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Rain Water Harvesting – "At Utsav Residency Complex Residential Campus"

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Abstract - **Water scarcity is a serious problem worldwide for both rural as well as urban communities. Industrial development, urbanization as well as rise in agricultural area along with production resulted in groundwater as well as surface water resources' overexploitation and consequently deterioration of water quality. Because of imbalanced precipitation, conventional water resources including rivers, wells, along with reservoirs, etc. have been insufficient in meeting demand for water. Nevertheless, RWH(rainwater harvesting) system explores novel water resource. Current research's goal has been to utilize rainwater hence move closer to nature conservation's view. In research, RWH system has been analysed as alternate water source in Utsav Residency Complex Campus DDA Flat Sector-34 Rohini Delhi Government, India. Anticipated research's result has been RWH system's development for catchment area of the Utsav residency complex from parking area, play-ground area, Garden area, Store area, Angan Badi & Community Hall area, Yoga centre area and some of the open footpath area. Outcome analysis indicates current RWH system possesses storage 5786036litres/year as well as construction expense Rs.18.06lakhs respectively, and is comparatively enough when evaluated against traditional water sources. Developed approach meets societal needs as well as can be applied in both rural as well as urban regions by addressing almost all technological aspects.**

Keywords - Catchment, Recharge pit, Rain water harvesting, AutoCAD, Google Earth.

INTRODUCTION

RWH has been an approach utilized in collecting, carrying as well as storing rainwater for utilizing from relatively cleaner areas including rocky catchment area or land surface, roof, later. RWH is water collecting approach from the roof, filtering it moreover storing it for future use. RWH has been non-complex approach of collecting rainwater, trapping it to location of descent. It could be stored in tanks for subsequent utilization or employed in replenishing groundwater, reliant upon circumstances. RWH systems gives high quality water, soft source, reduce reliance on wells along with other sources are cost effective in numerous scenarios. RWH systems construction has been cheaper economically when compared with other resources, including canal, well, diversion, dam etc.

COMPONENTS OF RAINWATER HARVESTING SYSTEM:

RWH method consists following elements- rainwater transportation via drains or pipes, filtration, as well as tank for storing gathered water. RWH system components' details have been illustrated in figure:

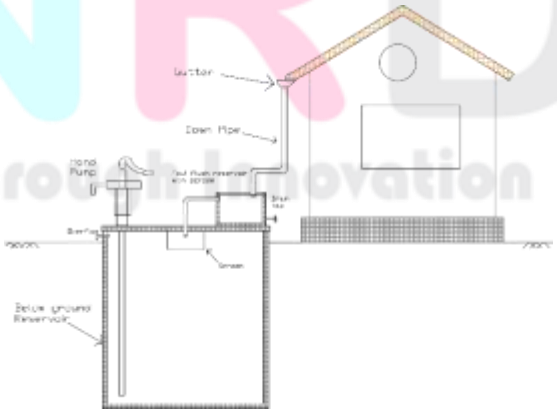

FIGURE I
RWH SYSTEM COMPONENTS

RWH system's installation as well as design involves:

1. RWH as well as conveyance
2. Sizing of rainwater tank as well as storage
3. Quality as well as treatment of rainwater

Aforementioned literature shows RWH system could be deployed using quantitative as well as qualitative method for considered case study. The main objective of this paper is about exploring RWH system's economic benefits as well as methodology is illustrated via application at Utsav Residency, DDA Complex, Pocket-3 Sector 34, Rohini New Delhi-110034, India.

STUDY AREA

The Utsav Residency DDA Complex, Sector-34 Rohini Delhi, is situated 28°46'10.45 N latitudes and 77° 4'19.41 E longitudes moreover is located in North West District of Govt of NCT of Delhi, India. KML file research region had been prepared moreover utilized in fig2 & 3, utilizing Google Earth software.

