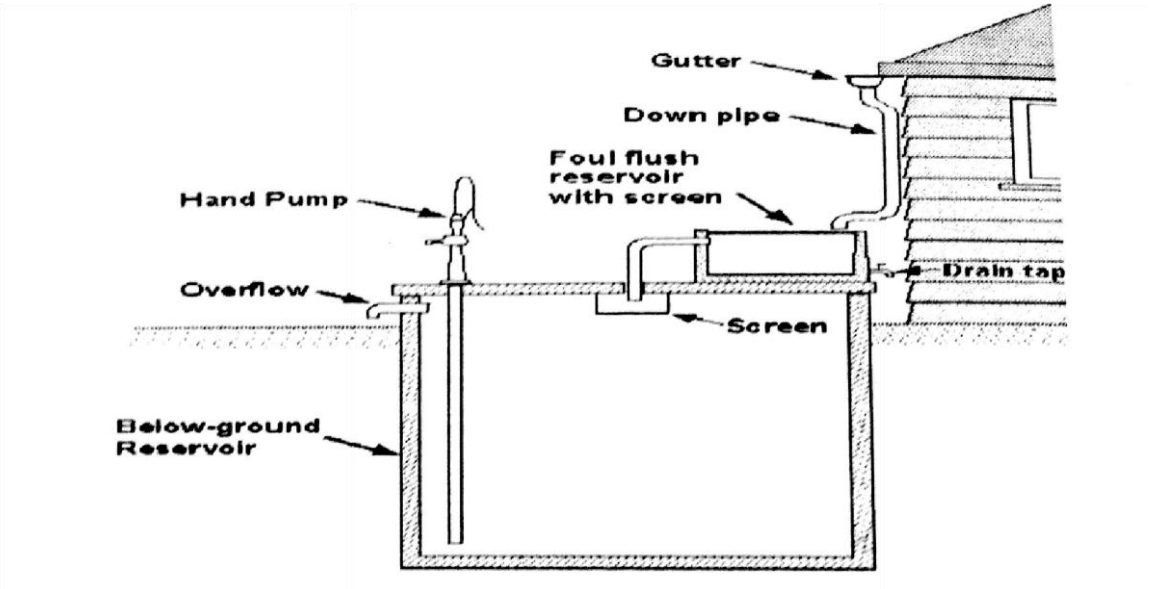

Figure 1: Components of Rainwater Harvesting System

The design and installation of RWH system includes following:

1. Rainwater Catchment and Conveyance
2. Rainwater Storage and Tank Sizing and
3. Rainwater Quality and Treatment

With above literature it is found that the rainwater harvesting system can be developed with qualitative and quantitative approach for the case study under consideration. This paper mainly aims to explore the economic benefit of rainwater harvesting system and the methodology has been demonstrated through application to the IIMT College of Engineering, Greater Noida in the state of Uttar Pradesh, India.

II.HEADINGS

2.1.Area Study

The campus of IIMT College of Engineering, Greater Noida is situated at 28.522^{o} N latitudes and 78.4817^{o} E longitudes and is located in the Delhi NCR region of Uttar Pradesh.KML file of Study area is prepared and shown in figure 2, using Q-GIS software.

Figure 2: Study Area of IIMT Campus

III. MODEL DESCRIPTION

3.1.The Description of the Case Study

The campus of this institute is situated at the centre area of Greater Noida city. The institute is at centre of the campus and surrounded by residential area. The residential accommodation is provided to all faculty staff and students. The total strength of campus including students and staff peoples is more 2000. Thus, with this present strength and also with the expansion, campus should also increase its facilities and maintenance requirements. Thus water is most natural resource being always in high demands by human beings and is indispensable part of the life. Hence, keeping in view all the above problems and status of campus IIMT, Greater Noida, administrative body focussed on water scarcity problem. Therefore, in this situation, rain water harvesting system can be considered as a best solution for fighting against water scarcity in campus.

3.2.Problem Formulation

Design of rainwater harvesting system of IIMT campus using Geographic Information System (GIS). For this taking catchment area of campus from parking area, workshop area, some of the electronics department area up to Hostel 'A'. Demarcate and calculate area by using GIS. The slope of the catchment shall be checked by auto level. Analyse the potential of runoff from the rainfall from the catchment and suggest suitable recharge pit locations and also volume of rainwater to be recharge in the ground. What will be the approximate expenditure for these recharge pits. If the institute wants to construct underground storage tank, what will be the approximate expenditure.

3.3.Design of RWH system

For the proposed location in IIMT campus, visual inspection, survey by Auto level and Geographic Information System (GIS) has been carried out and required analysis is done.

3.3.1 FOR CATCHMENT 1: *(Calculations are for 1 storm, considering intensity of storm as 2 cm/hr)*

Collected data –

1. Catchment area
    1. Rooftop area =4769 m2
    2. Open area =10251 m2

Assume,

2. Average rainfall intensity =4 cm per 2 hr.
3. Runoff coefficient,

    For roof top area = 0.95

    For open area =

0.84Storm duration = 2 hr.

Now, by using rational formula,

For roof top area,

Q = C.I.A /3.6

= $0.95 \times 20 \times 4769 \times 10^{-6}$ /3.6

= 0.02516 m3/sec

For open area,

Q = C I A /3.6

= $0.8 \times 20 \times 10251 \times 10^{-6}$ /3.6

= 0.04556 m3 /sec

Thus, Total runoff = 0.02516 + 0.04556

= 0.07072 m3/sec

Now,

Total runoff volume = peak runoff rate × storm duration

=0.07072×2×3600

= 509.0184 m3

= 509018 lit.

For this volume of water, recharge pit of dimensions 10 m ×10 m ×1.5 m can be constructed. As the topography of the area suggests the two locations, one pit can be constructed beside boy's hostel 'A', on the way of department of electronics. The second pit of same dimension can be constructed behind department of civil engineering, in front of old stage.

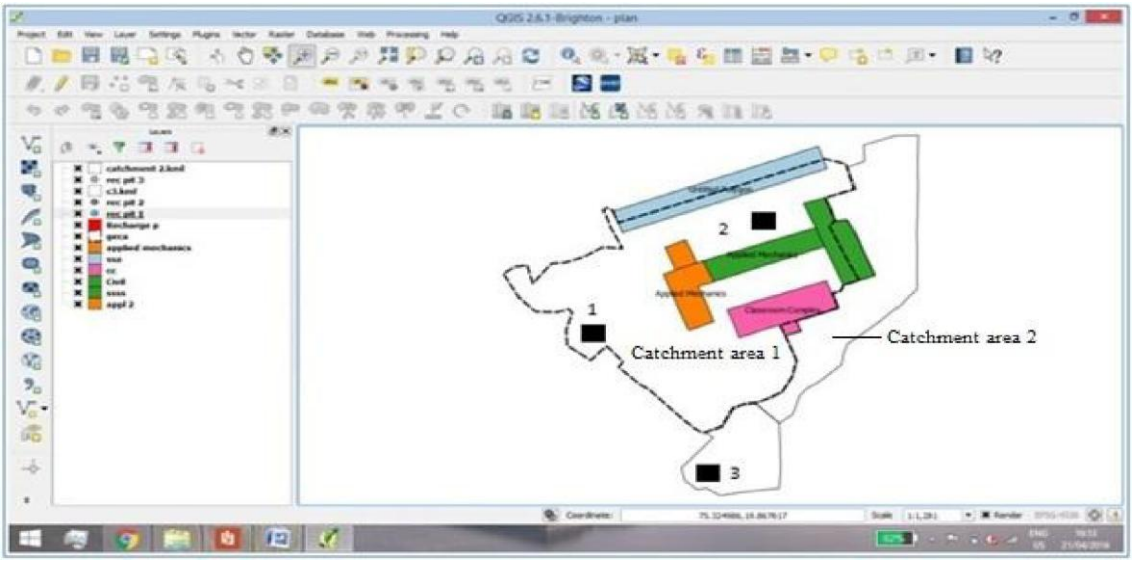

Figure 3: Position of Recharge Pits

3.3.2 FOR CATCHMENT 2: *(Calculations are for 1 storm, considering intensity of storm as 2 cm/hr)*

Collected data –

1. Catchment area

   Open area = 7383.61 m2

Assume,

2. Average rainfall intensity =4 cm per 2 hr.
3. Runoff coefficient

   For open area = 0.8

4. Storm duration = 2 hr.

Now, by using rational formula, For open area,

Q = C I A /3.6

= 0.8 × 20 × 7383.61 × 10-6 /3.6

= 0.03281 m3 /sec

Now,

Total runoff volume = peak runoff rate × storm duration

= 0.03281×2×3600

= 236.232 m3

= 236232 lit.

For this volume of water, recharge pit of dimensions 5 m × 5 m ×1.5 m can be constructed, at the open place available beside boy's hostel, in front of girl's hostel.

Water obstructed in pit:

% water obstructed =18%

For catchment 1:

If we consider a single storm of 2hrs of intensity 2cm/hr then **15.87 %** of rainfall can be obstructed.

For catchment 2:

If we consider annual rainfall data then we can obstruct**19.98%** of rain water.