FIGURE II
STUDY AREA OF UTSAV RESIDENCY COMPLEX RESIDENTIAL CAMPUS

MODEL DESCRIPTION

Case Study description: Utsav Residency Complex is located in the North-West district of New Delhi city. This residency complex is surrounded by other residential complex area of DDA flats which are defined by different pocket names, such as Pocket 1,2,3 and so on. The area of this residential complex is 15.16 acres, which includes all 5 storey buildings. This residential complex has six blocks of 1 BHK LIG flats, namely A, B, C, D, E, F. Total units' number is2680 and the population of its residential complex is more than 3000. Thus, with the current capacity and expansion, the residential complex has to rise its amenities along with its' maintenance requirements. Hence, water has been most natural resource which has always been in high demand by humans moreover has been life's essential part. Hence, considering all preceding issues along with status of Utsav residency DDA complex Rohini, RWA or housing society focused on WS(water scarcity) problem. Hence for this case, RWH system may serve as considerably optimum solution to combat against campus' WS.

FIGURE III
CAD LANDSCAPING FOR SHOWING POSITION OF RECHARGE PITS & UNDERGROUND STORAGE TANK

PROBLEM FORMULATION

RWH system design in Utsav Residency Complex is made using Google Earth software. Here, residency's catchment area has been derived from parking area, playground, garden area, store area, patio and community hall area, yoga center area and some open footpath area. Area is demarcated and calculated using Google Earth software. Slope of catchment area Will be verified by auto level. Analyze rain runoff's probability from catchment area moreover indicate appropriate recharge pit location along with rainwater's amount for recharging into ground. What would be projected cost for these recharging pits. If complex authority intends in constructing underground storage tank. What would be estimated cost.

DESIGN OF RWH SYSTEM:

Proposed geographical position in Utsav Residency Campus premises has been surveyed by visual inspection, auto-level as well as Geographic Information System GIS and necessary analysis can be performed.

FOR CATCHMENT 1: (CALCULATIONS ARE FOR 1 STORM, CONSIDERING INTENSITY OF STORM AS 2 CM/HR)

Collected Data-

1. *Catchment area*
   - *Rooftop = 10050m^2*
   - *Road/paved area= 25212m^2*

Assume,

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

- *For roof top area=0.95*
- *For Road/paved area=0.65 (Source: Center of science and Environment, 2010)*

4. *Storm duration=2hr.*

Utilizing a rational computation,

For roof top area, Q=C.I.A/3.6
= 0.95×20×10050×10^{-6}/3.6
= 0.05304m^3/sec

For Road paved area, Q = C I A /3.6
= 0.65 × 20 × 25212 × 10^{-6} /3.6
= 0.09104 m3 /sec

Hence, Total runoff=0.05304+0.09104
=0.1440 m^3/sec
Now,

Complete runoff volume=peak runoff rate× storm duration
= 0.1440×2×3600
= 1036.80m^3
*= **1036800lit.***

Regarding this water's volume, recharge pits of dimensions 10m×10m×1.5m could be constructed. As area's topography indicates 2locations, 1pit might be built beside Block-E corner and another Block-A corner respectively corner Parking side.

FOR CATCHMENT 2: (CALCULATIONS ARE FOR 1 STORM, CONSIDERING INTENSITY OF STORM AS 2 CM/HR)

Collected Data-

1. *Catchment area*
- *Rooftop = 9246m^2*
- *Road/paved area= 17431m^2*

Assume,
2. *Average rainfall intensity=4cm/2hr.*
3. *Runoff coefficient,*

- *For roof top area =0.95*
- *For Road/paved area=0.65 (Source: Center of science and Environment, 2010)*

4. *Storm duration = 2hr.*

Now, by employing rational formula,

For roof top area, Q=C.I.A /3.6
=0.95×20×9246×10^{-6} /3.6
= 0.04879m^3/sec

For Road/paved area, Q = C I A /3.6
= 0.65×20×17431 × 10^{-6} /3.6
=0.06294m3 /sec

So, Total runoff= 0.04879 + 0.06294
= 0.1117m^3/sec
Next,

Total runoff volume=peak runoff rate×storm duration
= 0.1117×2×3600
= 804.24 m3
*= **804240 lit***

Volume of water, recharge pits of dimensions5m×5m×1.5m might be constructed. As topography area indicates 2locations, 1pit might be constructed beside Block-D another Block-C corner respectively corner Parking side.

WATER OBSTRUCTED IN PIT:

% of water obstructed= volume of recharge in pit
---------- x100
total run off

For catchment 1:	For catchment 2:
• Considering 1storm lasting 2hours with an intensity of 2cm/hr,28.93% of the rainfall can be hindered. • Considering annual rainfall statistics, we can capture33.40% of rainwater.	• Considering 1storm lasting 2hours with an intensity of 2cm/hr, 9.32% of rainfall can be hindered. • Considering annual rainfall statistics, we can capture13.52% of rainwater.