3.4.DESIGN OF RECHARGE PIT

The recharge pit should be filled with the metal, to recharge silt free water. Hence the materials to be filled in the pit are 60 mm metal, 40 mm metal, 20 mm metal, fine sand. The material should be filled depth wise in the pit. The coarser material to be filled at the bottom and finest on the top. The uppermost fine sand layer can be separated from the 20 mm metal layer by using non corrosive wire mesh. It will help for the yearly maintenance.Depth of material for recharge pits:

3.5.FIGURES AND TABLES

Material to be filled	% depth of material	Depth (in m)
60 mm metal	30 %	0.45 m
40 mm metal	30 %	0.45 m
20 mm metal	20 %	0.30 m
Fine sand	20 %	0.30 m

For the recharge pit 1, 2				
Item No.	Item	Quantity (cu.m.)	Rate	Total cost
1	Excavation	150	140.00/-per cu.m.	Rs. 21000 /-
2	Labour Charges	Lumsum	1000 /- per day	Rs.3000 /-
3	Materials (60,40,20mm metal)	150	804.25/-per cu.m	Rs. 120637.5/-
			Total	Rs. 144637.5 /-
TOTAL=Cost of 2 pits=2×144637.5=				**Rs. 289275 /-**
For the recharge pit 3				
Item No.	Item	Quantity (cu.m.)	Rate	Total cost
1	Excavation	37.5	140.00/-per cu.m.	Rs. 5250 /-
2	Labour Charges	Lumsum	1000 /- per day	Rs. 2000 /-
3	Materials (60,40,20mm metal)	37.5	804.25/-per cu.m	Rs. 30159 /-
			Total	**Rs. 37409.375 /-**
Underground storage tank				

Item No.	Item	Quantity (cu.m.)	Rate	Total cost
1	Excavation	37.5	140 /- per cu.m.	Rs. 5250 /-
2	P.C.C (1:2:4)	5.40	4010 /- per cu.m.	Rs. 21686 /-
3	BBM (1:6)	12.25	4454 /- per cu.m.	Rs. 44540 /-
4	R.C.C (1:2:4)	15	4819 /- per cu.m.	Rs. 72285 /-
5	Plaster (1:4)	60	74 /- per cu.m.	Rs. 4440 /-
6	Labour Charges	Lumsum	2000 /- per day	Rs. 2000 /-
			Total	**Rs. 182052.875/-**
			Grand Total	**Rs. 508737.25 /-**

Total Cost of RWH system = Cost of Recharge pit 1 + Cost of Recharge pit 2 + Cost of Recharge pit 3 + Cost of Underground Tank

= Rs. 144637.5 /- + Rs. 144637.5 /- + Rs. 37409.375 /- + Rs. 182052.875/-

= Rs. 508737.25 /-

IV. RESULTS AND DISCUSSIONS

1. Design of rainwater harvesting system of IIMT Campus is done using Geographic Information System (GIS).
2. For Catchment 1:

   Runoff potential for one storm of two hours = 5,09,018liters

   For recharge, size of recharge pit (1&2 each) is taken as = 10 m x 10 m x 1.5 m % of runoff from rainfall obstructed and recharge in pit = 58.9 % = 2,99,811liters
3. For Catchment 2:

   Runoff potential for one storm of two hours = 2,36,232liters

   For recharge, size of recharge pit (3) is taken as = 5 m x 5 m x 1.5 m

   % of runoff from rainfall obstructed and recharge in pit = 15.87 % = 37,490 litres

4. Total annual runoff potential from catchment area considered (1 & 2): 1,19,24,000liters
5. Total annual recharge through pits: 30, 96, 816 litres
6. Filter material for filling the recharge pit is decided as 60 mm metal (30% depth), 40 mm metal (30% depth), 20 mm metal (20% depth), Fine sand (20% depth)
7. Approximate expenditure for: Recharge pit 1: Rs. 1,44,637.5/-
   Recharge pit 2: Rs. 1,44,637.5/-
   Recharge pit 3: Rs. 37,409.375/-
8. Approximate expenditure for underground storage tank (5 m x 5 m x 1.5 m) (Optional) is Rs. 1,82,052.875/-
9. Recharge pit/underground tank can be connected to bore well for bore well recharge.

V. CONCLUSION

Recharge of ground water table is a gradual process, we can not suddenly increase the ground water table after constructing recharge structures, by constructing any type of recharge structure, and we can give our contribution in aquifer recharge. This will help to rejuvenate the depleting ground water resources. Also help to save the little amount of rain water which used to drain away from many years. Thus it is concluded that implementation of RWH system of IIMT College of Engineering Greater Noida campus would result in the form of the best approach to deal with present scenario of water scarcity and storing huge quantity of 30,96,816 litres in a year in college campus.

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