DESIGN OF RECHARGE PIT

Recharge pit must be metal-filled, for recharging silt free water. Therefore, materials must be filled in pit have been 60mm stone aggregate (SA), 20mm SA,40mm SA along with fine sand. Material must be filled in pit to certain depth. Coarser material should be placed at bottom, while finest material should be positioned at top. Top fine sand layer could be distinguished from 20mm SA layer utilizing non-corrosive wire mesh. It will assist with annual maintenance.

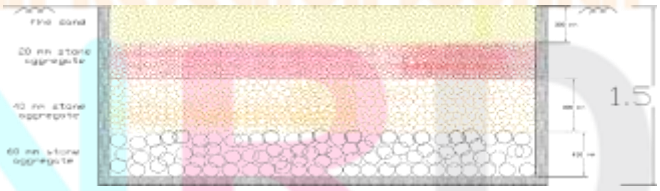

FIGURE IV
CAD DESIGN OF RECHARGE PIT

Depth of material for recharge pits:

Materials to be filled	%depth of material	Depth(in m)

60mm stone aggregate	30%	0.45m
40mm stone aggregate	30%	0.45m
20mm stone aggregate	20%	0.30m
Fine sand	20%	0.30m

ESTIMATION AND COSTING FOR RECHARGE PIT 1 & 4

S.No.	DSR CODE	Item Descriptions	Nos	Unit	L	B	H/dep	Qty.	Rate	Amount
1	2.8.1	Excavation earthwork utilizing mechanical (hydraulic excavator) or manual methods in foundation trenches or drains (not exceeding 1.5m in width or 10m^2 in area), encompassing dressing of sides as well as ramming of bottoms, with lift of up to 1.5m, including removal of excavated soil as well as disposal of surplus soil as instructed, within lead of 50m. All Types of Soil.	2	cum	10	10	1.5	300	252.30	75690.00
2	291	Stone Aggregate (Single size) : 63mm nominal size	2	cum	10	10	0.45	90	1000	90000.00
3	293	Stone Aggregate (Single size) : 40mm nominal size	2	cum	10	10	0.45	90	1300	117000.00
4	295	Stone Aggregate (Single size) : 20mm nominal size	2	cum	10	10	0.30	60	1350	81000.00
5	983	Fine sand (zone IV)	2	cum	10	10	0.30	60	900	54000.00
6	2206	Stone aggregate Carriage 40mm nominal size n above		cum				180	112.79	20302.20
7	2202	Stone aggregate Carriage below 40mm nominal size		cum				120	103.77	12452.40
Total										450444.60
Add GST 18 %										81080.03
GRAND TOTAL										531524.63
SAY										531525

ESTIMATION AND COSTING FOR RECHARGE PIT 2 & 3

S.No.	DSR CODE	Item Descriptions	Nos	Unit	L	B	H/dep	Qty.	Rate	Amount
1	2.8.1	Excavation of earth using mechanical (hydraulic excavator) or manual methods in foundation trenches or drains (not greater than 1.5m in width or 10m^2 in area), that include dressing of sides as well as ramming of bottoms, with lift of upto 1.5m, as well as removal along with disposal of surplus excavated soil as instructed, within lead of 50m. All types of soil.	2	cum	5	5	1.5	75	252.30	18922.50
2	291	Stone Aggregate (Single size) : 63 mm nominal size	2	cum	5	5	0.45	22.5	1000	22500.00
3	293	Stone Aggregate (Single size) : 40 mm nominal size	2	cum	5	5	0.45	22.5	1300	29250.00
4	295	Stone Aggregate (Single size) : 20 mm nominal size	2	cum	5	5	0.30	15	1350	20250.00
5	983	Fine sand (zone IV)	2	cum	5	5	0.30	15	900	13500.00
6	2206	Carriage of Stone aggregate 40 mm nominal size and above		cum				45	112.79	5075.55
7	2202	Carriage of Stone aggregate below 40 mm nominal size		cum				30	103.77	3113.10
Total										112611.15
Add GST 18 %										20270.01
GRAND TOTAL										132881.16
SAY										132881

ESTIMATION AND COSTING FOR Underground Storage Tank 02 Nos 10mx10mx1.5

S.No.	DSR CODE	Item Descriptions	Nos	Unit	L	B	H/dep	Qty.	Rate	Amount
1	2.8.1	Excavation of earth using mechanical (hydraulic excavator) or manual methods in foundation trenches or drains (not greater than 1.5m in width or 10m^2 in area), that include dressing of sides as well as ramming of bottoms, with lift of upto 1.5m, as well as removal along with disposal of surplus excavated soil as instructed, within lead of 50m. All types of soil.	2	cum	10	10	1.5	300	252.30	75690.00
2	4.1.3	Executing as well as placing cement concrete of defined grade, minus centering expenses along with shuttering, for all work up to plinth level: every work upto plinth level: 1cement : 2coarse sand (zone-III) : 4graded stone aggregate (1:2:4 20mm nominal size)	2	cum	10	10	0.075	15	6788.60	101829.00
3	4.1.2	Executing and placing cement concrete of defined grade, minus the expenses for centering and shuttering, for all work up to plinth level: - Every work upto plinth level: 1 Cement: 1½ coarse sand (zone-III) : 3 graded stone (1:1½:3 aggregate 20mm nominal size)	2	cum	10	10	0.075	15	7210.55	108158.25
4	6.1.2	Brickwork utilizing F.P.S. common burnt clay (non-modular) bricks having class designation 7.5 in plinth as well as foundation: in:Cement mortar 1cement : 6coarse sand (1:6)	2	cum	40	0.225	1.5	27	6157.45	166251.15
5	13.1.2	CEMENT PLASTER (IN FINE SAND) 1:6 (1 cement: 6 fine sand)	2	sqm				1618	254.25	411376.50
6	13.18	Neat cement punning	2	sqm				1618	2.2	3559.60
7	5.22.1	R.C.C. ‘s Steel reinforcement in work like cutting, straightening, placing in position bending, as well as binding all finished upto plinth level.	2	kg				1235	82.1	101393.50
Total										968258.00
Add GST 18 %										174286.44
GRAND TOTAL										1142544.44
SAY										1142544

Total Cost of RWH system = Cost of Recharge pit *1&4* + Cost of Recharge pit *2&3* + Cost of Underground Tank-*1&2.= Rs. (531525+132881+1142544)/-* **= *Rs. 18,06,950 /-***

RESULTS AND DISCUSSIONS

1. RWH system's design of Utsav Residency complex campus has been done utilizing Google Earth software & AutoCAD software.
2. For Catchment 1:
   - Runoff potential during a 2h storm = *1036800litres*
   - The dimensions of the recharging pit (1 and 4 each) are specified as =*10m x 10m x 1.5m*
   - % of runoff from rainfall obstructed and recharge in pit = *28.93% = 299946litres.*
3. For Catchment 2:
   - Runoff potential during a 2h storm= *804240litres*
   - For recharge, size of recharge pit (2 & 3) is taken as = *5m x 5m x 1.5m*
   - % of runoff from rainfall obstructed and recharge in pit = *9.32% = 74955L.*
4. *Total yearly runoff potential from the examined catchment areas (1 & 2): 28412325litres.*
5. *Total annual recharge through pits: 5786036litres.*
6. Filter material for filling the recharge pit is decided as 60mm stone aggregate *(30% depth),* 40mm stone aggregate (30% depth), 20mm stone aggregate *(20% depth), Fine sand (20% depth).*
7. Approx cost for:

Recharge pit1&4: *Rs.531525/-*

Recharge pit2&3: *Rs.132881/-*

8. Approx cost for02 nos. of underground storage tank *(10mX10mX1.5m) (Optional) is Rs.1142544/-*
9. Recharge pit/underground tank could be connected with bore-well for it's recharge

CONCLUSION

Recharging ground water level has been a gradual procedure, we could not rise ground water level suddenly by constructing recharge structures, we might contribute in aquifer recharge. This will assist in reviving depleting ground water resources. Moreover, it will assist in saving small rain water amount that is utilized in flowing away for many years. Hence, concluded RWH system's implementation in Utsav Residency Complex premises will prove to be optimal way of dealing with current WS situation as well as store 5786036 liters' big amount annually in residential complex.

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